→ 6th ESA ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

Practicals on Land Cover Land Use D3P1b

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Practicals on Land Use/Cover & Change Detection

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Tutorial

Basics for image visualization and processing

in ArcGIS

ArcGIS is a GIS software that contain some image processing tools. In this tutorial we will demonstrate how to use some of the basic image visualization and processing utilities of this software.

ArcGIS desktop has the following modules:

ArcMap – it is an application for desktop geographic information systems (GIS) and mapping. ArcMap provides all the tools you need to put your data on a map and display it in an effective manner.

ArcCatalog – after connecting to a folder, database, or geographic information system (GIS) server, you can browse through its contents with ArcCatalog. You can look for the map you want to print, draw a coverage, examine the values in a table, and find out which coordinate system a raster uses or read about why it was created.

ArcToolbox – it provides a way to create new information by applying a pre-defined operation to existing data. Any alteration or information extraction you want to perform on your data involves a geoprocessing task. It can be a simple task, such as converting geographic data to a different format, or it can involve multiple tasks performed in sequence, such as those that clip, select, and then intersect datasets.

The visualization tools are mainly explored in the ArcMap module. Next, in this tutorial, we will be showing you how to:

1. Open an existent project in ArcMap
2. Import image data into ArcMap
3. Browse trough an image using ArcMap visualization tools
4. Browse trough an image using ArcMap Bookmarks
5. Basic image enhancements
6. Create an image stack

1. Open an existent project in ArcMap

a) *File → Open* (Figure 1); select the ArcMap project file (*.mxd);

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Supervised classification in ArcGIS

The supervised classification in ArcGIS is implemented with the several functions of the *Multivariate Tool* of the ArcToolbox.

For doing a supervised classification in ArcGIS you have to follow the steps:

1. Import input data into ArcGIS – ArcMap
2. Collect samples for training the algorithm
3. Specific sample visualization
4. Create signatures
5. Analysis of the training samples
6. Edit signatures
7. Run the supervised classification algorithm – the maximum likelihood is the only available supervised algorithm in ArcGIS
8. Apply a pre-existent symbology to the produced map

1. Import input data into ArcGIS – ArcMap

a) *File → Add data* (Figure 1); select the stack file if importing multi-band images

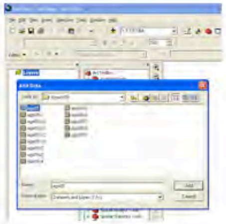

Figure 1

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Exercise

Land cover mapping with very high spatial resolution data using a multi-stage classification approach

Exercise rational

In land cover map nomenclatures, classes usually define landscape units (e.g. Forest, Agriculture, Urban areas – see Fig 1). Nevertheless, the pixel of an IKONOS image, due to its small size (PAN: 1 m; MS: 4 m), does not represent landscape units. On the contrary, it identifies components of those units, which can be designated by surface elements (e.g. water, non-vegetated area, eucalyptus tree crown, cork tree crow, shadow – see Fig 2). Due to this constraint, development of land cover maps (landscape units maps) with these images cannot make use of simple per-pixel classifications.

Fig 1. Landscape units representing forest areas.

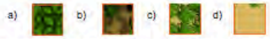
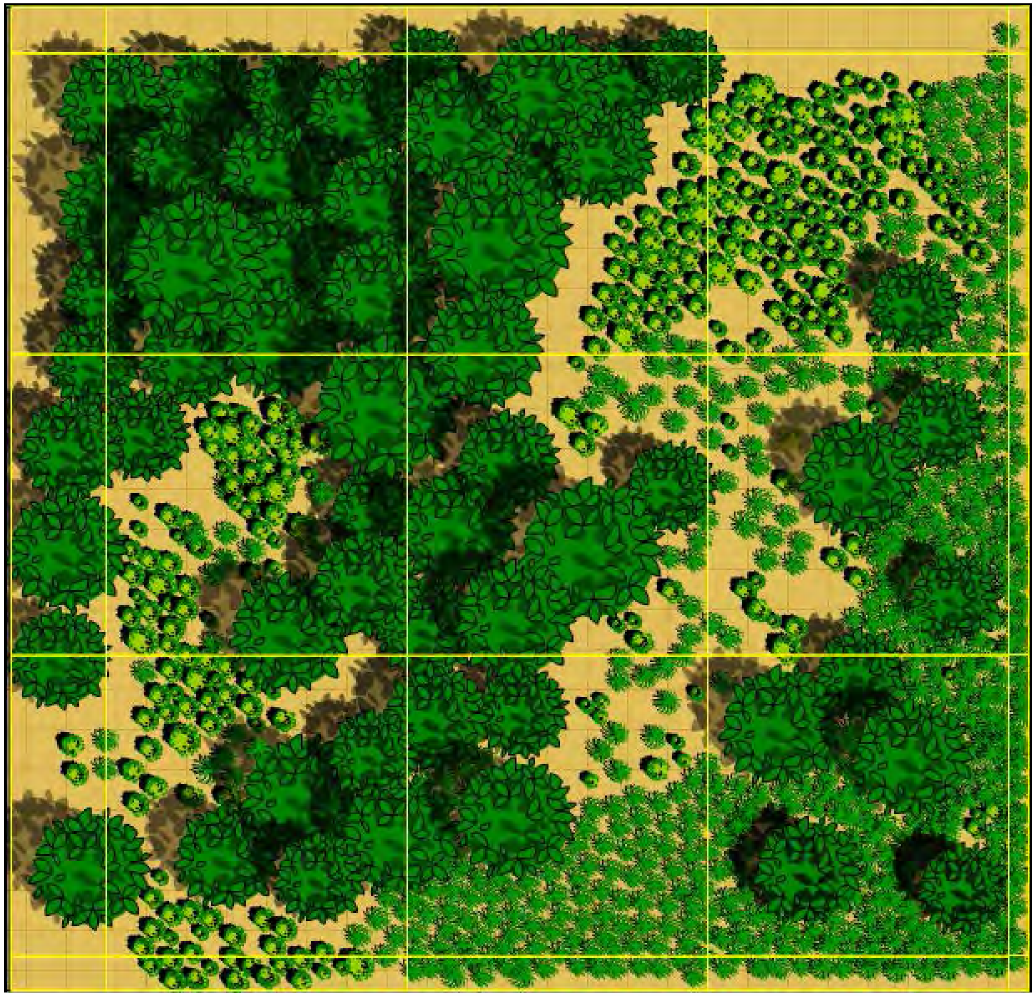


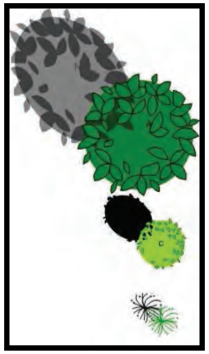
Fig 2. IKONOS pixels representing surface elements: a) tree crown; b) shadow; c) herbaceous; d) bare soil.

In this exercise we apply a methodology developed in the Remote Sensing Unit of the Portuguese Geographic Institute (IGP) to produce a Landscape Units Map (LUP) with an IKONOS image. In brief, the methodology (Fig 3) consists in image classification at the pixel level, producing a Surface Elements Map (SEM). The IKONOS image is also segmented to derive a Map of Objects (MO), i.e. landscape units. Then the MO is overlaid on the SEM. A set of rules is then created to assign a landscape unit to each object. These rules take into account the abundance and spatial arrangement of the classified pixels inside each object. In the last step the set of rules are applied to the product SEM+Objects in order to derive the final mapping product, i.e. the LUM.

