Image Digital Analysis for River Segmentation and Biodiversity Assessment

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Digital Image Analysis for River Segmentation and Biodiversity Assessment

- **Getting Information**
    - IES, INSPIRE, IDEE-Spain

- **To get information**
    - Hydraulic and environmental information IES
    - Topographic and photogram mosaic

- **Methodology for segmentation**
    - RGB and ISODATA
    - Contextural Patches SCRM (Size-Constrained Region Merged)

- **Texture and diversity Indexes in GIS**

Object of study

Digital Images

Diversity Index

Segmentation

Getting Information

IES: **Institute of Environment and Sustainability**

Hydraulic and environmental information

IES-JRC   http://ies.jrc.ec.europa.eu/index.php

-Geological
-Soil
-Hydraulic
-CMM
-Floods
-WISE

-Land cover
-CORINE

-Desertification

- Image 2000 & Corine Land Cover 2000 Project

http://image2000.jrc.ec.europa.eu

http://mapserver.jrc.ec.europa.eu/website/image2000/viewer.htm

- Catchment Characterisation and Modelling (CCM)

http://ccm.jrc.ec.europa.eu/php/index.php?action=view&id=23

- Water Information System for Europe (WISE)

http://www.wise-rtd.info/wpis/wise.html

-Topography and Photogram mosaic

-*Spatial Infrastructure Information Directive*

- -TM Land Sat

- -Ancillary photogram

- -Current information

-*Google*

-*SIPAC or SIA (DataBase of some European countries)*

INSPIRE An European Directive

-INSPIRE (Infrastructure for Spatial Information in Europe)

