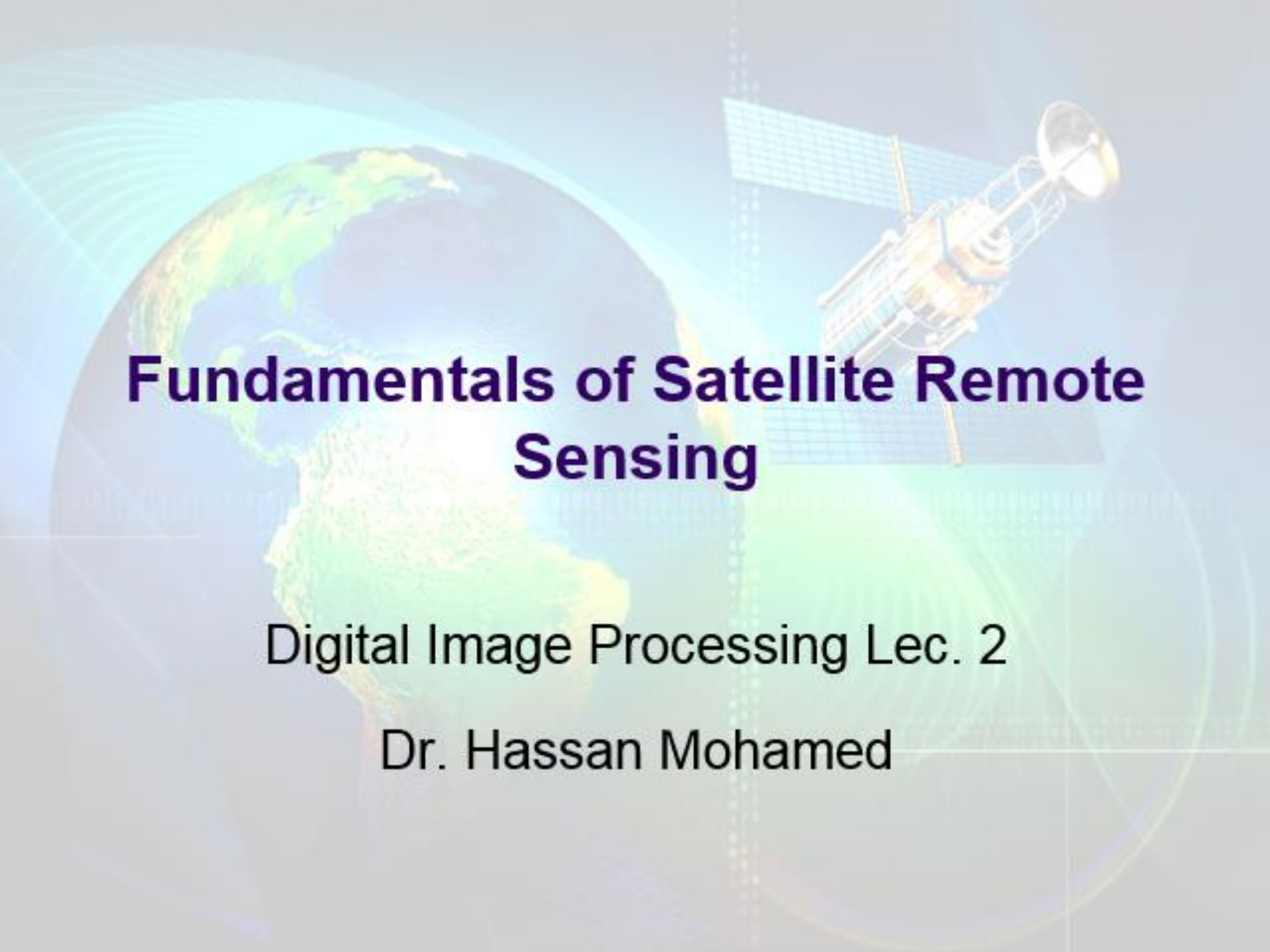

Fundamentals of Satellite Remote Sensing

Digital Image Processing Lec. 2

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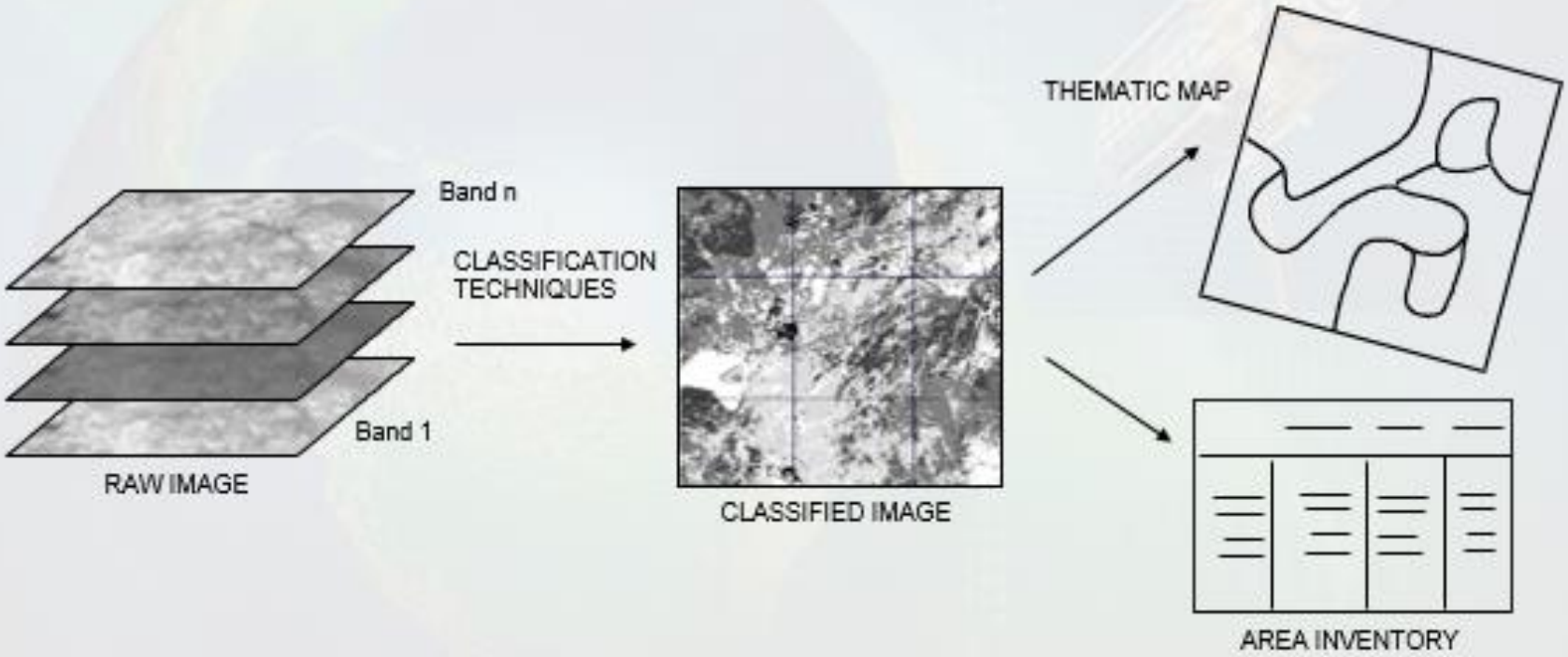
Fundamentals of digital image classification



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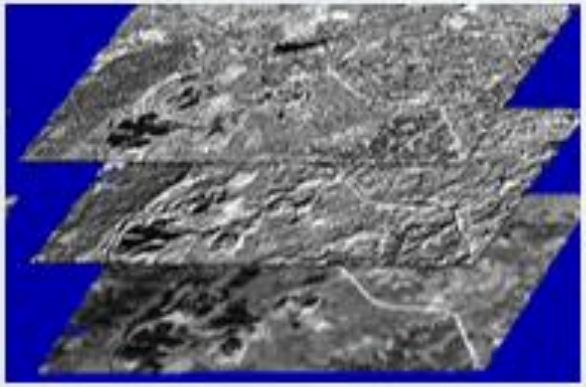
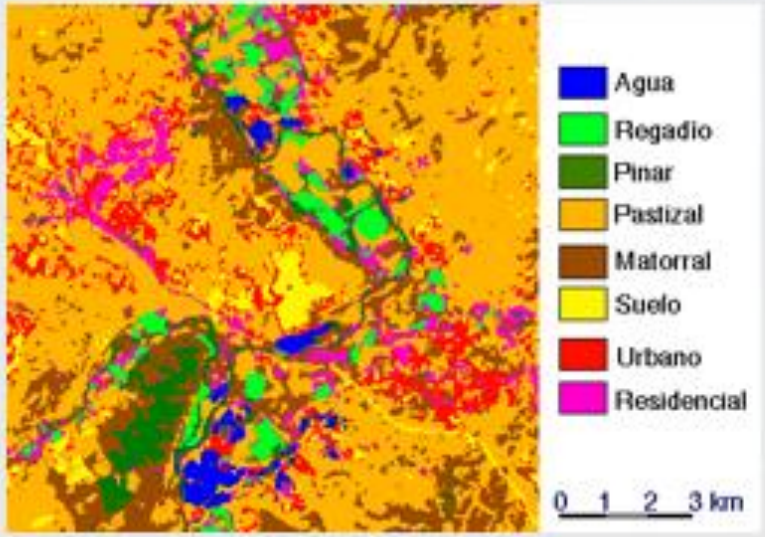
Land Cover

- Visual or digital interpretation



Clasification



Categorizing Borders

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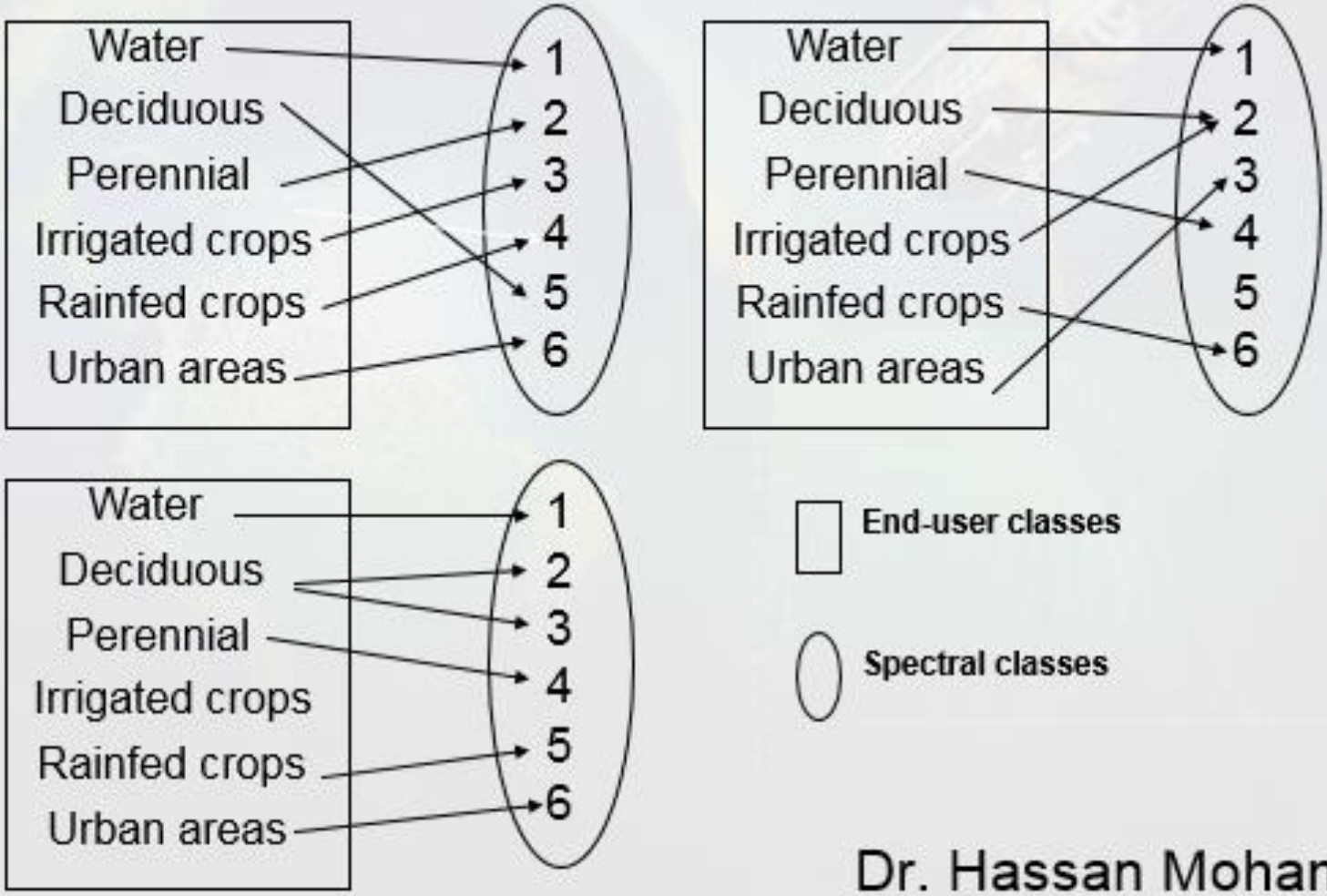
Relations between spectral and end-user classes