Code	Class name	Description
1	Urban / Bare soil	Areas with < 10% trees and with > 70% of bare soil
2	Sparse vegetation	Areas with < 10% trees and with 30% - 70% of bare soil
3	Cropland	Areas with < 10% trees and with > 70% of herbaceous vegetation
4	Other natural vegetation	Areas with < 10% trees and that are not Urban / Bare soil, Sparse vegetation and Cropland
5	Broadleaf forest	Areas with >30% trees in which >70% are of the broadleaf type
6	Needleaf forest	Areas with >30% trees in which >70% are of the needleleaf type
7	Mixed forest	Areas with >30% trees in which both broadleaf and needleleaf types are between 30% - 70%
8	Agro-forestry	Areas with 10% - 30% trees and with > 50% of herbaceous vegetation
9	Transitional-woodland forest	Areas with 10% - 30% trees and with < 50% of herbaceous vegetation
10	Water	Areas that are in their major part constituted by water

Map of landscape units



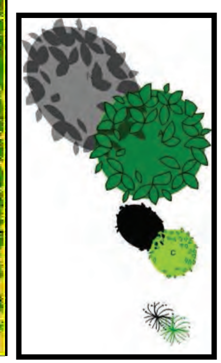


Pixel 30 m (e.g. Landsat)

Map of landscape units

Forest

Shrubland



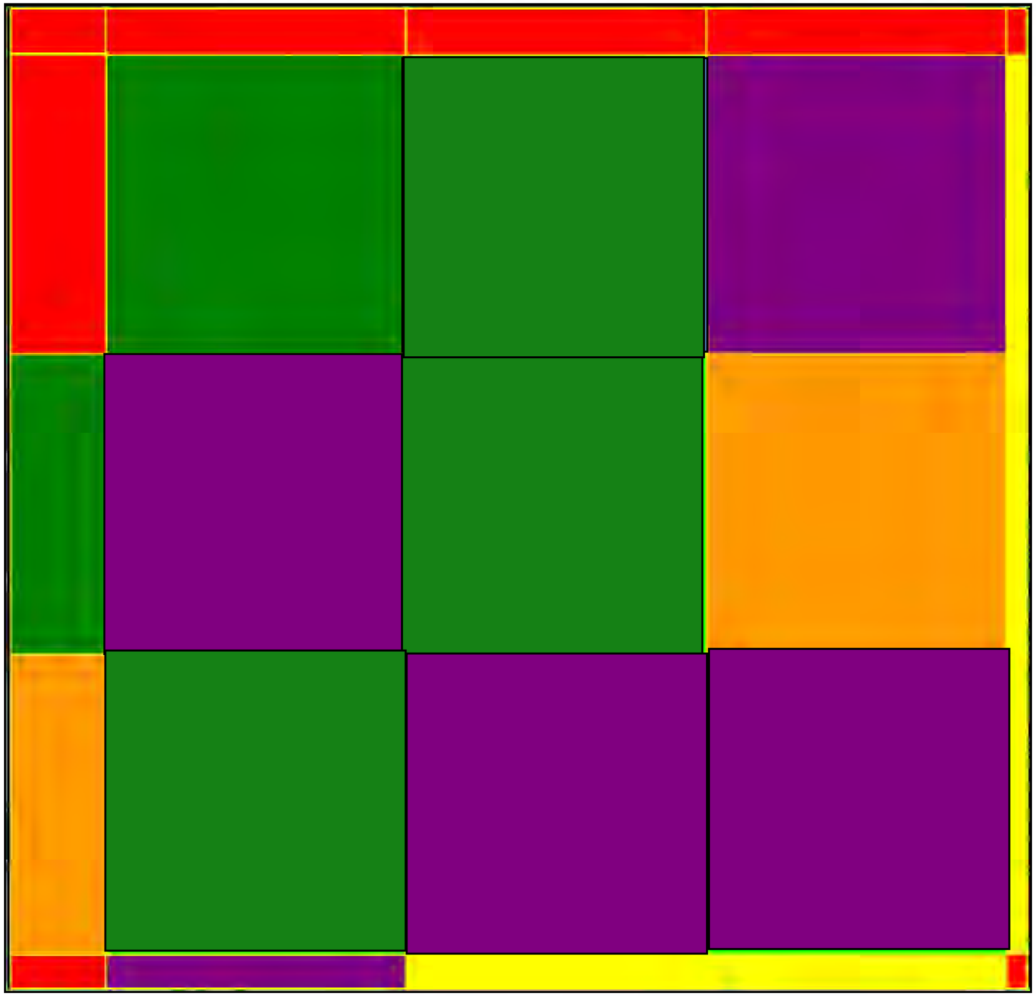
Tree

Shrub

Herbaceous veg.

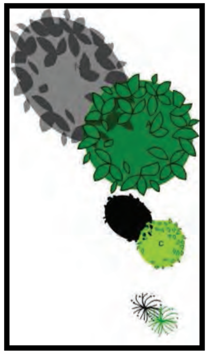
Pixel 30 m (e.g. Landsat)