http://inspire.jrc.it/reports/MoU.pdf

http://www.idee.es

# Spanish INSPIRE Application: IDEE
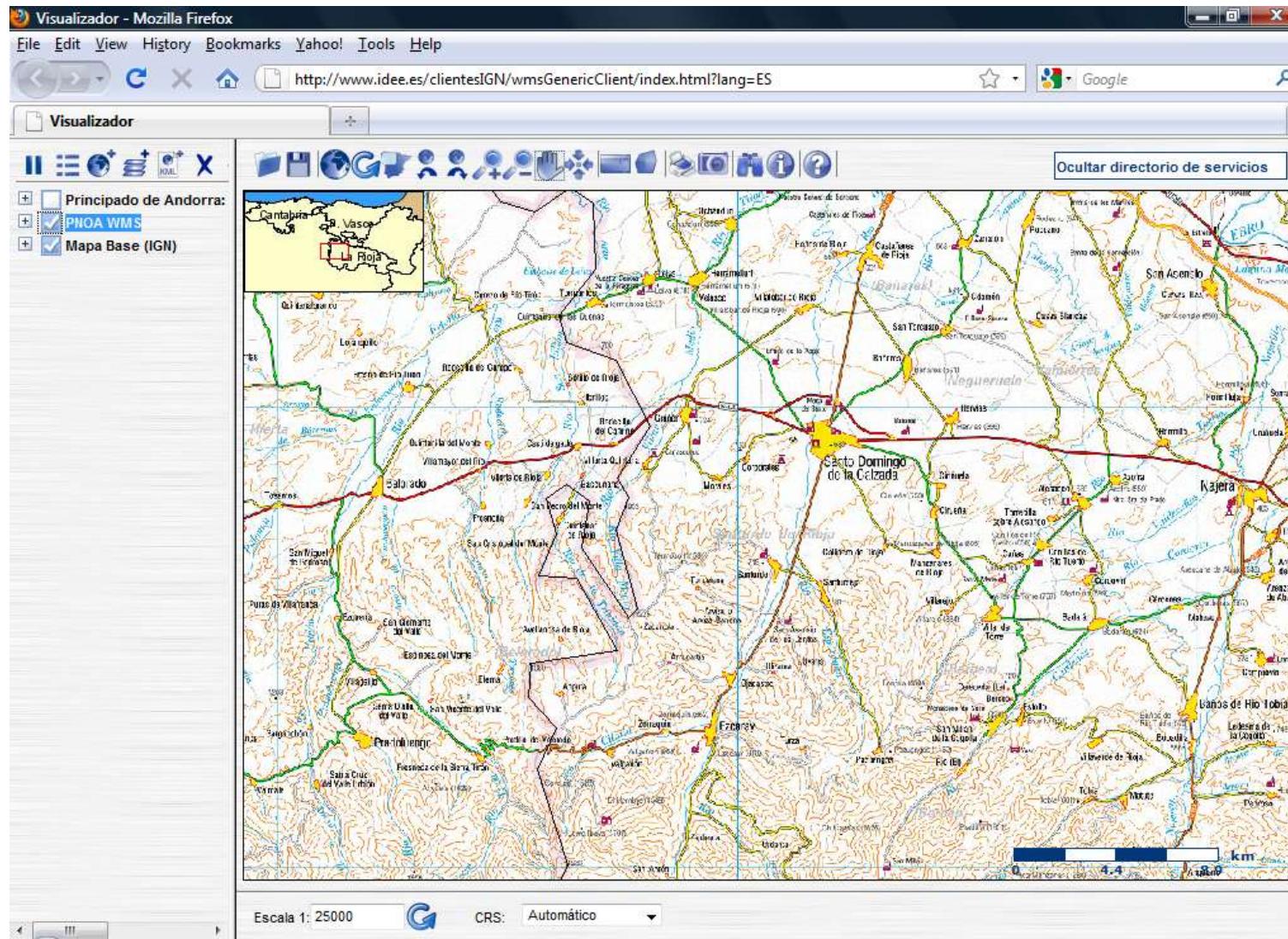
Fluvial Landscape Analysis

•**Current Photogram**

•**American Photo Flight 1956**
  - Photogram

• **Mosaic of photogram and bank changes**

• **Segmentation**
  - Fragmentation index
  - Grey Break and ISODATA
  - SCRM (Size-Constrained Region Merged)

• **Fluvial Change Determination**

Current Photogram (IDEE-Spain)

Ancillary Information
American Photo Flight 1959

vista 3
vista 4
vista 5
vista 6
vista 7
vista 8
vista 9
vista 10
vista 11
vista 12
vista 13
vista 14
vista 15
vista 16
vista 17