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When discrimination problems are found…

- Modify the legend (if end-user agrees!!).
- Use non-spatial criteria: textures, context.
- Use ancillary information: DEM, property limits, soil maps…
- Use images from another dates.

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Classification phases

- Training (define quantitatively the required classes):
  - Supervised.
  - Unsupervised.
- Assignment (include all pixels in any of the defined categories).
- Assessment of the results.

http://gisgeography.com/image-classification-techniques-remote-sensing/
http://www.sc.chula.ac.th/courseware/.htm18/Lecture/remote2309507
http://gisgeography.com/open-source-remote-sensing-software-packages/

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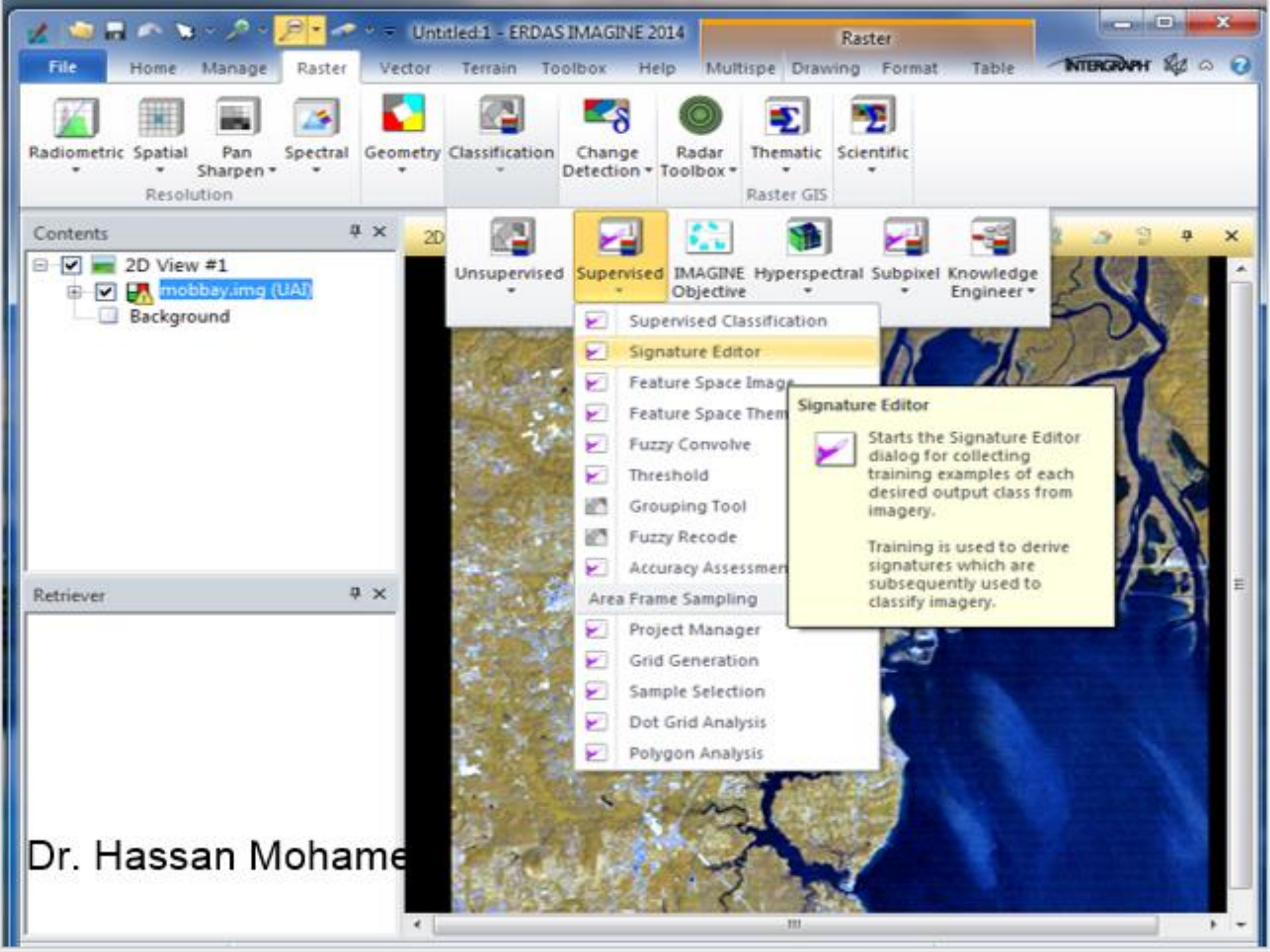
Untitled:1 - ERDAS IMAGINE 2014
Raster
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Manage
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Terrain
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Help
Multispe
Drawing
Format
Table
Radiometric
Spatial
Pan Sharpen
Spectral
Geometry
Classification
Change Detection
Radar Toolbox
Thematic
Scientific
Resolution
Raster GIS
Contents
2D View #1
mobbay.img (UAI)
Background
Retriever
Unsupervised
Supervised
IMAGINE Objective
Hyperspectral
Subpixel
Knowledge Engineer
Supervised Classification
Signature Editor
Feature Space Image
Feature Space Them
Fuzzy Convolve
Threshold
Grouping Tool
Fuzzy Recode
Accuracy Assessmen
Area Frame Sampling
Project Manager
Grid Generation
Sample Selection
Dot Grid Analysis
Polygon Analysis
Signature Editor
Starts the Signature Editor dialog for collecting training examples of each desired output class from imagery.
Training is used to derive signatures which are subsequently used to classify imagery.
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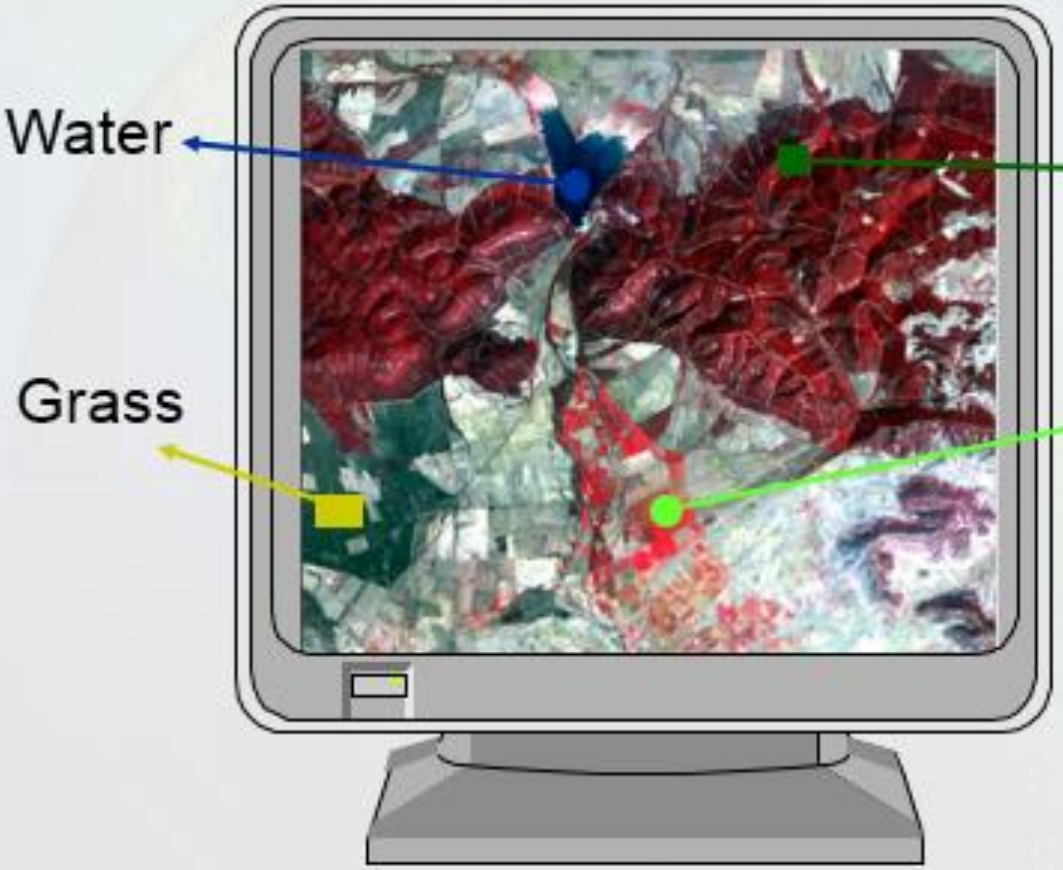
Supervised training



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Identification of training areas