Map of landscape units



Forest

Shrubland

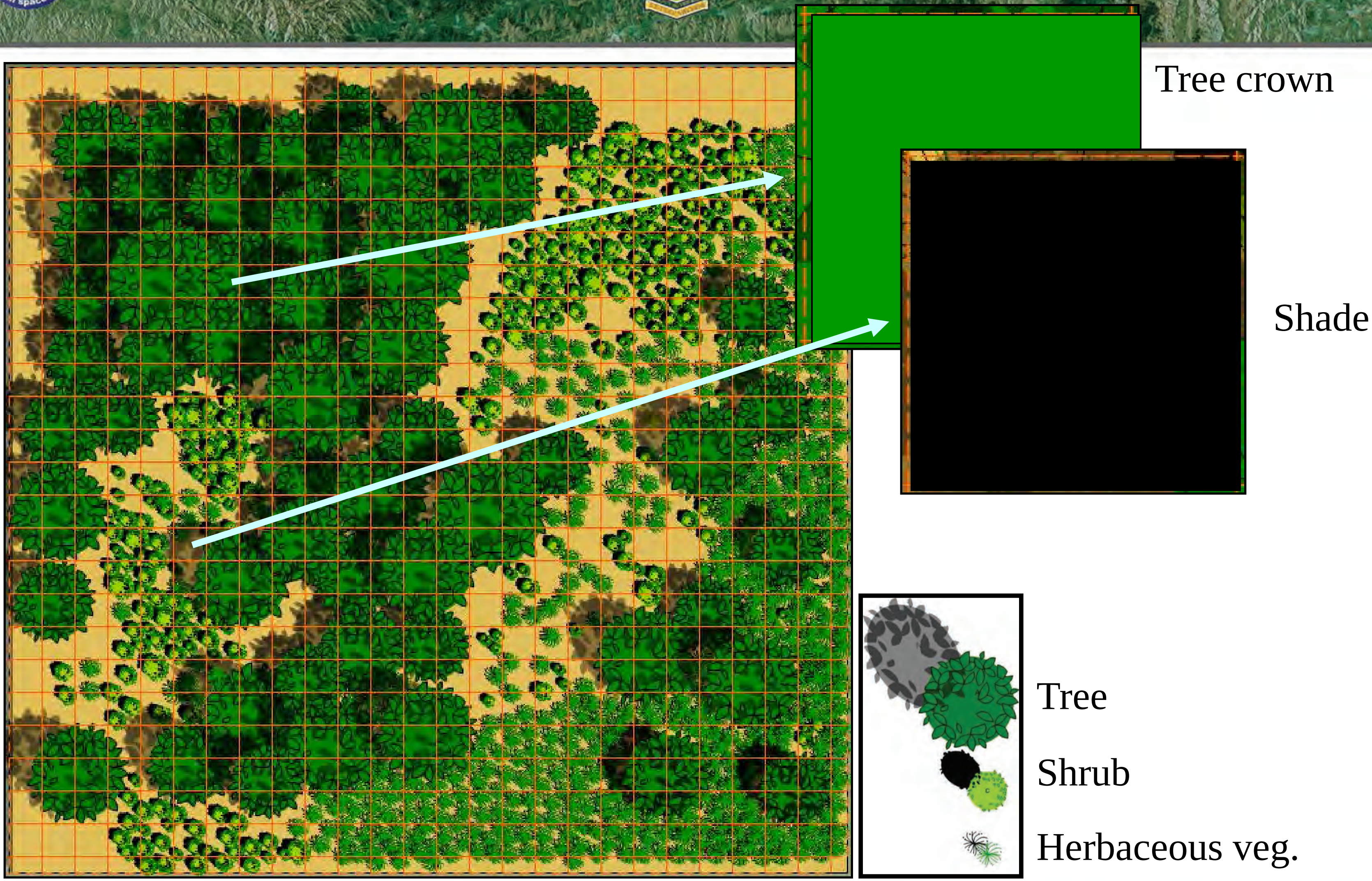


Tree

Shrub

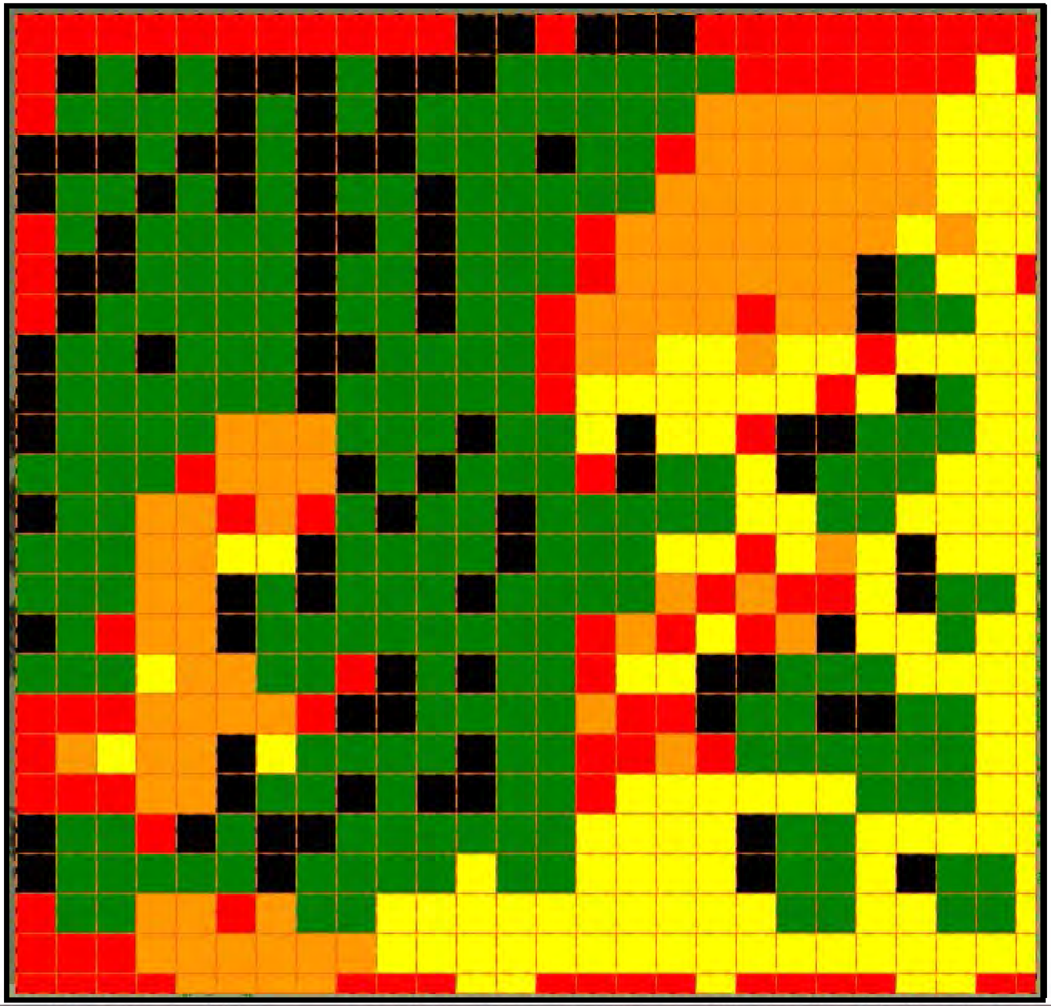
Herbaceous veg.

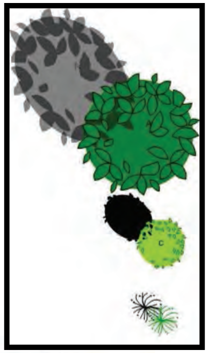
Pixel 30 m (e.g. Landsat)



IKONOS 4 m (e.g. Landsat)