Fotografías
aéreas

Límites
vistas
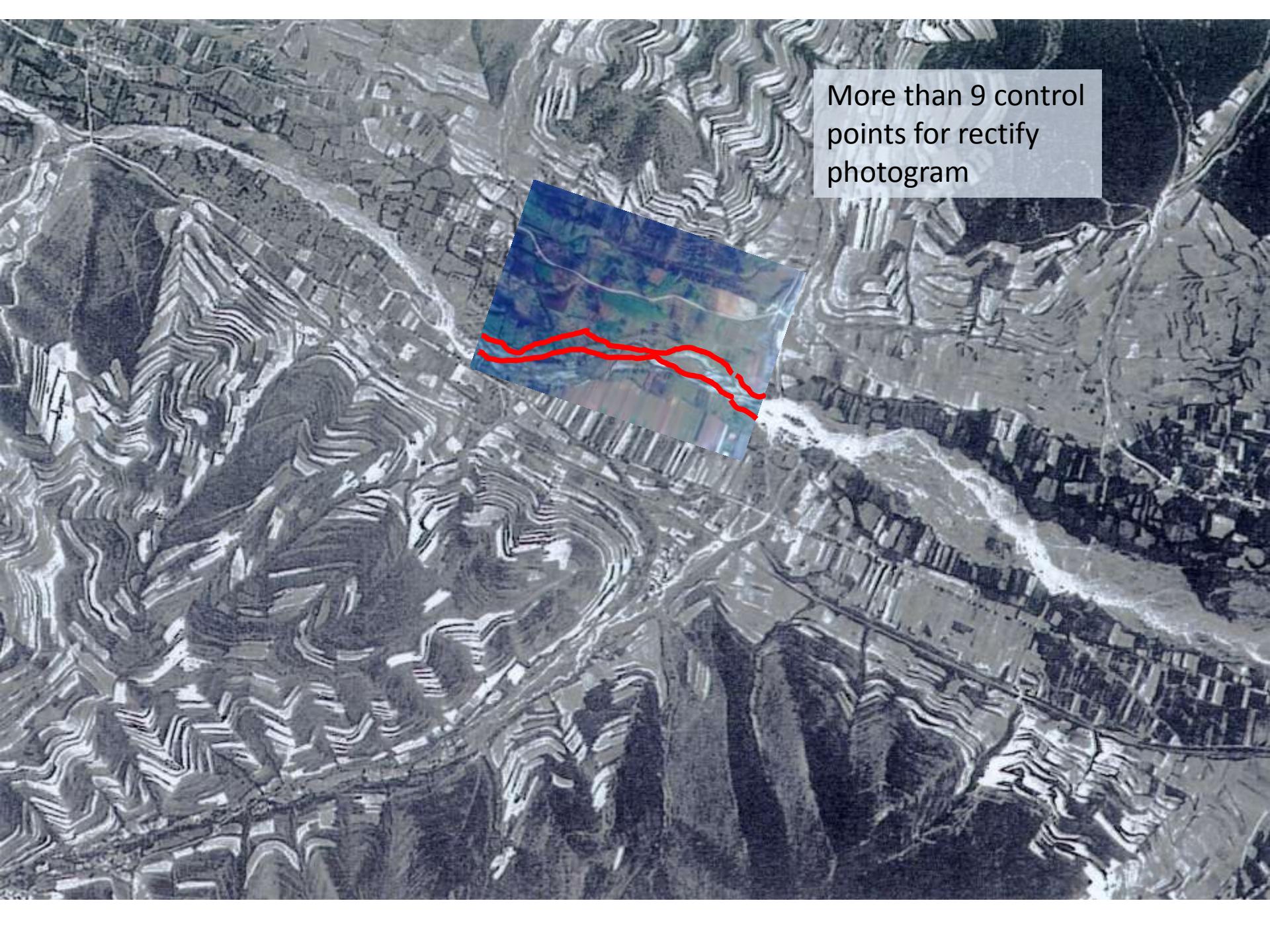
More than 9 control points for rectify photogram