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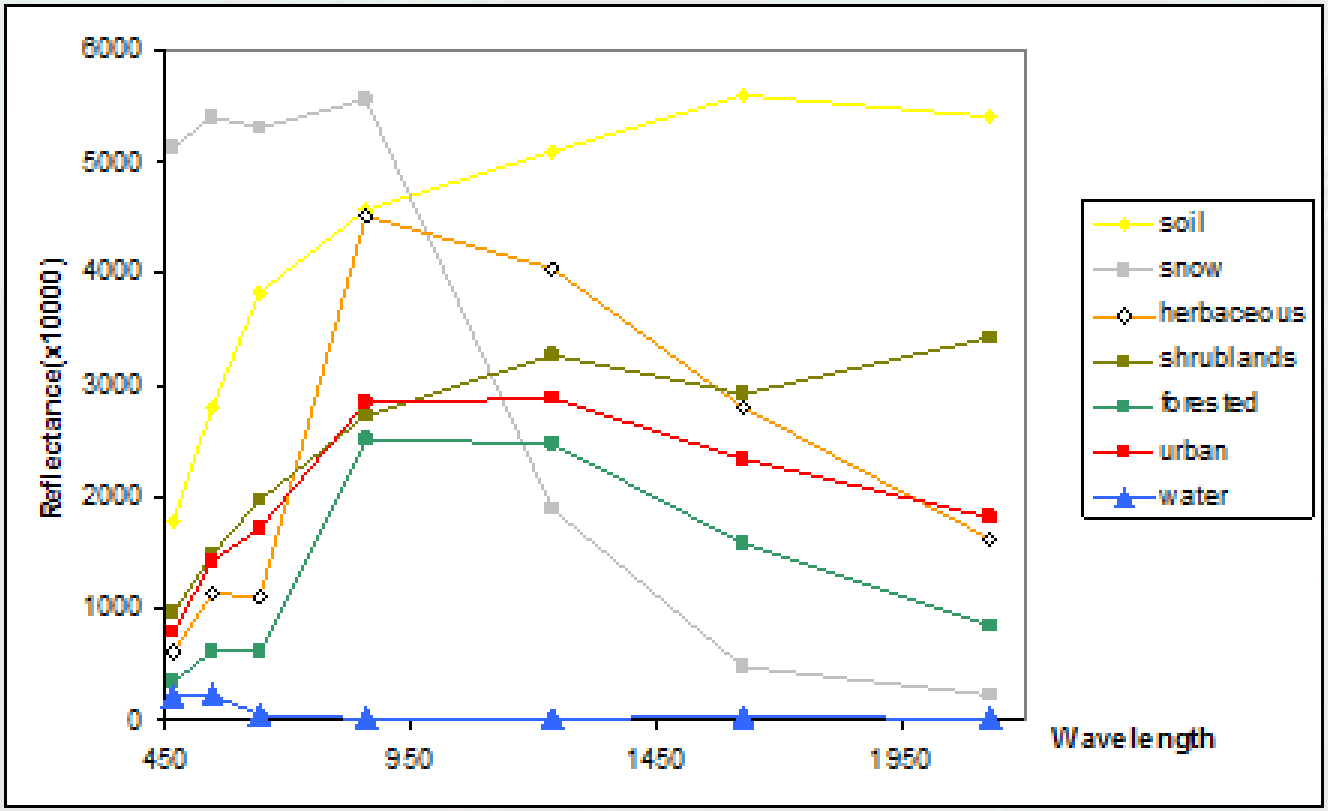
Spectral training signatures graph



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Portable radiometers are very useful during the training phase

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Spectro-radiometric measurements in the field are useful to select the most convenient sensor and spectral bands

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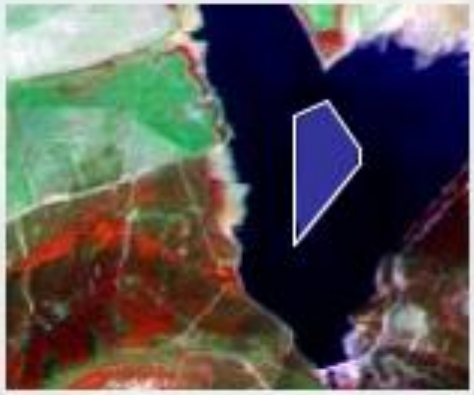
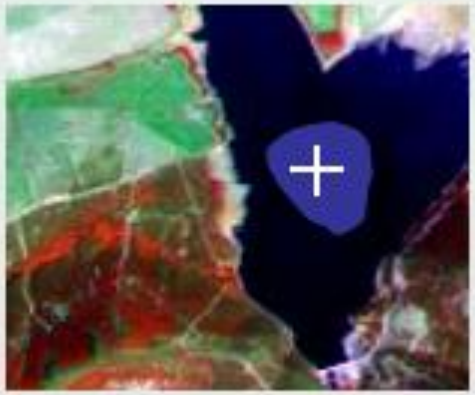
Methods to extract training fields

- Polygon digitizing
  - Be aware of spatial autocorrelation.
  - Border effects.



- Seeds.
  - Spectral Distance.
  - Spatial Distance.



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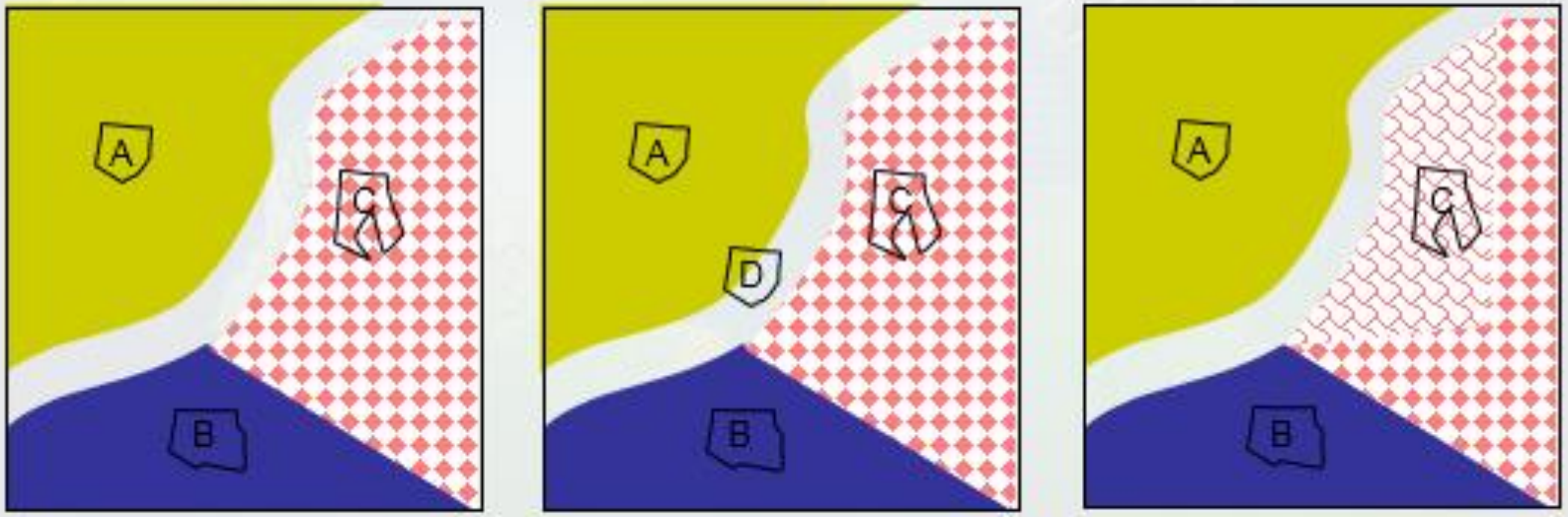
Problems while selecting training fields



a) homogeneous areas b) Heterogeneous areas c) Heterogeneous categories

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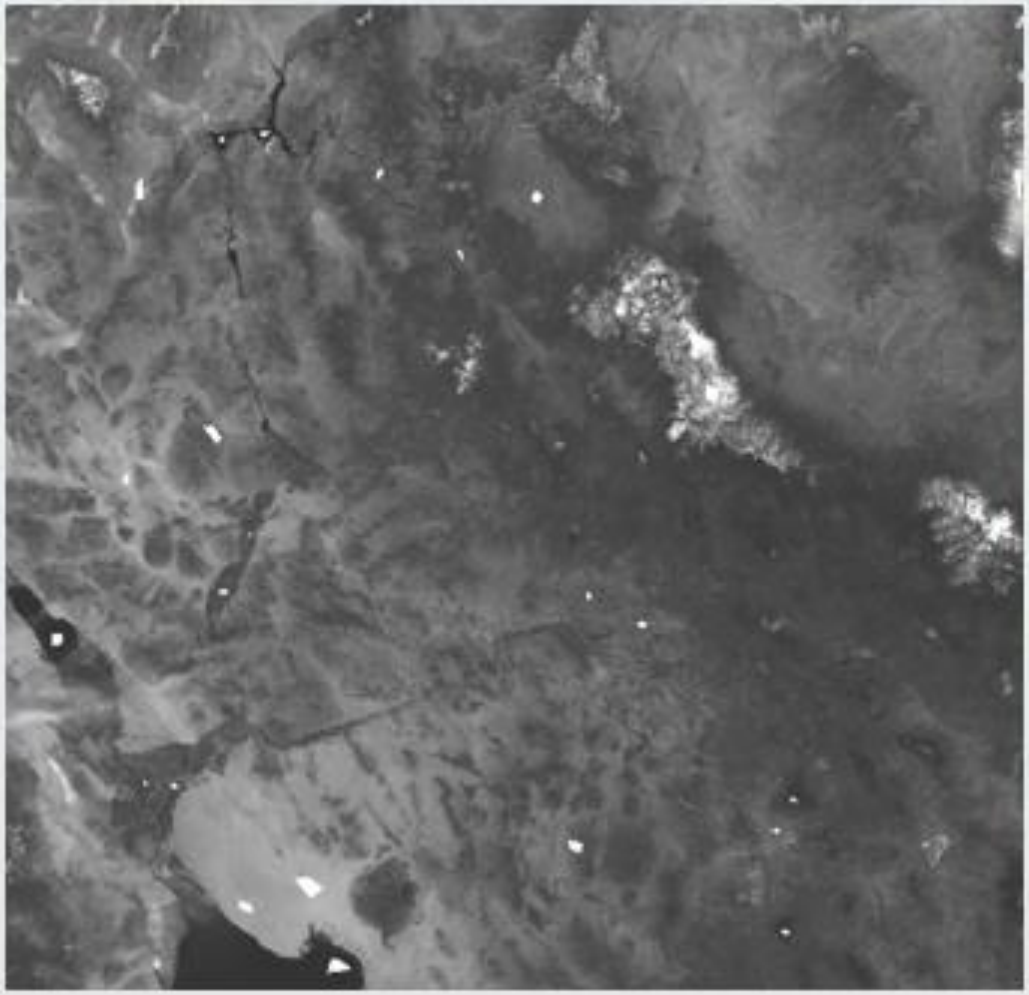
Training fields in the study area



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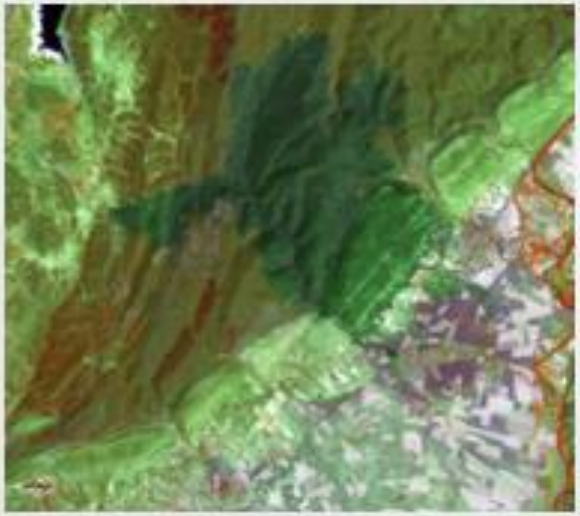
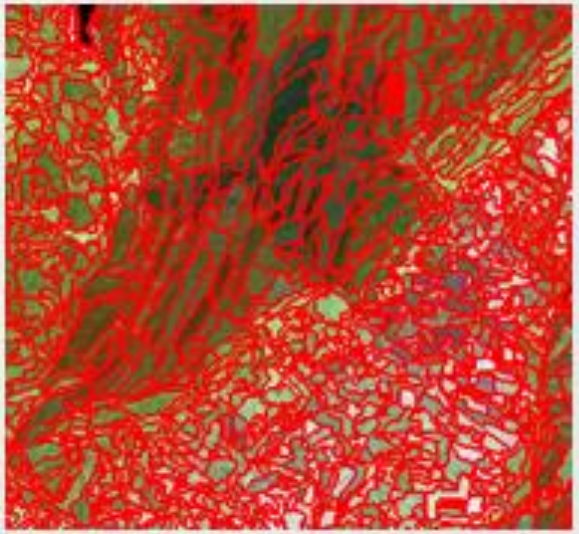
Training selection after segmenting the image