Surface elements map

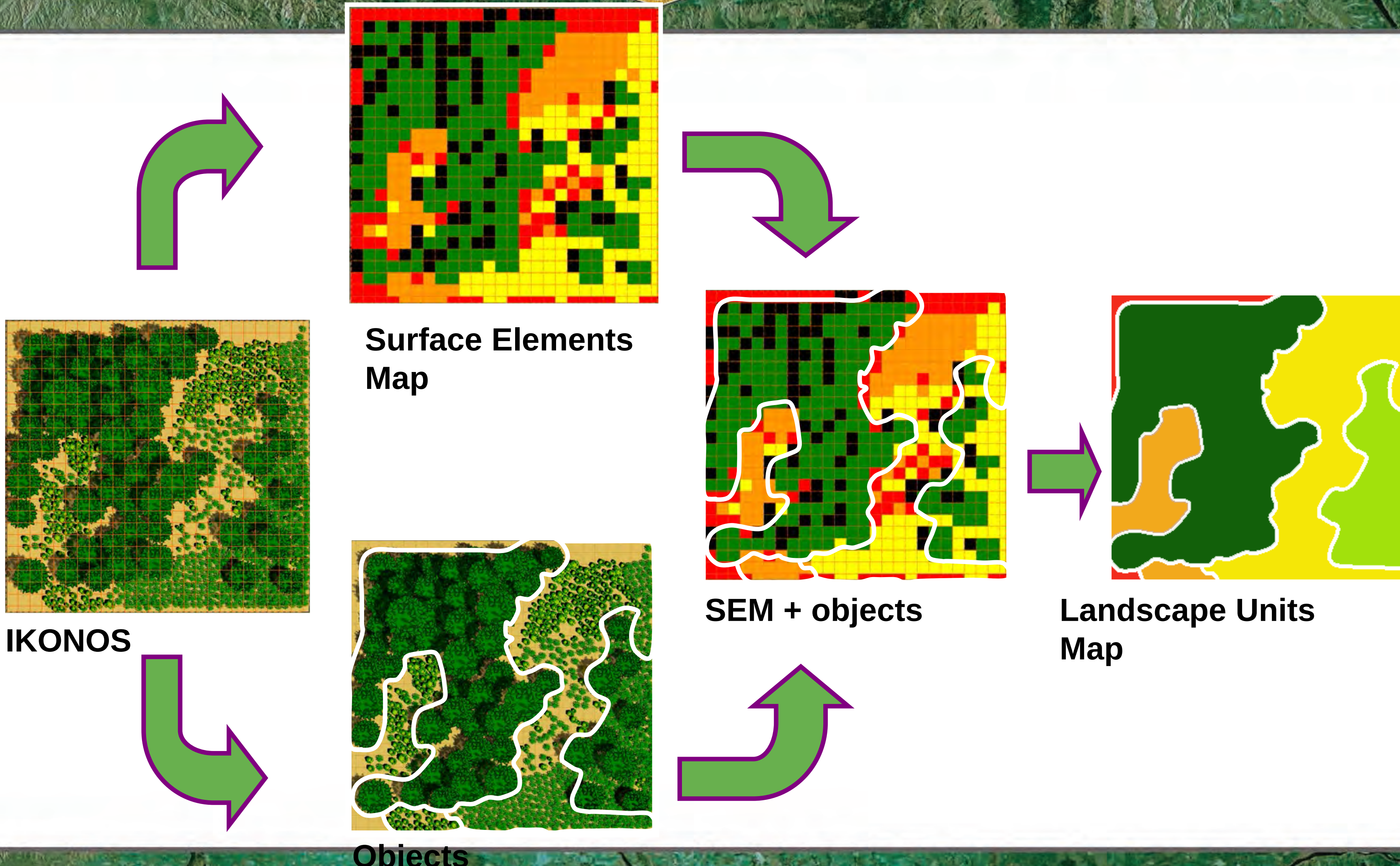




Tree

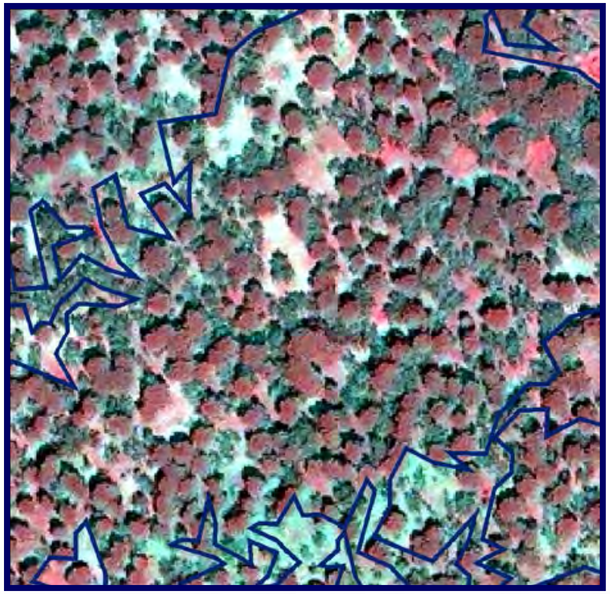
Shrub

Herbaceous veg.