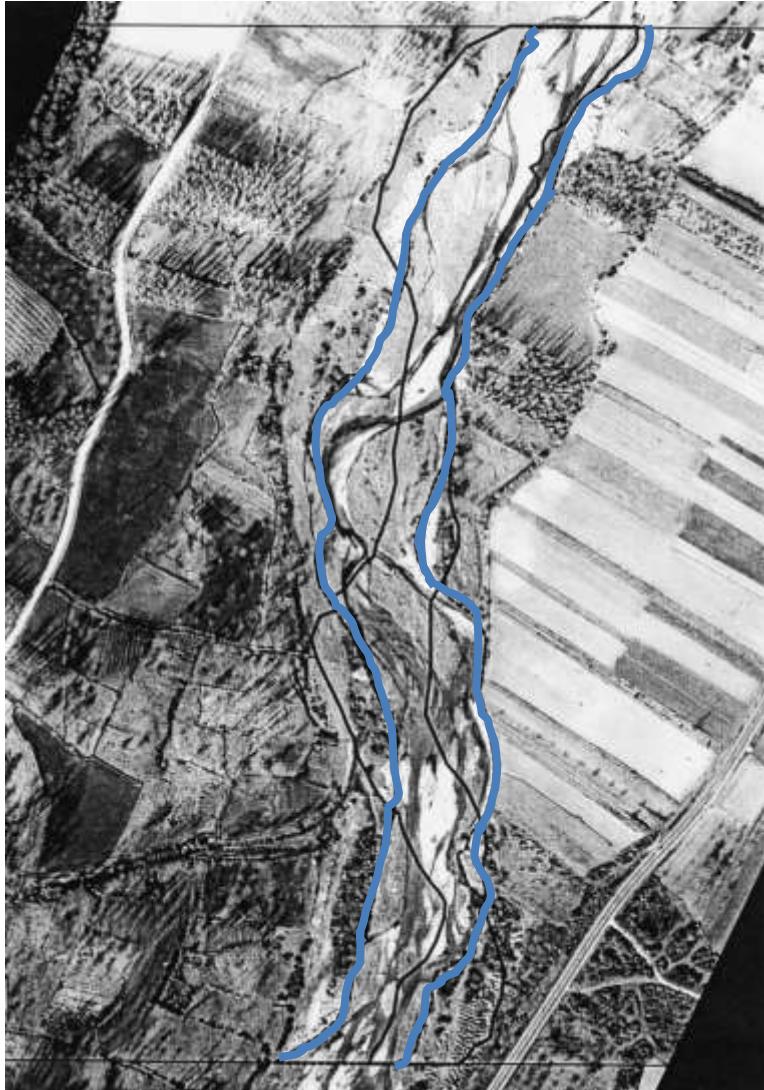
Old (1959)   New (1999)
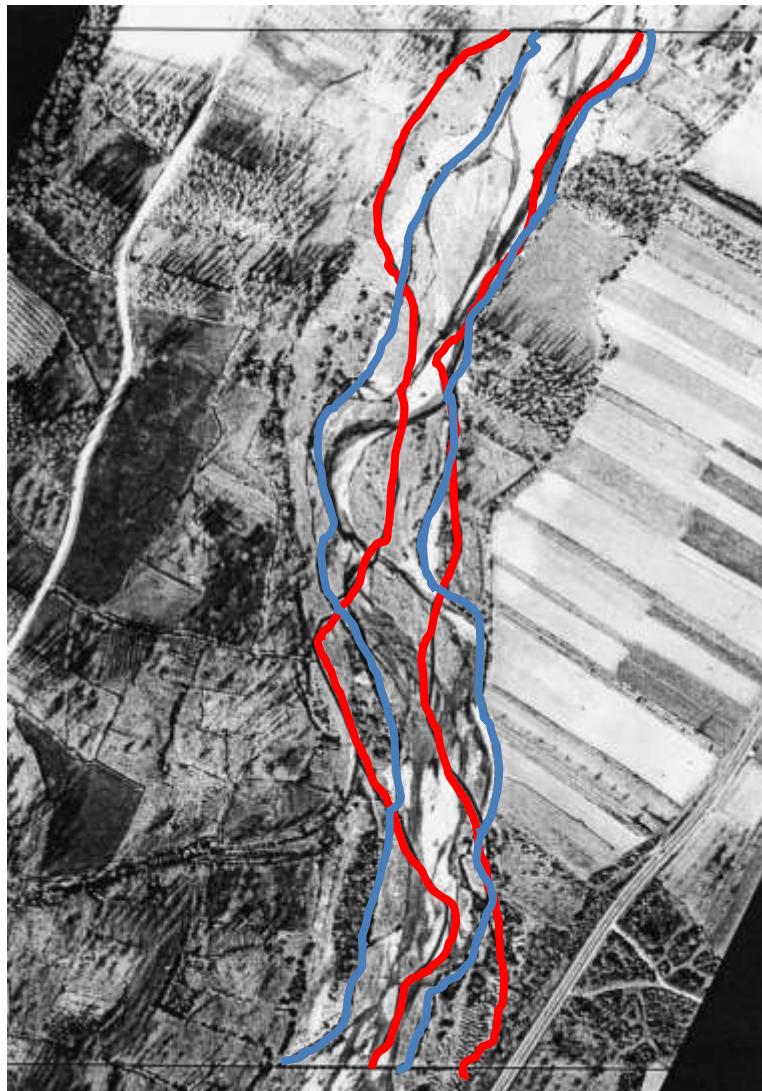
New (1999)