Original

Segmented



Polygon Limits

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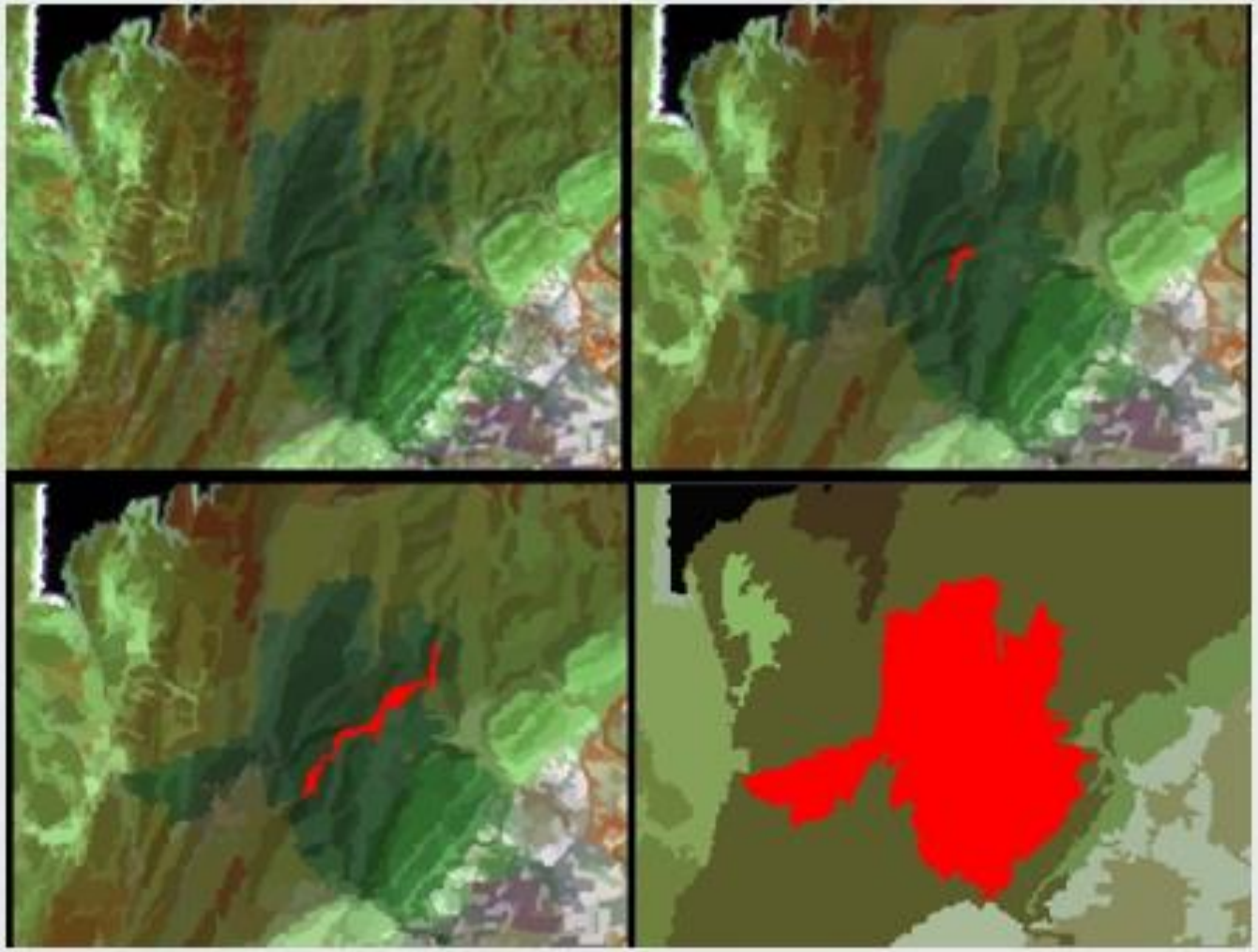
Multisegmentation



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Other classification criteria

- Decision tree classifier.
- Contextual classifiers:
- Fuzzy classification.
- Neural network classifier.

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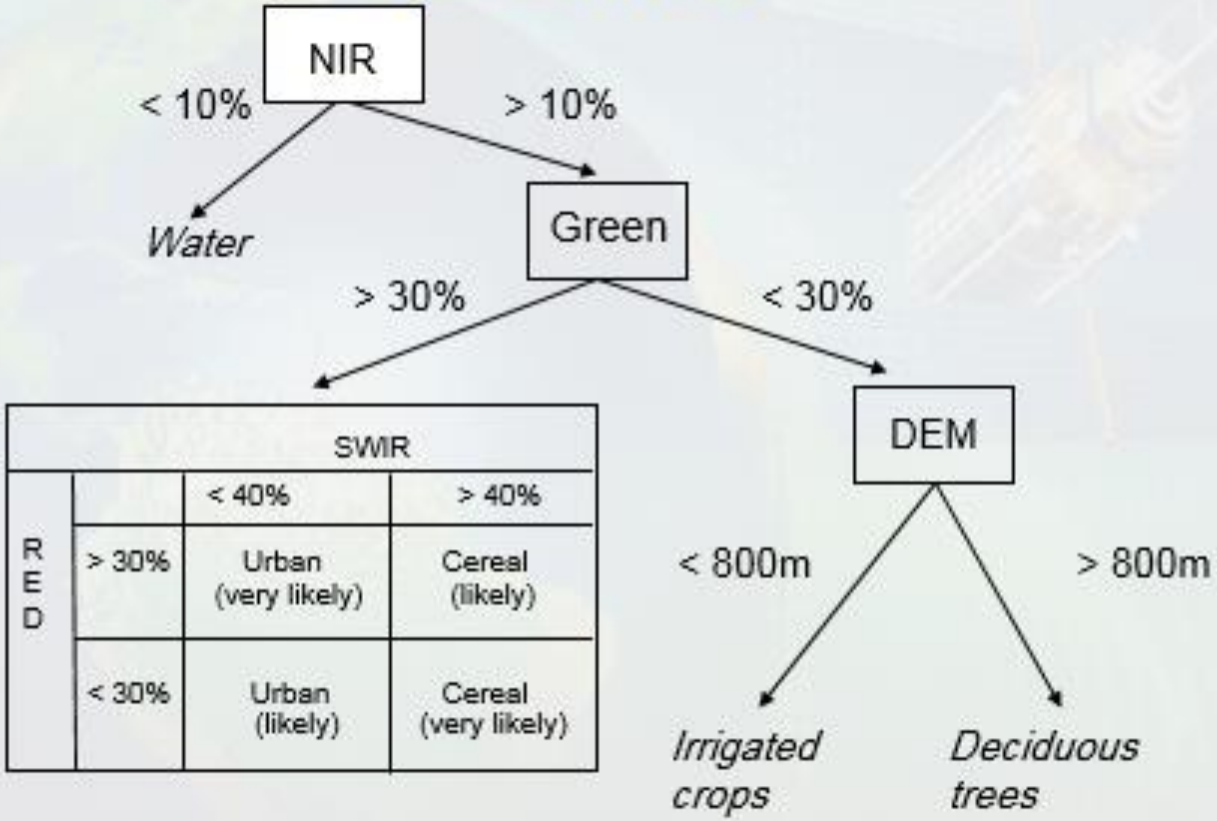
Example of a simple decision tree classifier



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Contextual classifiers

- Use objects instead of pixels.
- Objects are defined by spatial and spectral properties.
- Spatial properties are used in the classification, not just the spectral variables.

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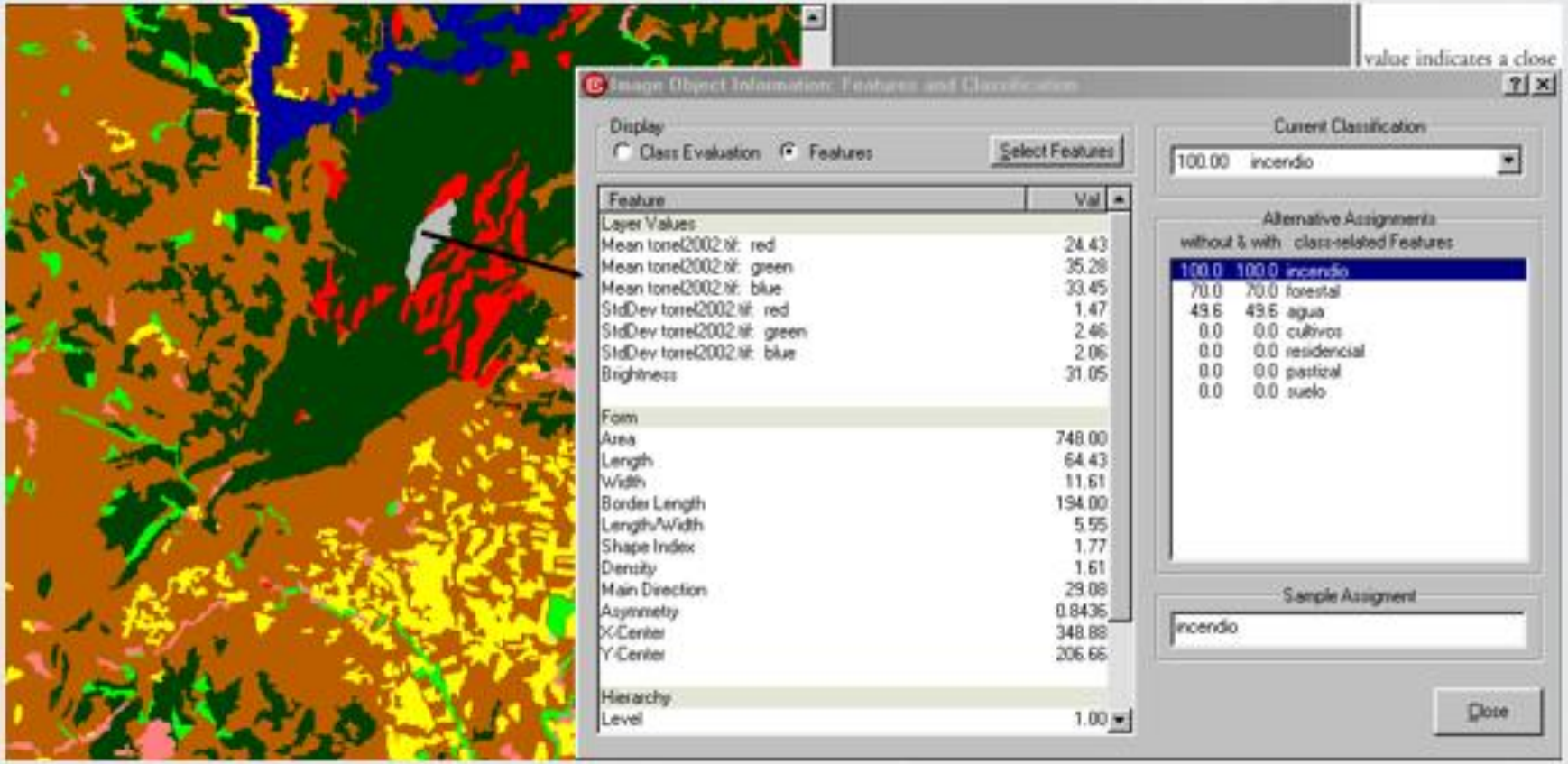
Objects can be characterized by spatial and spectral variables