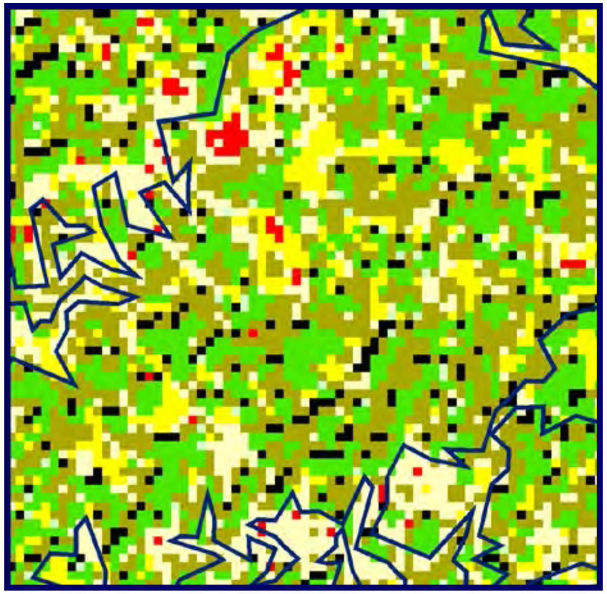

Surface Elements Map
IKONOS
SEM + objects
Landscape Units Map
Objects

Forest = crowns + shade + herbaceous veg. + bare soil

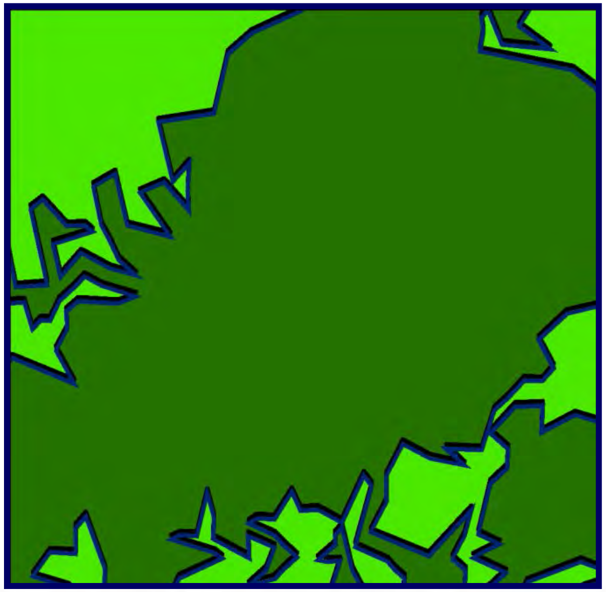
Segmentation



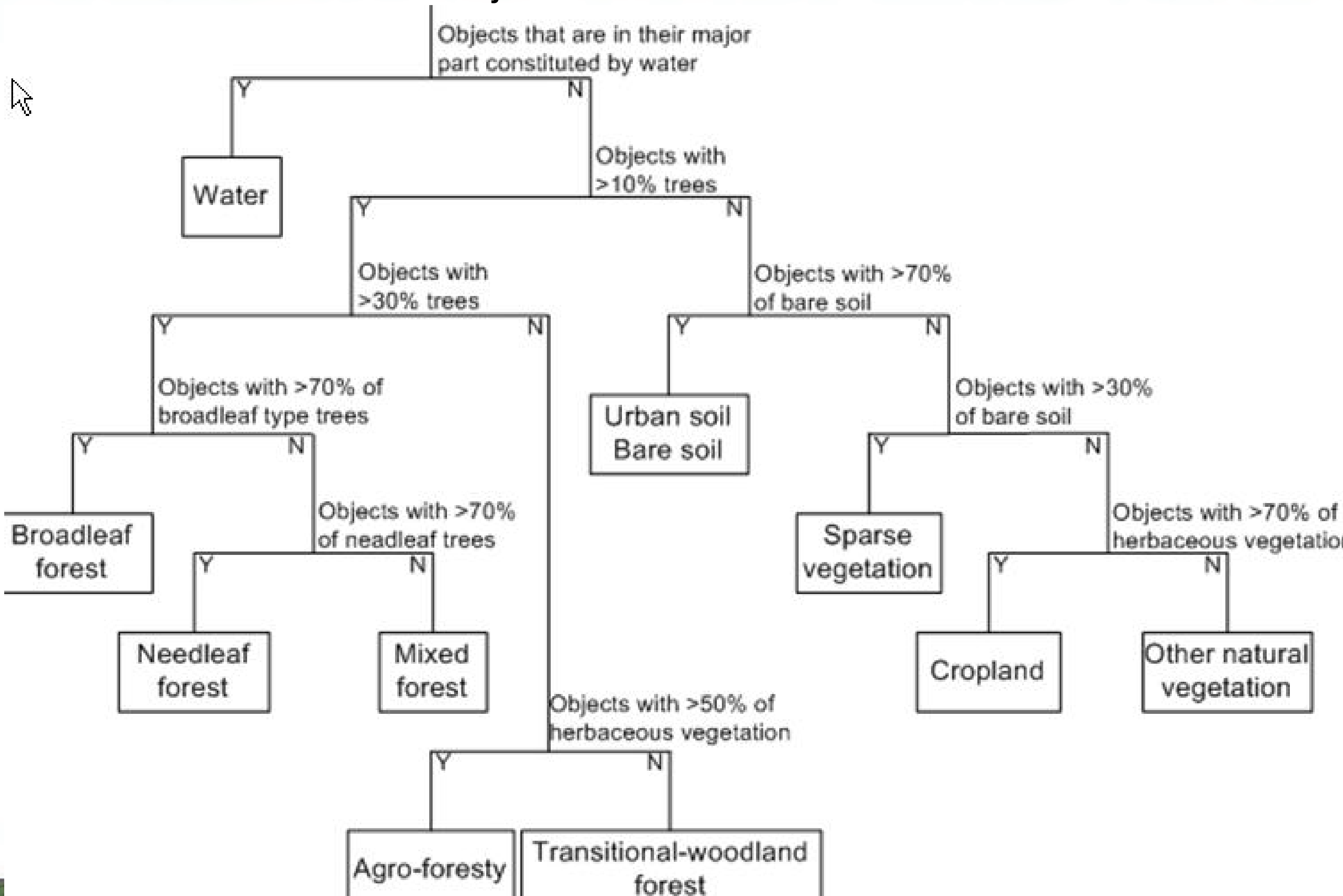
SEM
+
Objects



LUM



SEM+Objects



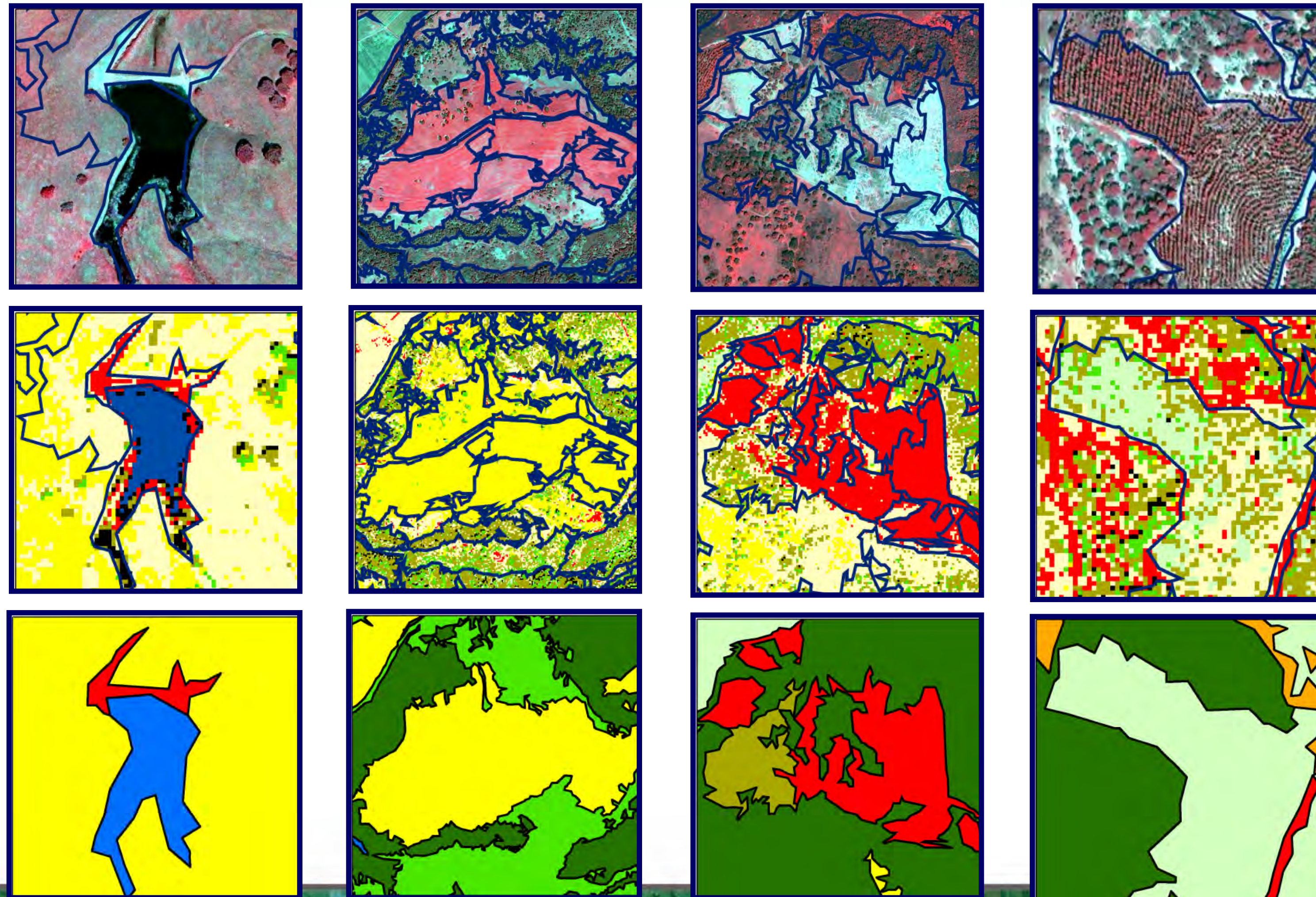
Objects that are in their major part constituted by water
Y
N
Water
Objects with >10% trees
Y
N
Objects with >30% trees
Objects with >70% of bare soil
Y
N
Y
N
Objects with >70% of broadleaf type trees
Urban soil Bare soil
Objects with >30% of bare soil
Y
N
Y
N
Broadleaf forest
Objects with >70% of neadleaf trees
Sparse vegetation
Objects with >70% of herbaceous vegetation
Y
N
Y
N
Needleaf forest
Mixed forest
Cropland
Other natural vegetation
Objects with >50% of herbaceous vegetation
Y
N
Agro-foresty
Transitional-woodland forest