New (2006)

ARCVIEW / ARGIS / ERDAS / ENVI
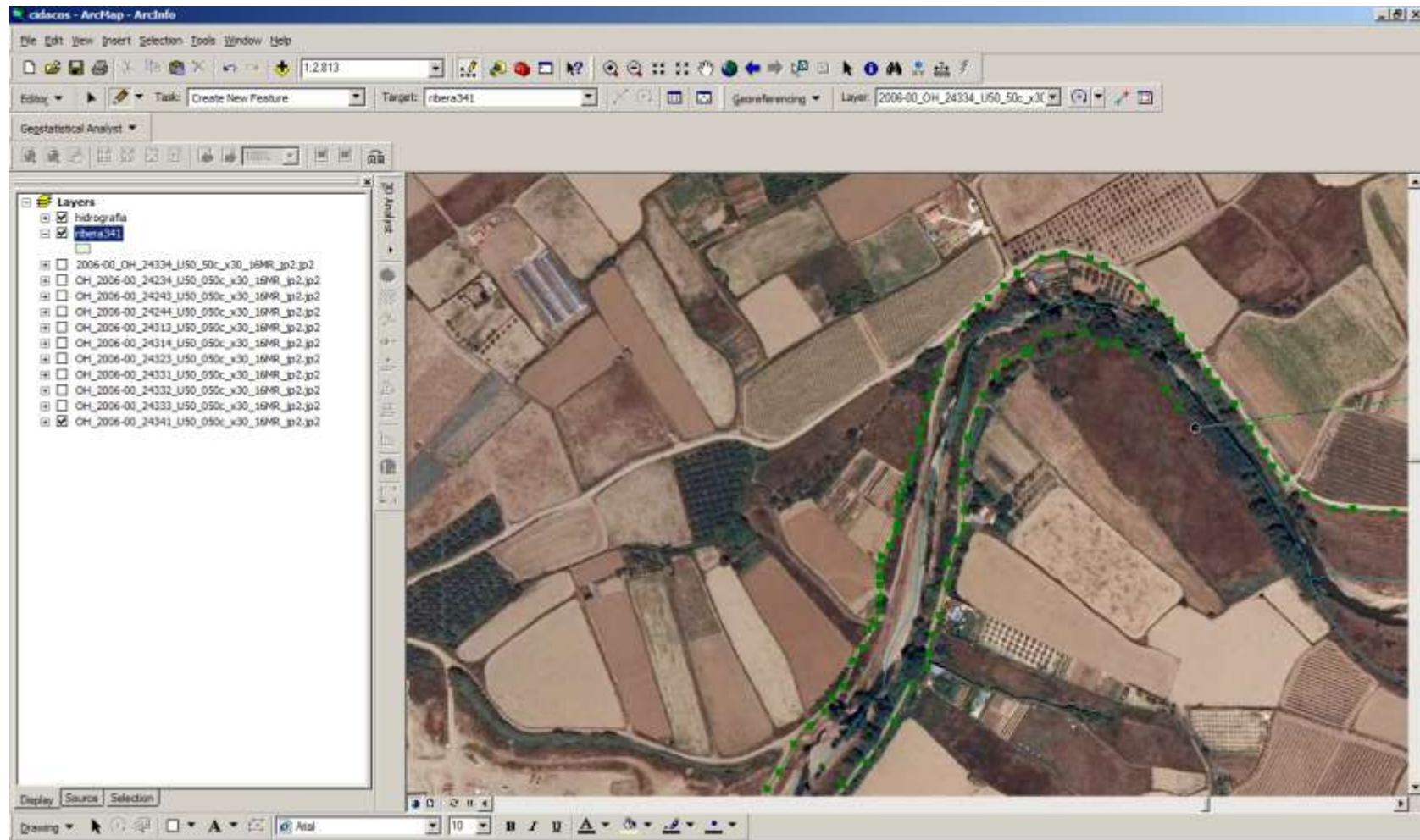
ARCVIEW / ARGIS / ERDAS / ENVI
Texture analysis and Unsupervised Classification
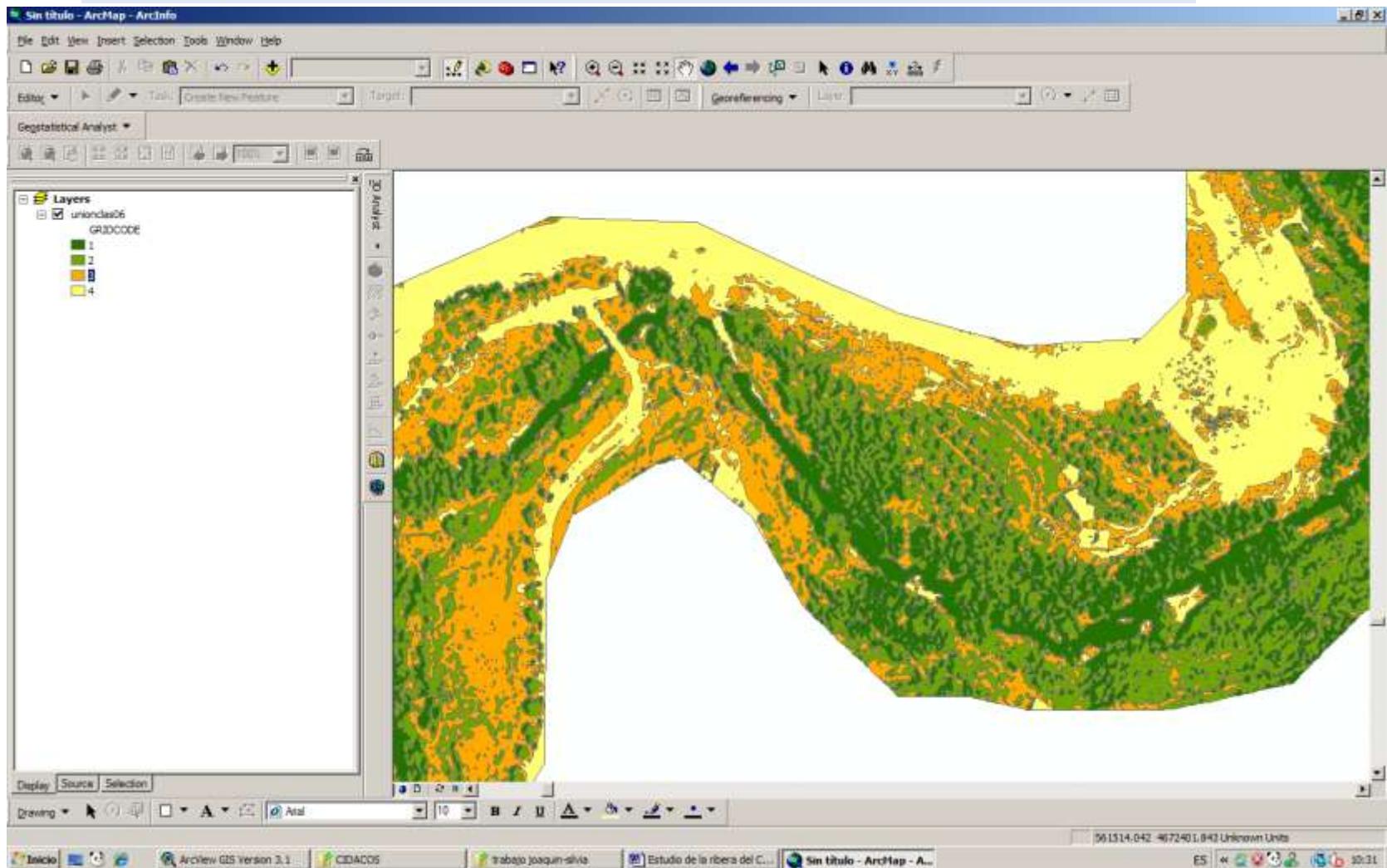
Texture analysis
Unsupervised Classification: RGB, ISODATA, Euclidean, K-mean