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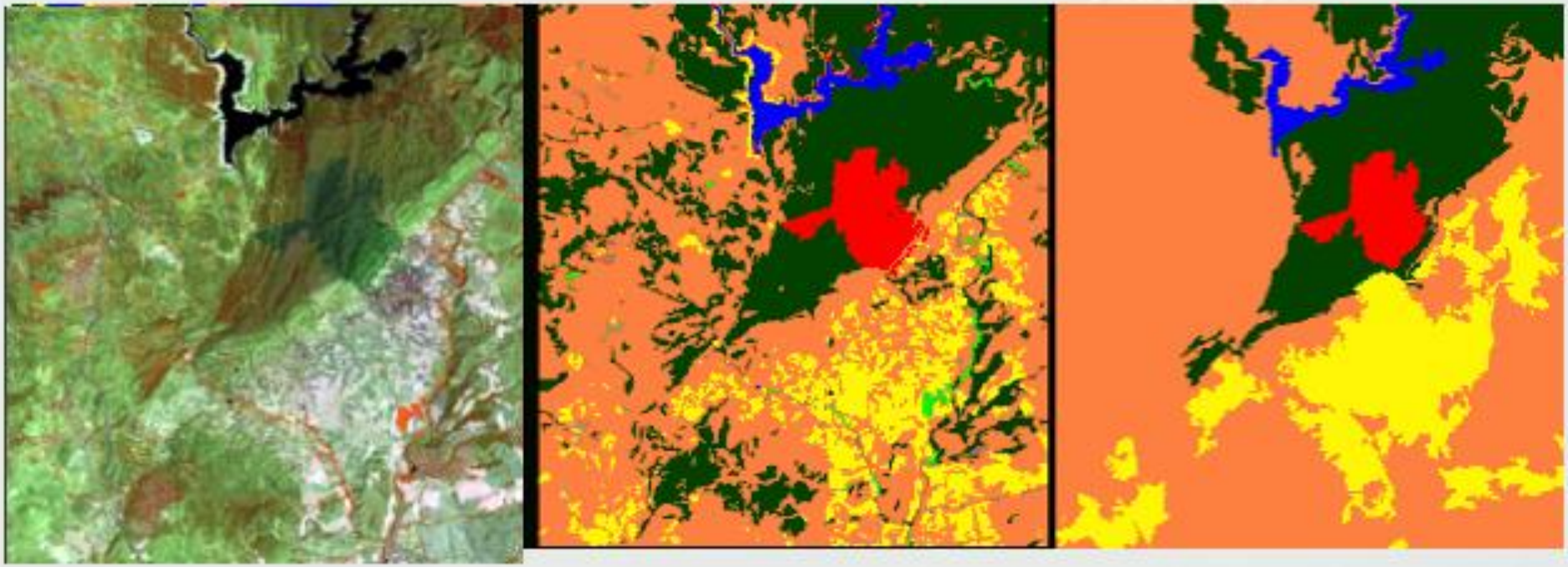
Classification can be adapted to the size of the objects



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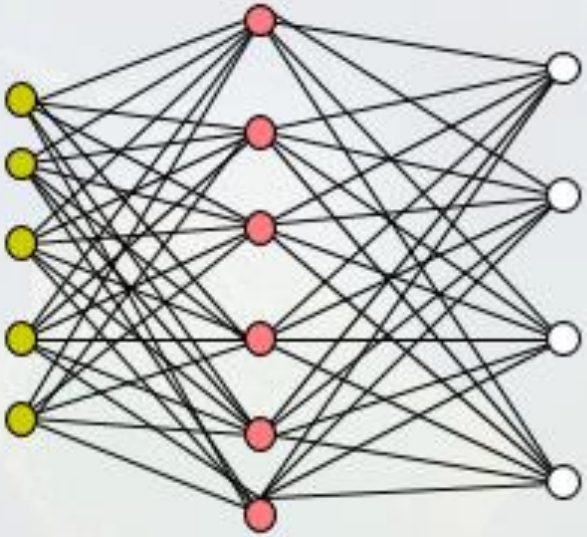
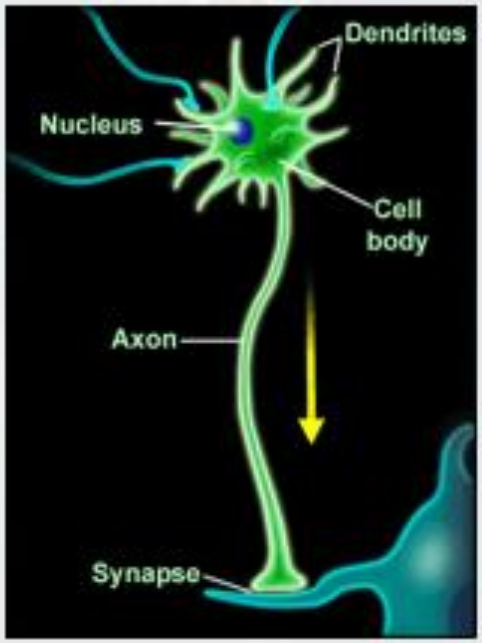
Neural network classifiers



Input layer Hidden layer Output layer



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Neural network structure

- Network Topology:
  - Number of layers.
  - Number of neurons.
- Learning algorithm: back propagation, quick-pro, unsupervised.
- Number of iterations.
- Error levels.

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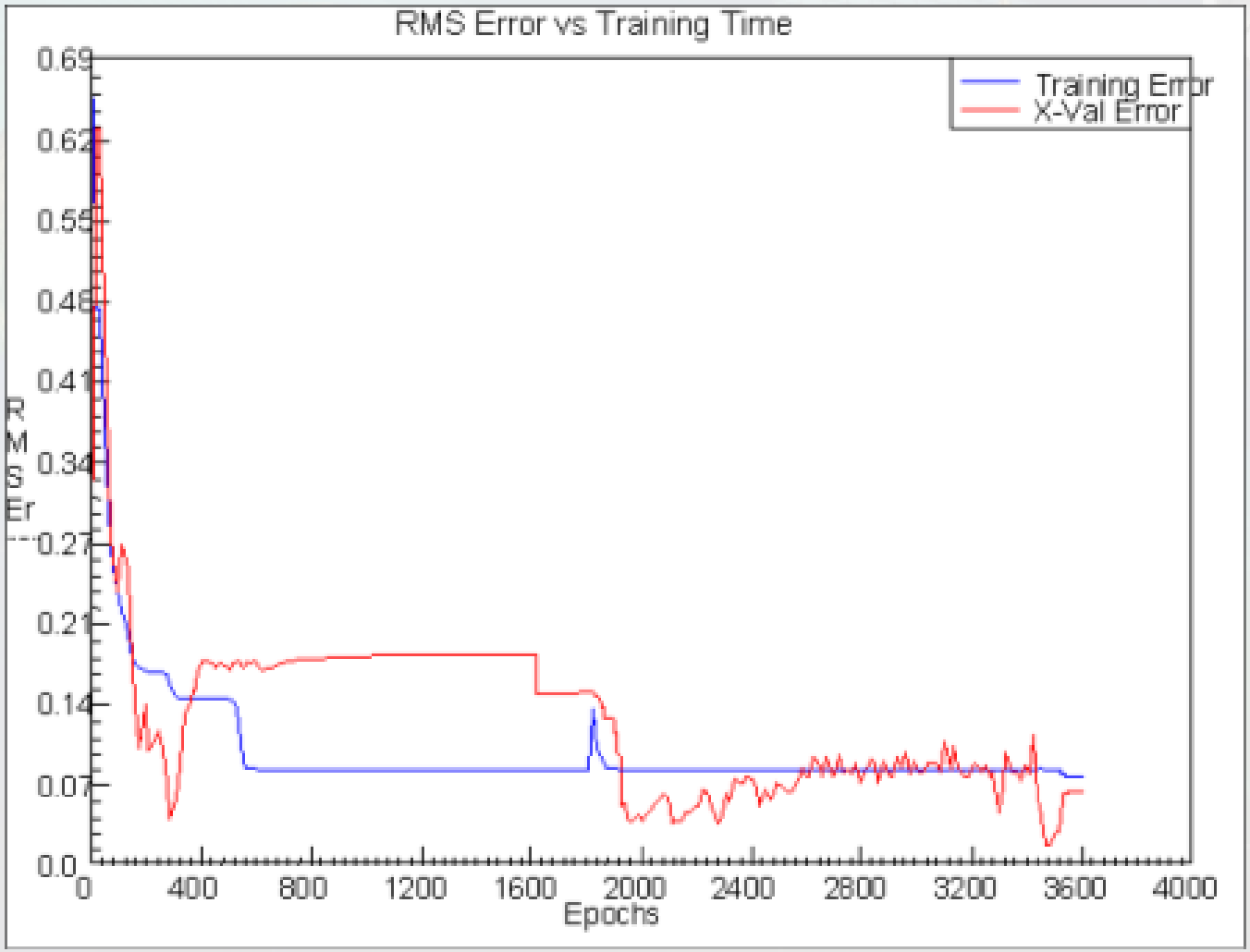
Learning process of an ANN



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Variation of weights during the network learning

Iteration	w_1	w_2	w_3	w_4	w_5	w_6	Error
0	0.050	0.100	0.300	0.150	1.000	0.500	0.461
1	0.375	0.051	0.418	0.121	0.951	0.520	0.424
5	0.606	0.007	0.570	0.117	1.240	0.909	0.391
10	0.642	-0.072	0.641	0.196	1.464	1.034	0.378
50	2.224	-2.215	2.213	2.216	3.302	3.259	0.040
150	2.810	-2.834	2.810	2.835	4.529	4.527	0.007
250	2.901	-2.976	2.902	2.977	4.785	4.784	0.005

After Richards, 1993

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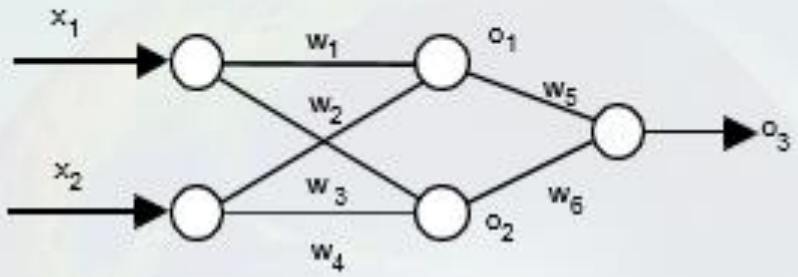
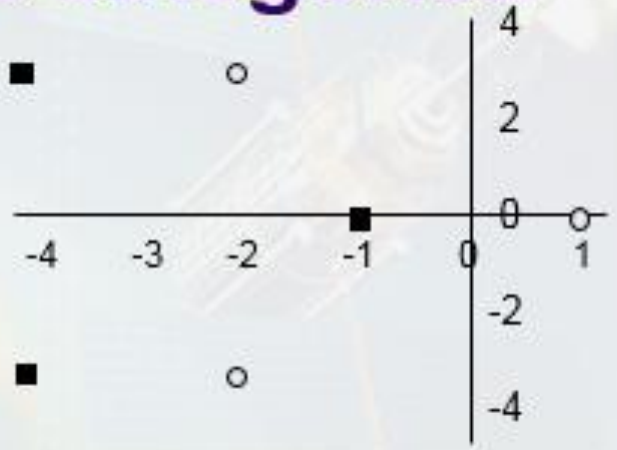
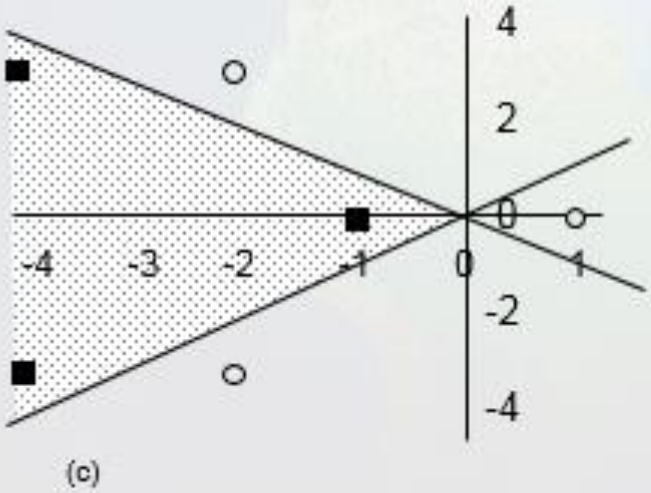
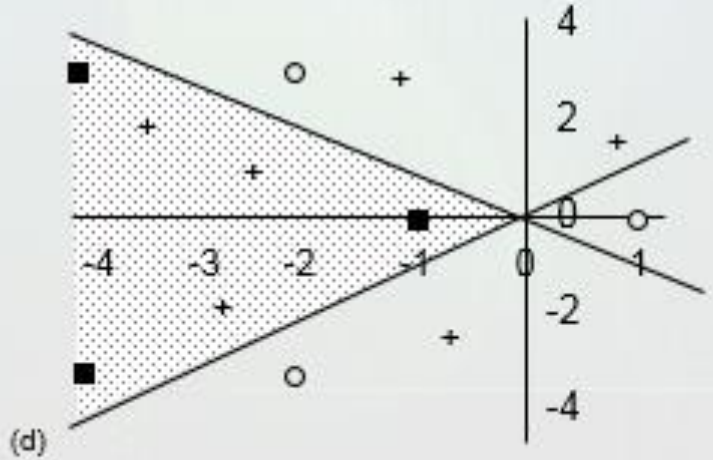
An example of using an ANN for classification of two categories









(adapted from Richards, 1993).