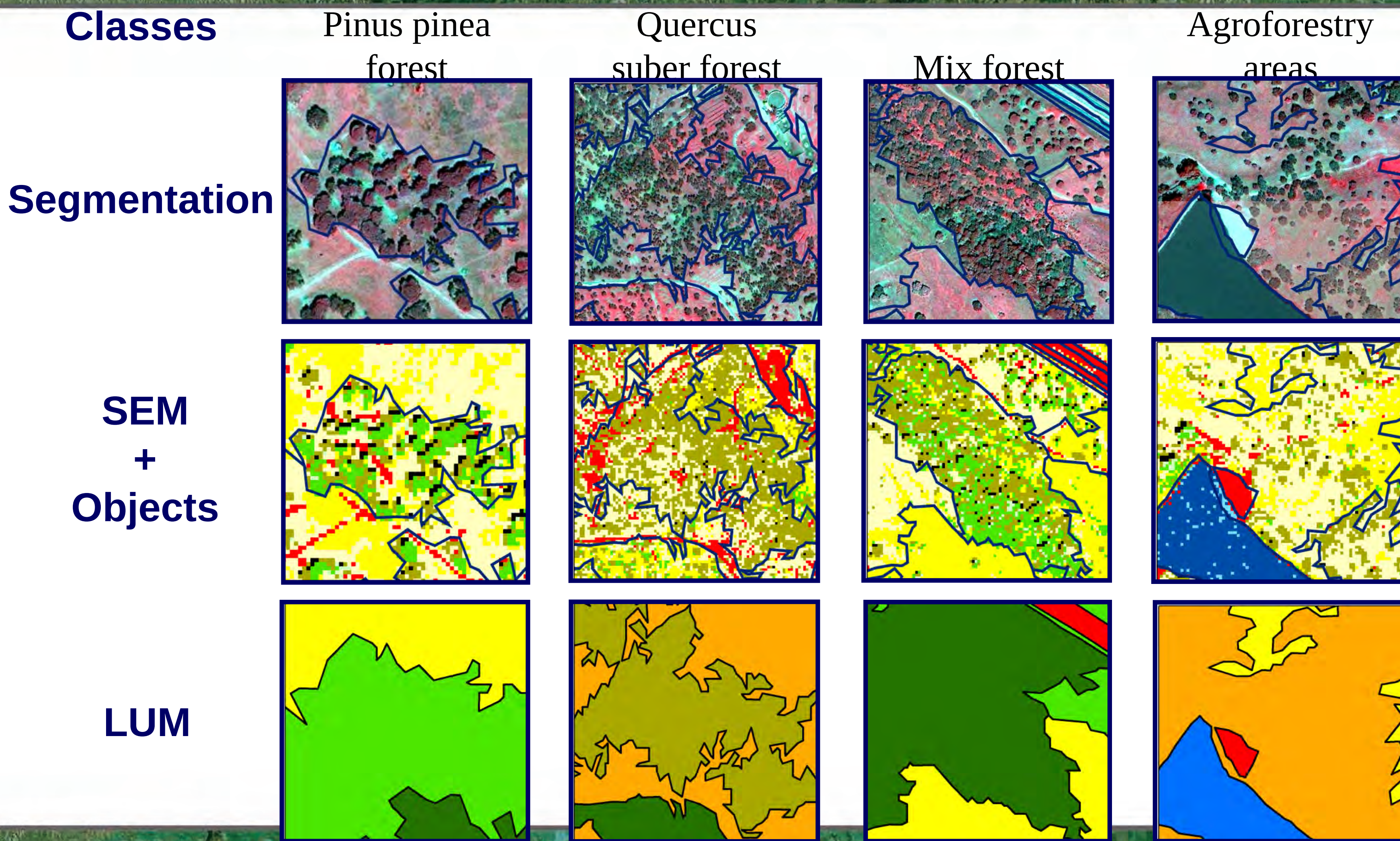
Classes | Water | Agriculture | Bare soil/urban | Eucaliptus forest

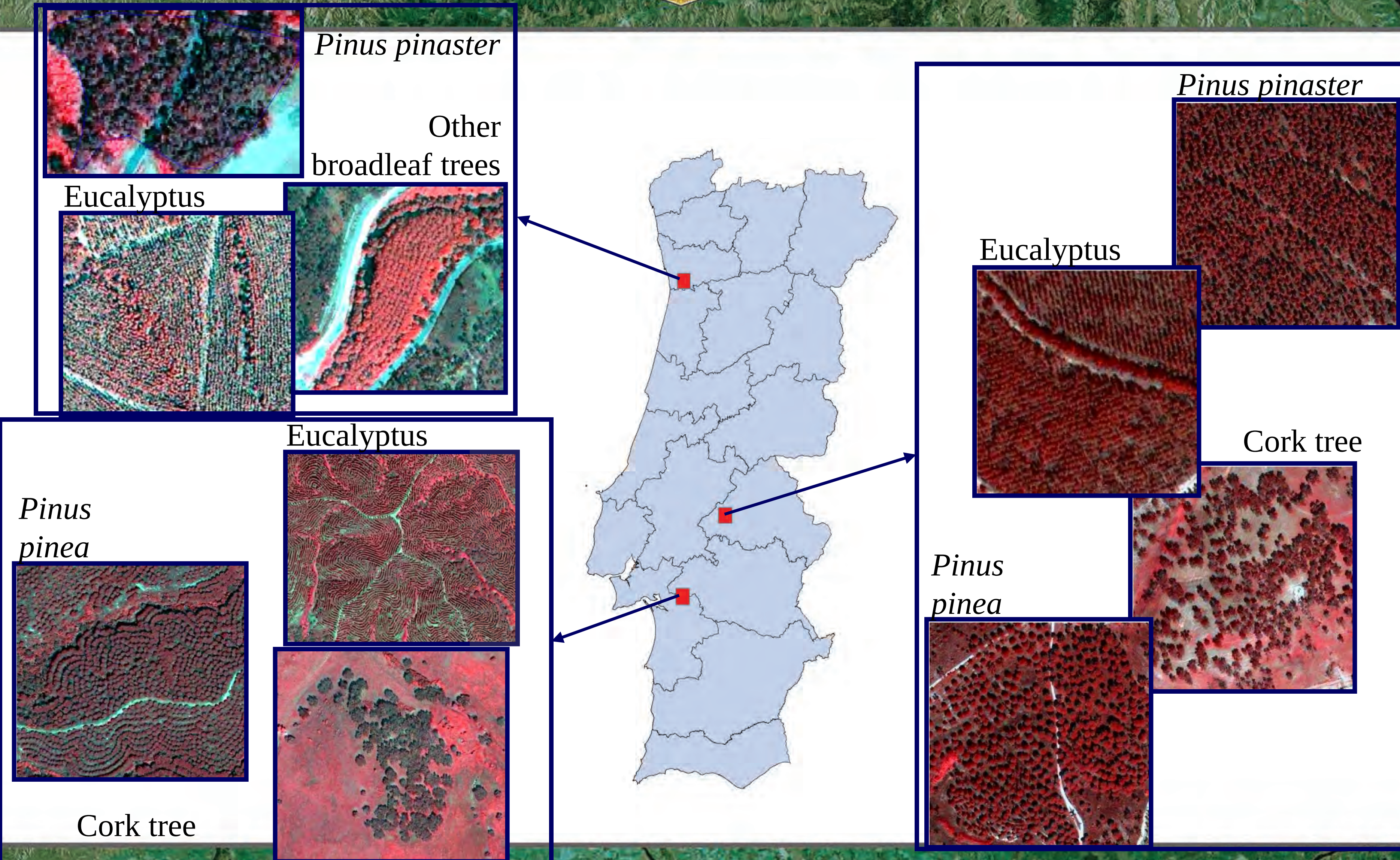
Segmentation

SEM + Objects

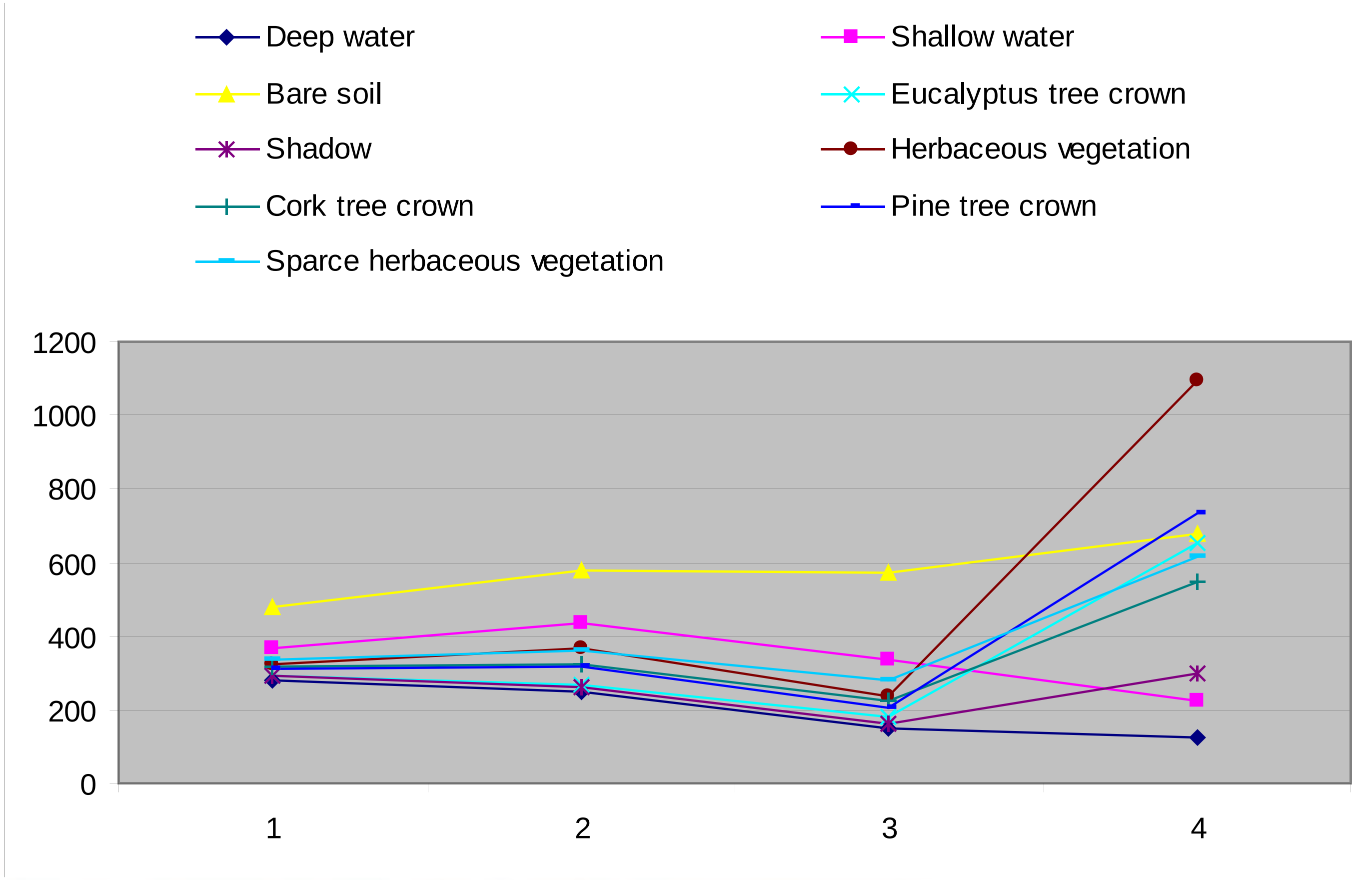
LUM




Classes
Pinus pinea forest
Quercus suber forest
Mix forest
Agroforestry areas
Segmentation
SEM + Objects
LUM


Pinus pinaster
Other broadleaf trees
Eucalyptus
Eucalyptus
Pinus pinea
Cork tree
Pinus pinaster
Eucalyptus
Cork tree
Pinus pinea

Spectral class means IKONOS



The mixed pixel problem

The problem of mixed pixels exist in coarse and fine resolution images:

In course resolution images the mixed pixels are mainly due to co-existence in the same pixel of different classes.