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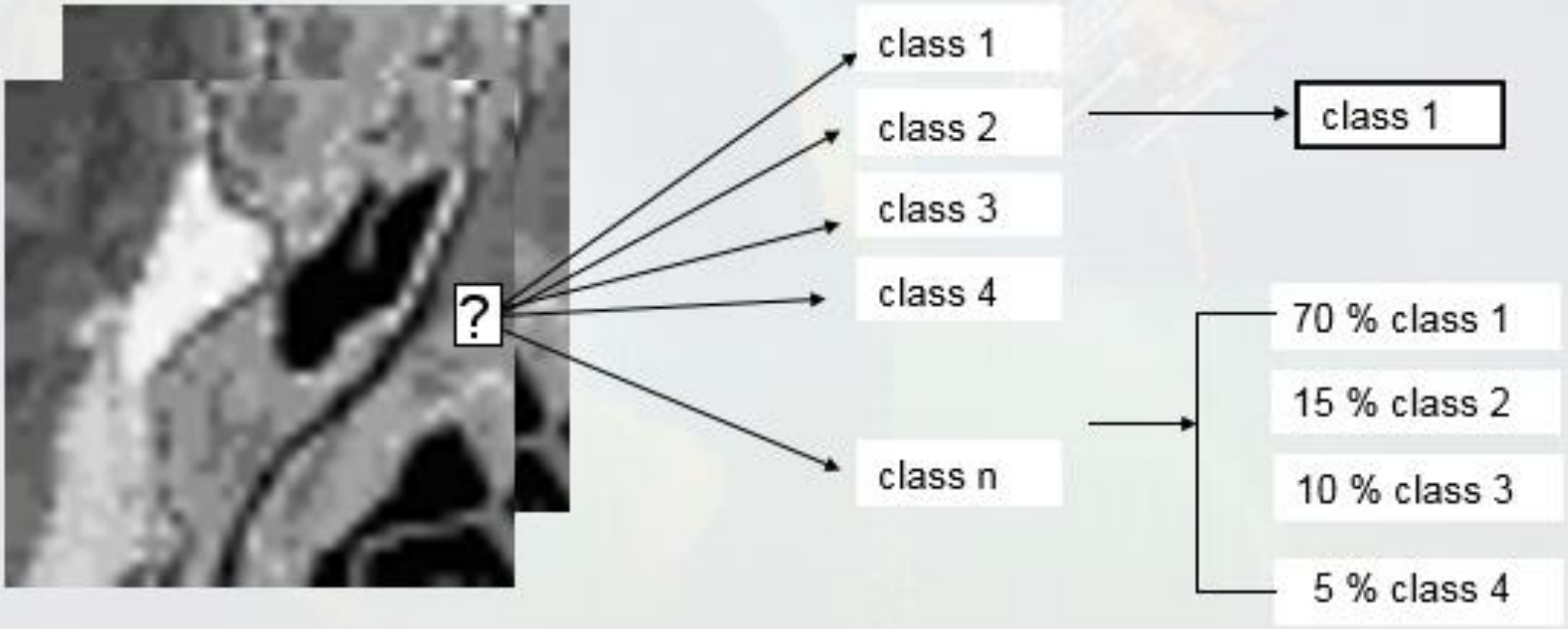
Basis of fuzzy classification system



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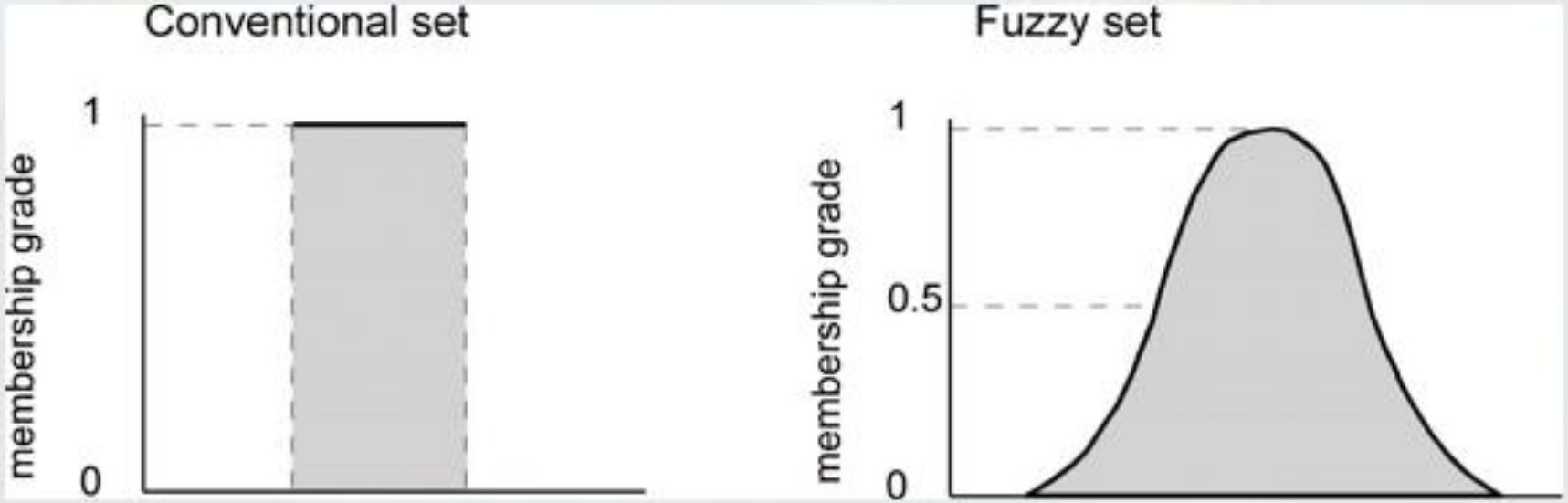
Crisp vs Fuzzy sets



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Types of fuzzy classifications

- Fuzzy k- or c-means (FCM)
  - Parametric, similar to unsupervised clustering, performed on one 'layer' (or band) only. It uses the c-means algorithm of Bezdek
- Fuzzy maximum likelihood
  - Uses the 'hard' mean and 'hard' covariance matrix. Based on Wang's proposition for resolving mixed pixels, fuzzy membership grades for each fixel.
- Fuzzy rule based
  - Requires 'fuzzification' of the layer(s), inference and 'de-fuzzification'.

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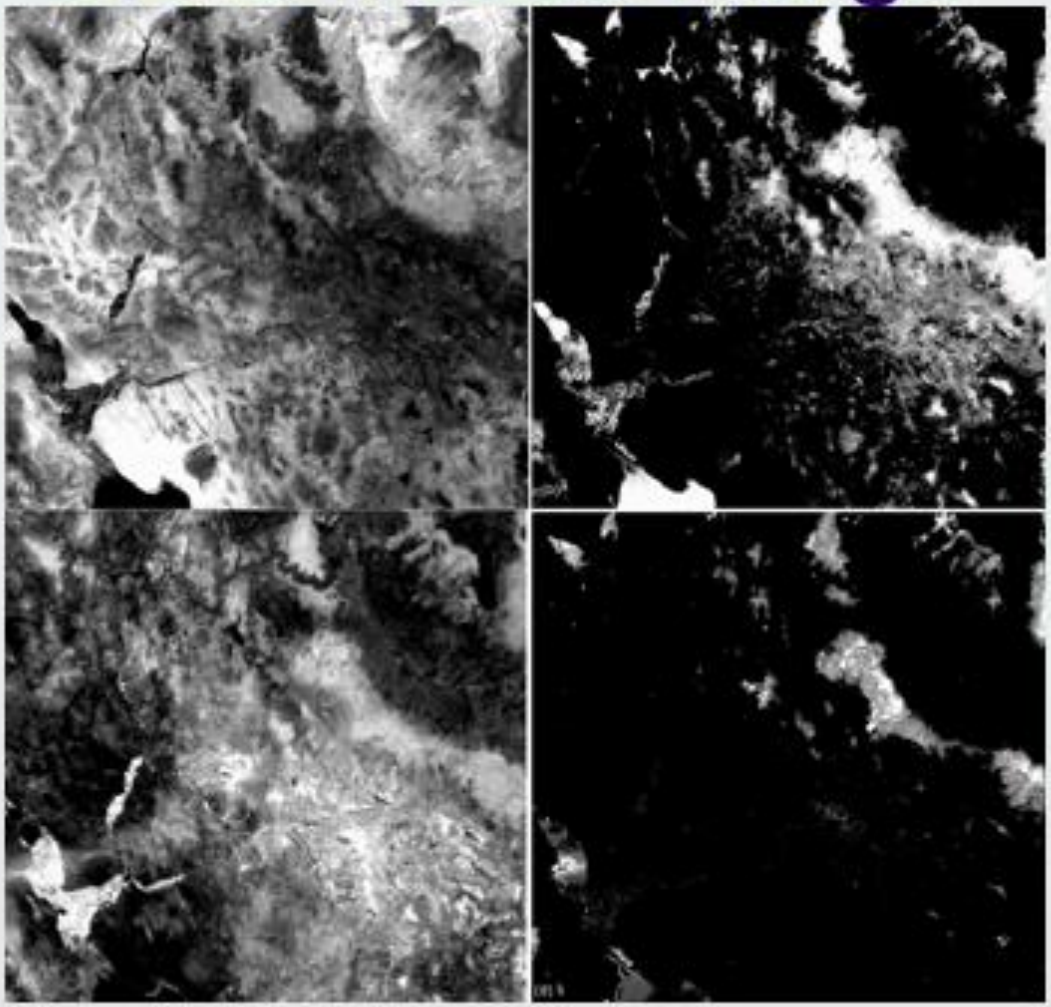
Examples of fuzzy classification of the MODIS image