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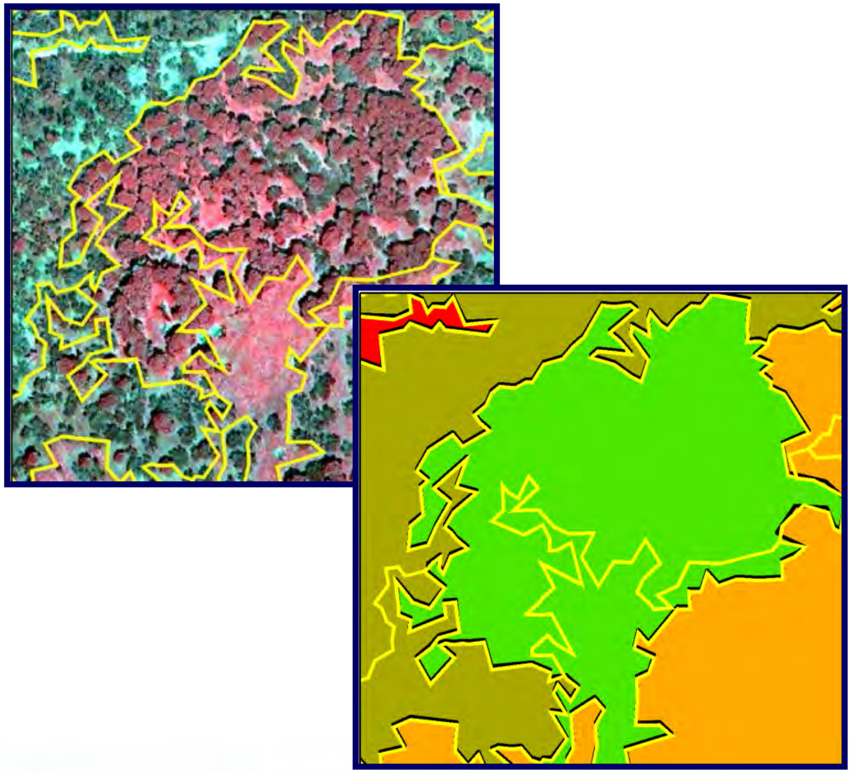
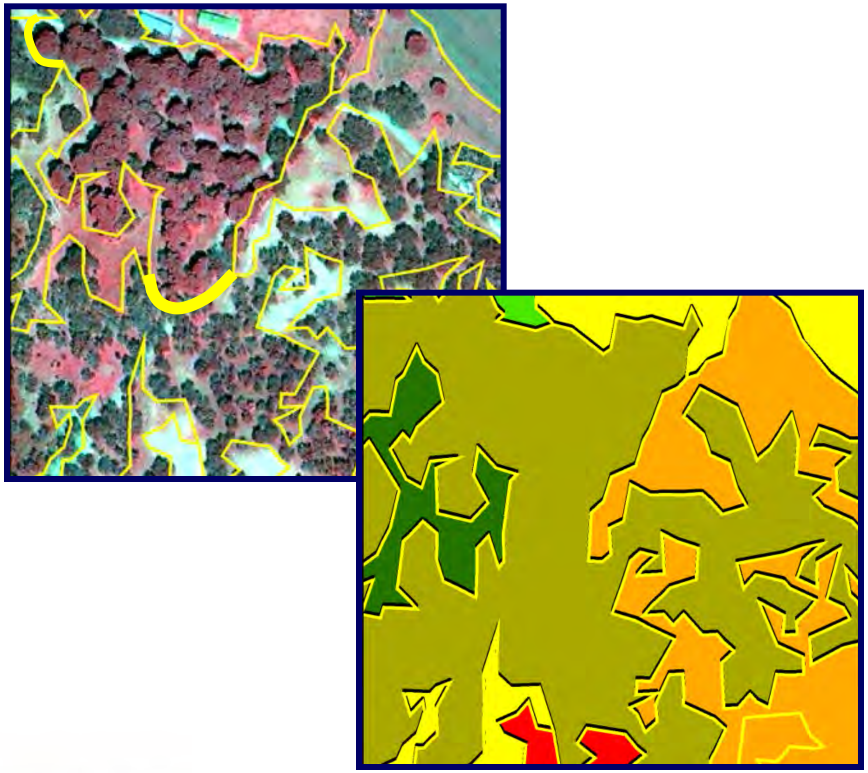
In fine resolution images the mixed pixels are mainly due to co-existence in the same pixel of different components (e.g., houses, trees).

IKONOS

Meaningful segmentation



Meaningless segmentation



Thematic information extraction from satellite images

1 Definition of the mapping approach *

2 Geographical stratification

3 Image segmentation

4 Feature identification and selection *

5 Classification *

6 Ancillary data integration

7 Post-classification processing

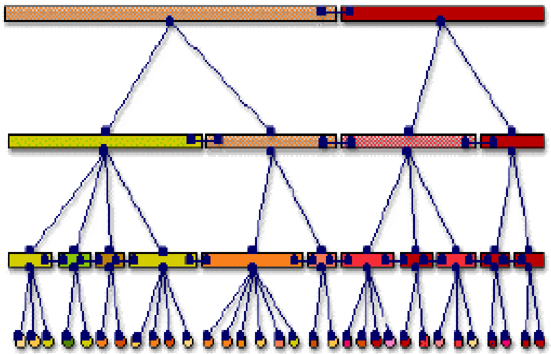
8 Accuracy assessment *

* mandatory

Sample ID (ID)	Surface element – your decision	Surface element – our decision
12		7 - Cork tree crown
13		3 - Bare soil
104		9 - Sparse herbaceous vegetation
151		5 - Shadow
254		1 - Deep water
614		8 - Pine tree crown
630		4 - Eucalyptus crown
713		6 - Herbaceous vegetation

3. Image segmentation

A type of segmentation that is very common is the **multi-resolution segmentation**, because of its ability to deal with the range of scales within a single image.

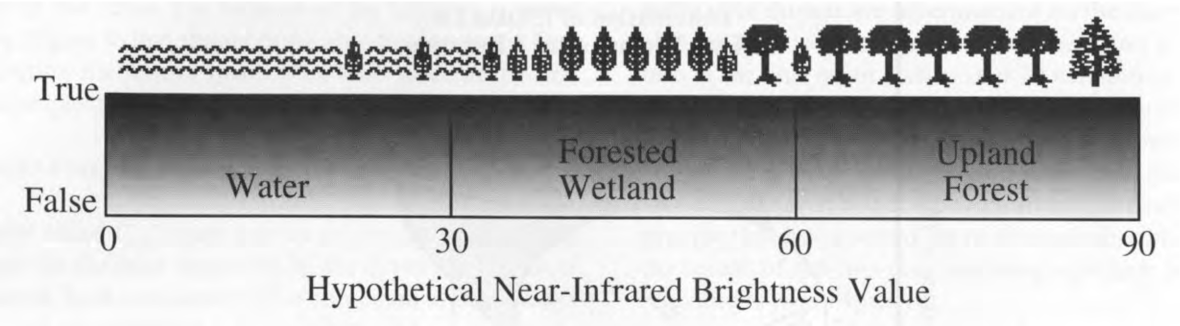


Super-objects

Sub-objects

6. Classification

Hard classification



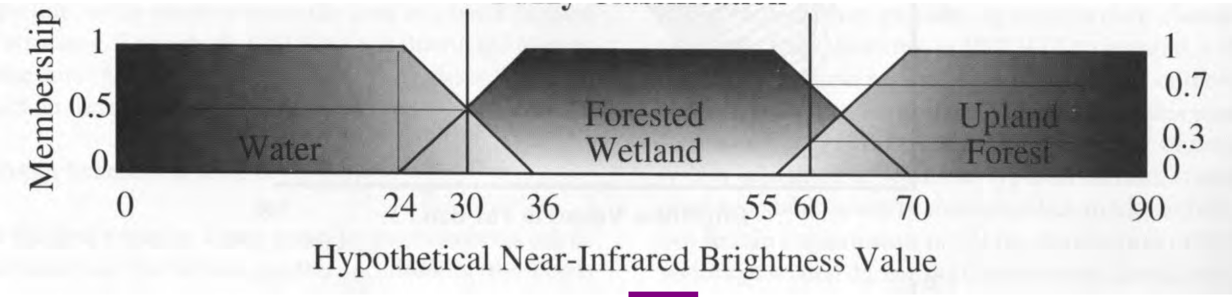
Decision rules

0 – 30 -> Water

30 - 60 -> Forest wetland

60 - 90 -> Upland forest

Fuzzy classification



Decision rules are defined as membership functions for each class.

Membership functions allocates to each pixel a real value between 0 and 1, i.e. membership grade.

But, how can we represent the sub-pixel information?

Source: Jensen (1996)