(a) Soil



(b) Water

(c) Green vegetation

(d) Snow

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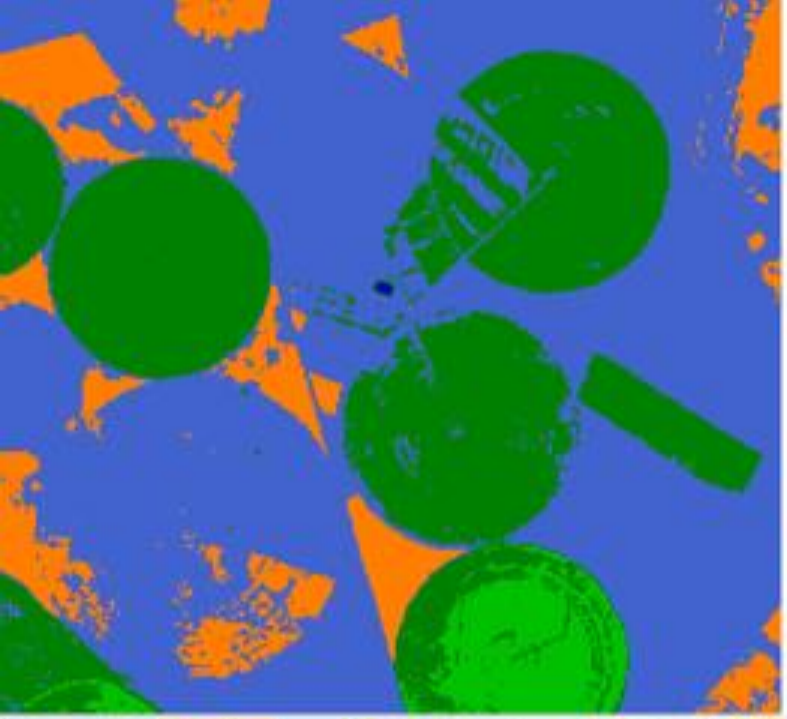

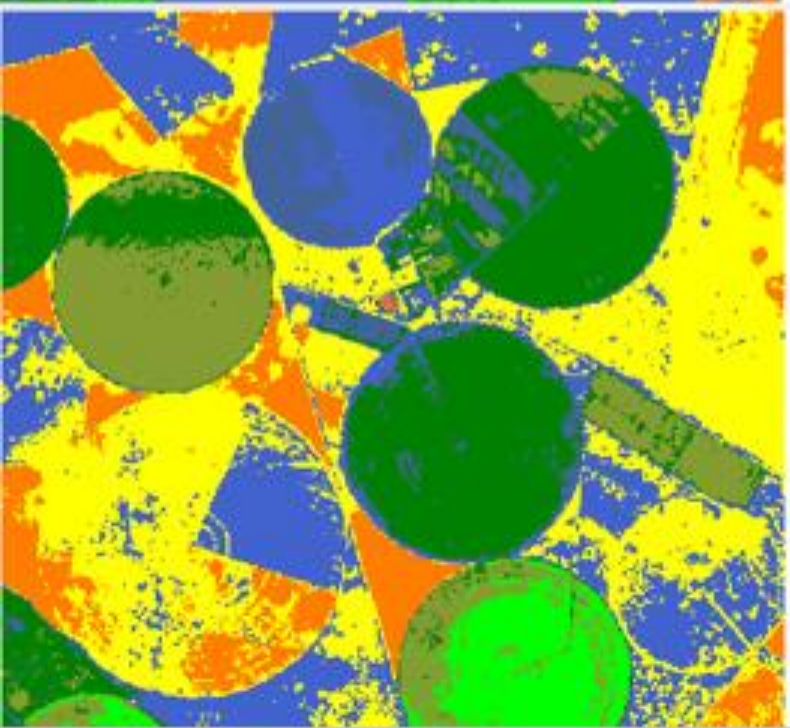

Hard / soft classifier

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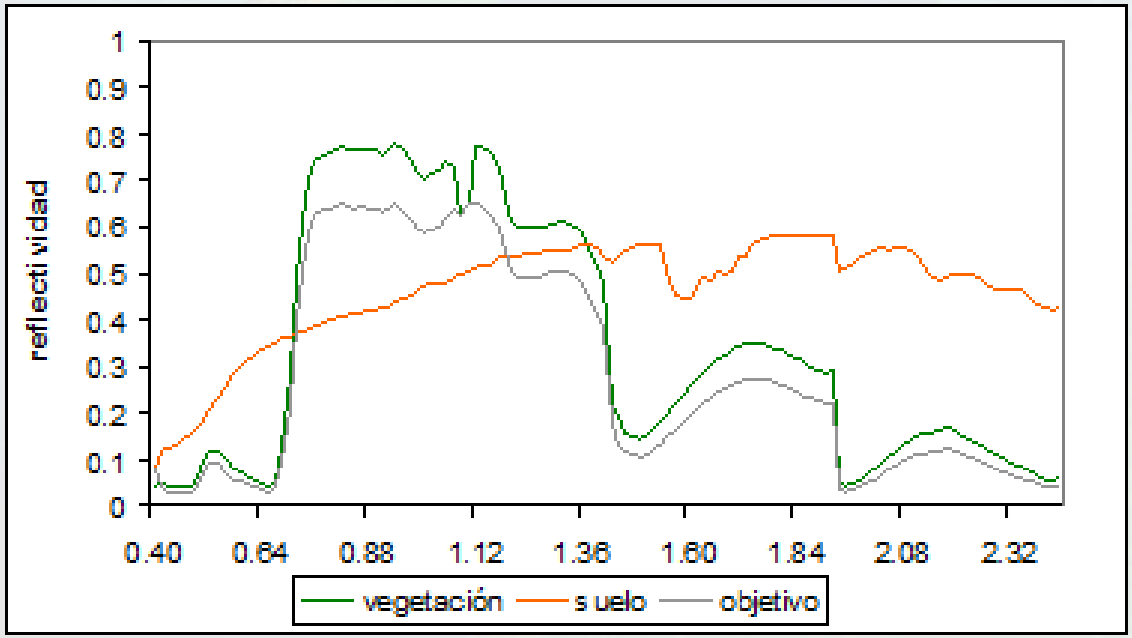
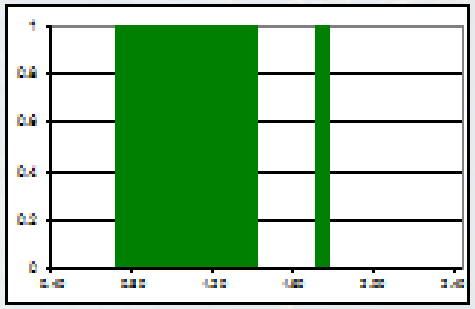
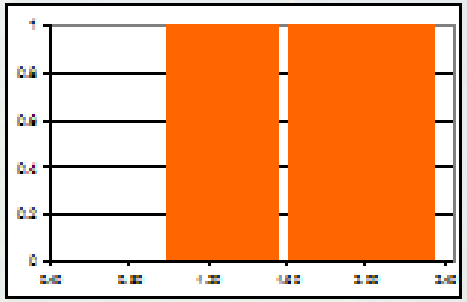
Basis of classification by binary encoding

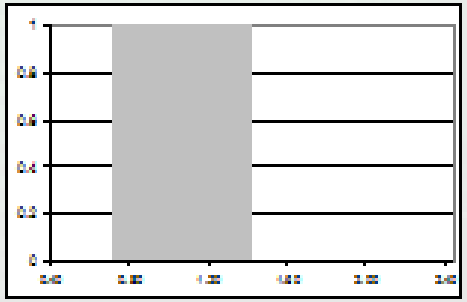




Vegetation



Soil



Target

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Classification with ancillary information

- To stratify the image before the classification: i.e. bioclimatic regions.
- To include additional layers in the classification (DTM, slopes, rainfall...).
- To modify assignments after the classification: boundaries or properties, soil maps, etc.

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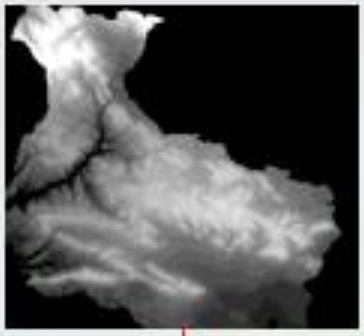
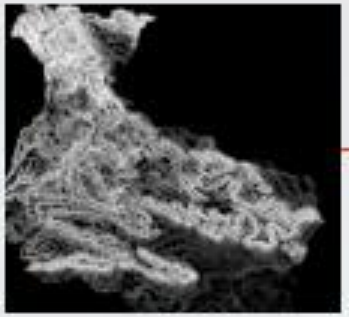


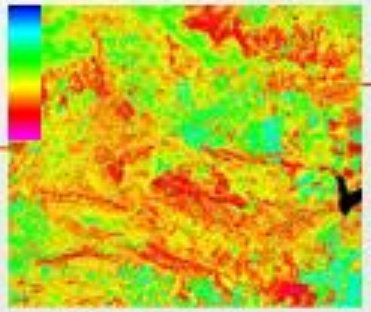
DTM



Slope

Calibrated bands

Raw bands: TM1-TM7



Spectral unmixing and NDVI

Texture

Fuel Mapping

After Riaño et al, 2002

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Change detection

Change detection involves the use of multi-temporal data sets to discriminate areas of land cover change between dates of imaging. Ideally, change detection procedure should involve data acquired by the same (or similar) sensor and be recorded using the same spatial resolution, viewing geometry, spectral bands, radiometric resolution, and time of day. Often anniversary dates are used to minimize sun angle and seasonal differences. Accurate spatial registration of various dates of imagery is also a requirement for effective change detection. Registration to within 0.25 to 0.5 pixel is generally required. Clearly, when misregistration is greater than one pixel, numerous errors will result when comparing the images.

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Change detection

1984

2000

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Change detection methods

- **Image Differencing**

  The most common and simple method

- **Image ratioing**
  - Division of one image by another
  - Operates on individual image bands
  - Areas of 'change' may be thresholded (e.g., > +25% and < -25%)

- **Post-classification comparison**
  - Each image is classified independently, reducing preprocessing need
  - Resulting classifications are compared to identify change
  - Change detection results affected by accuracy of input classifications

- **Change vector analysis**
  - Compares spectral properties of image pixels between dates
  - Expresses change as vectors in spectral space

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Image differencing

- Image differencing or image subtraction simply involves the subtraction of one image from another
- No change = zero, change = +ve or –ve values
- Operates on individual image bands
- Areas of 'change' may be thresholded (e.g., > +25% and < -25%)

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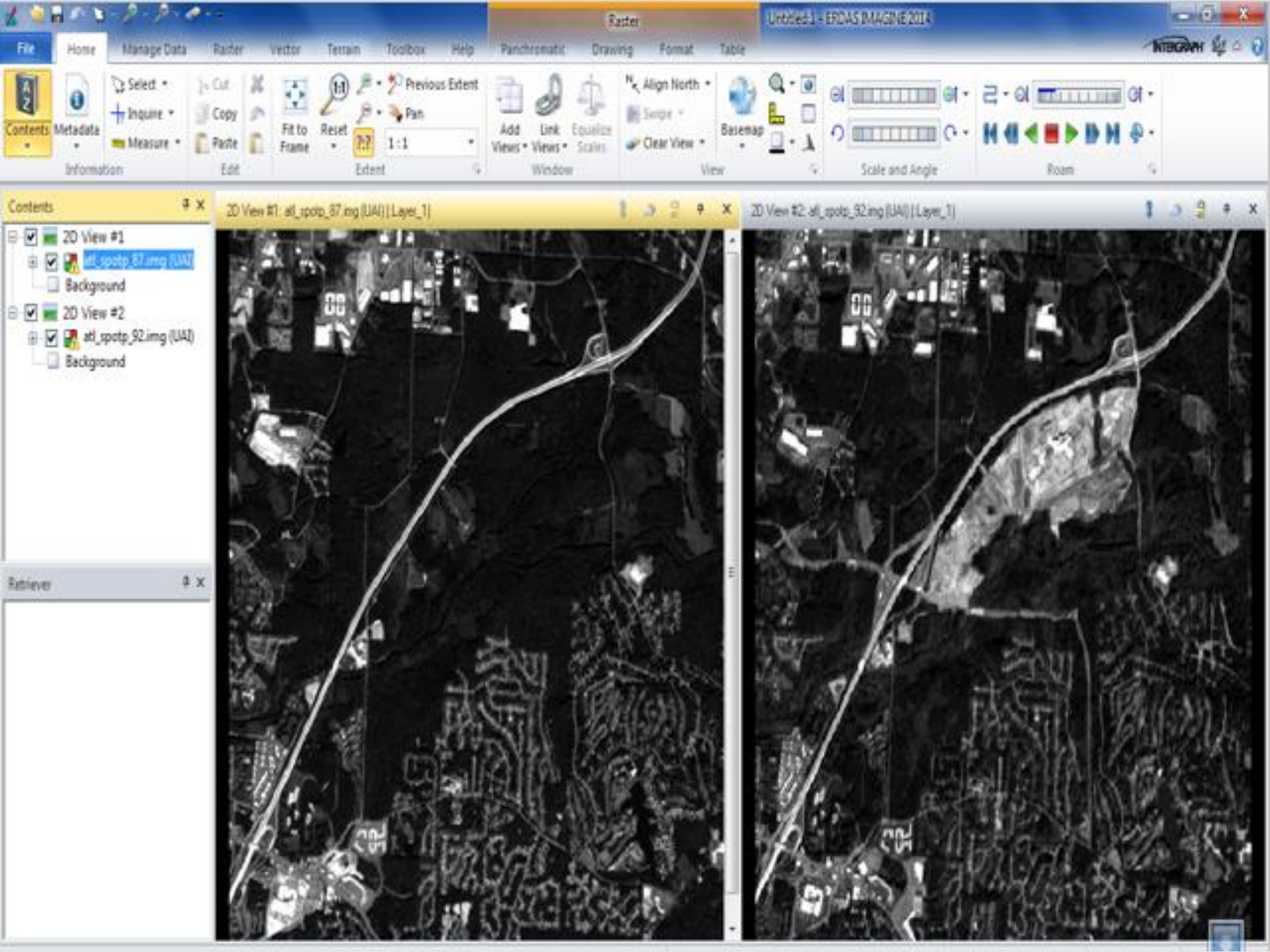
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Raster
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Help
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Format
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Inquire
Measure
Information
Cut
Copy
Paste
Edit
Fit to Frame
Reset
Previous Extent
Pan
1:1
Extent
Add Views
Link Views
Equalize Scales
Window
Align North
Swipe
Clear View
View
Basemap
Scale and Angle
Roam
Contents
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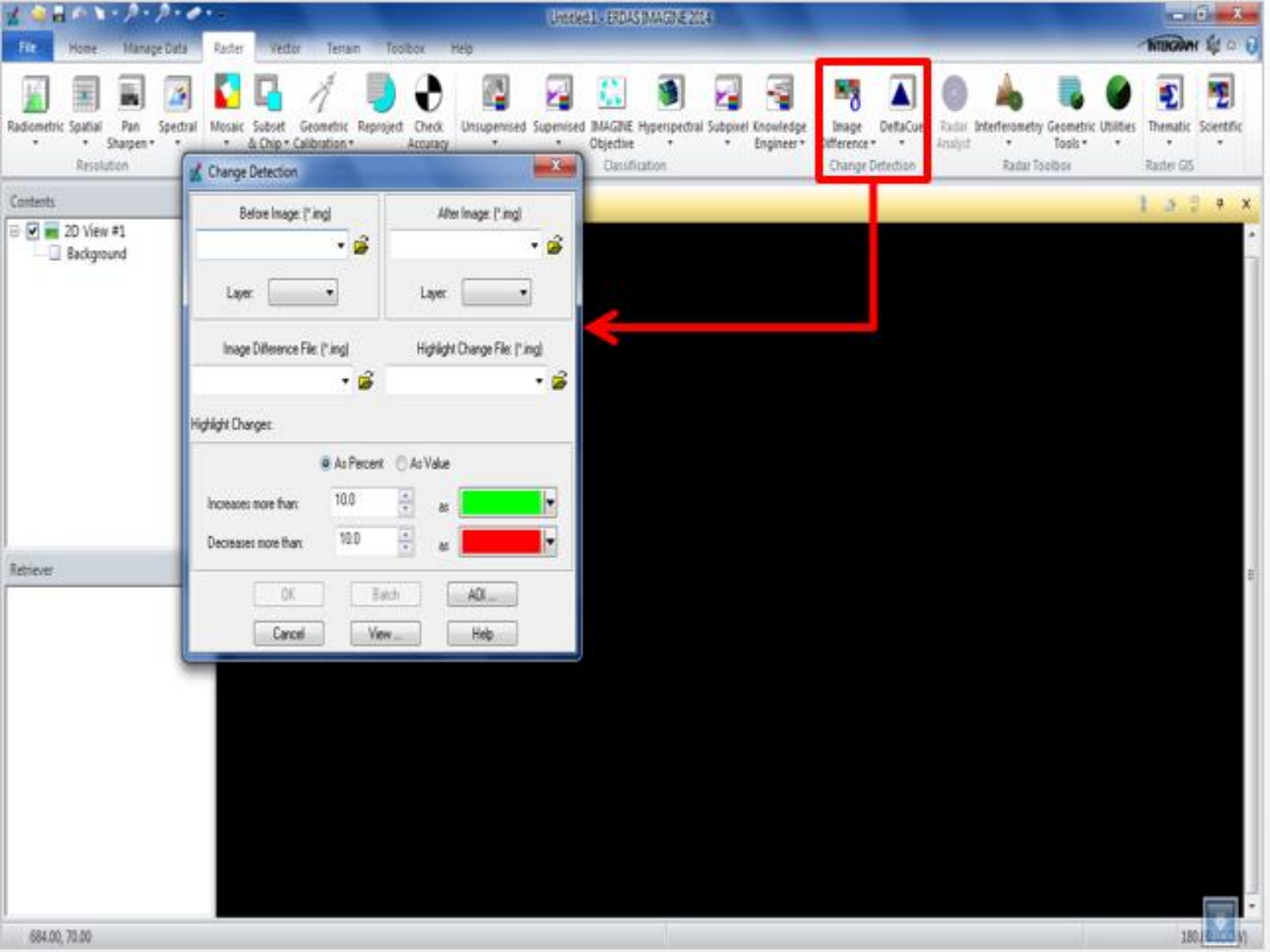
atl_spotp_87.img (UAI)
Background
2D View #2
atl_spotp_92.img (UAI)
Background
Retriever
2D View #1: atl_spotp_87.img (UAI) : Layer_1
2D View #2: atl_spotp_92.img (UAI) : Layer_1


Change Detection
Before Image: (*.img)
After Image: (*.img)
Layer:
Layer:
Image Difference File: (*.img)
Highlight Change File: (*.img)
Highlight Changes:
As Percent
As Value
Increases more than:
10.0
as
Decreases more than:
10.0
as
OK
Batch
AOI...
Cancel
View...
Help
Image Difference
DeltaCue
Change Detection
Contents
2D View #1
Background
Retriever

Untitled:1 - ERDAS IMA...

Raster

File | Home | Manag | Raster | Vector | Terrain | Toolbo | Help | Panchrc | Drawin | Format | Table

INTERGRAPH

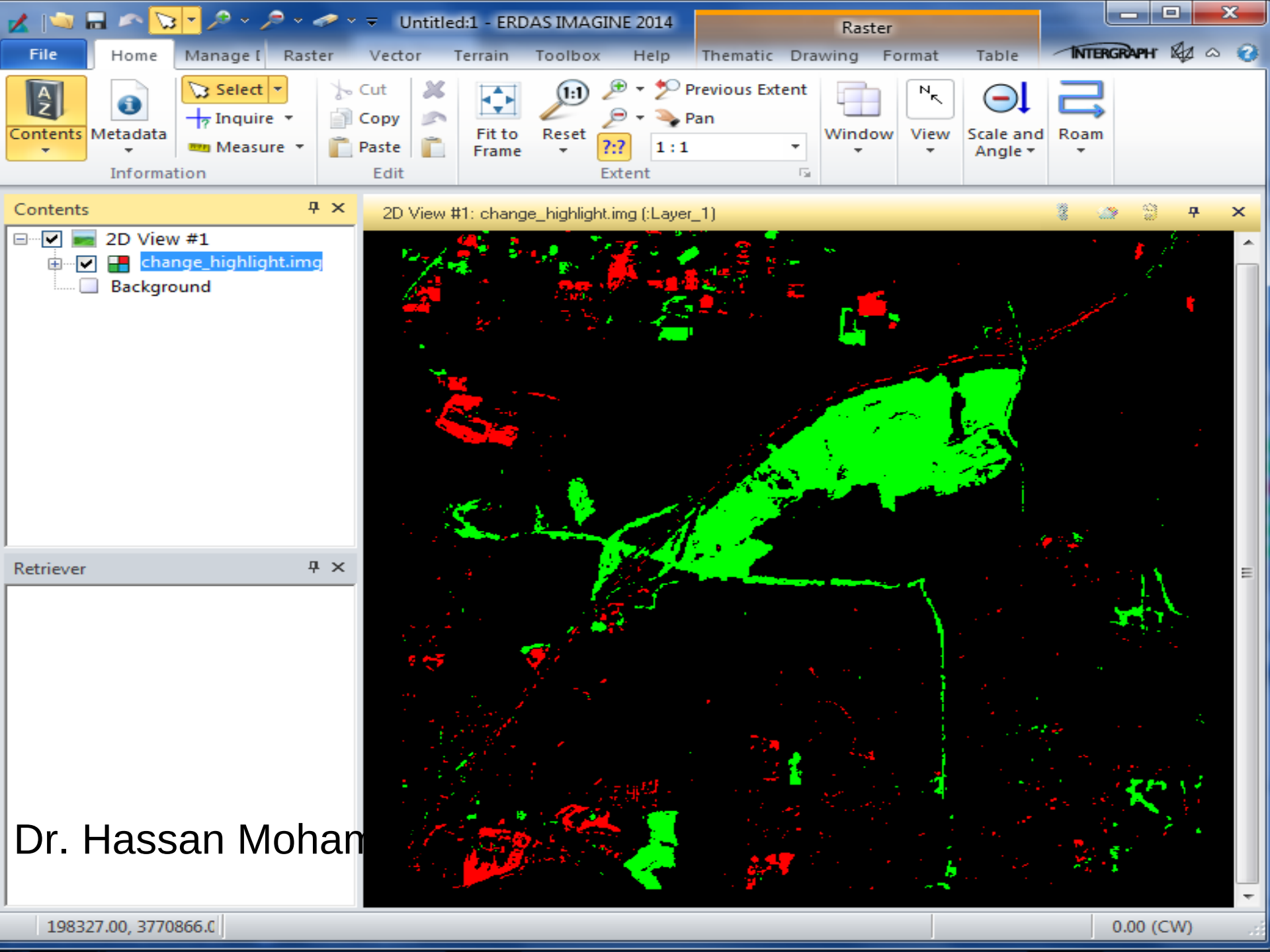
Contents | Metadata | Select | Inquire | Measure | Information | Cut | Copy | Paste | Edit | Extent | Window | View | Scale and Angle | Roam

Contents

- 2D View #1
  - change_diff.img
  - Background

Retriever

2D View #1: change_diff.img (:Layer_1)


Untitled:1 - ERDAS IMAGINE 2014
Raster
File
Home
Manage [
Raster
Vector
Terrain
Toolbox
Help
Thematic
Drawing
Format
Table
INTERGRAPH
Contents
Metadata
Select
Inquire
Measure
Information
Cut
Copy
Paste
Edit
Fit to Frame
Reset
Previous Extent
Pan
1 : 1
Extent
Window
View
Scale and Angle
Roam
Contents
2D View #1
change_highlight.img
Background
Retriever
2D View #1: change_highlight.img (:Layer_1)
Dr. Hassan Moham
198327.00, 3770866.0
0.00 (CW)

Dr. Hassan Mohamed

Chuvieco and Huete (2009): Fundamentals of Satellite Remote Sensing, Taylor and Francis