ERDAS / ENVI: Texture analysis

	Índice
CA	class area
TLA	total landscape area
patch density and size metrics	
NUMP	num of patches
MPS	mean patch size
MEDPS	median patch size
PSCOV	patch size coefficient of variance
PSSD	patch size standard deviation
edge metrics	
TE	total edge
ED	edge density
MPE	mean patch edge
shape metrics	
MSI	mean shape index
AWMSI	area weighted mean shape index
MPAR	mean perimeter-area ratio
diversity metrics	
SDI	Shannon's diversity index
SEI	Pielou's evenness index

METRIC INDEXES

1- Class Area
Sum of areas of patches for a class:

$$CA = \sum A_{tesela}$$

2- Landscape Area
Total sum of areas of all patches:

$$TLA = \sum A_{landscape}$$

SIZE and DENSITY OF PATCHES INDEXES

1-**Number of Patches** (NUMP)
Number of patches. Very usefull (Iverson 1998, Turner & Ruscher 1995)

2-**Mean Patch Size** (MPS)
Mean size of patches. The greater fragmentation the lower index

$$MPS = \frac{\sum A_{teselas}}{NUMP}$$

3- Median Patch Size (MEDPS)
Median Patch size

4- Patch Size Coefficient of Variance (PSCOV)
Variance of patch sizes in %.

$$PSCOV = \left(\frac{MEDPS}{MPS}\right)100$$

5- Patch Size Standard Deviation (PSSD)
Standard deviation of patch sizes.

EDGE INDEXES

1- Total Edge (TE)
Patch Edges Summation in meters.

$$TE = \sum_{tesela} Perímetro$$

2- Edge Density (ED)

$$ED = \frac{TE}{TLA}$$

3- Mean Patch Edge (MPE)

Average of Edge per patch:

$$MPE = \frac{TE}{NUMP}$$

SHAPE INDEXES

1-**Mean Shape Index** (MSI)
It measures complexity and sharpness of patches. The index is one when the patch is a circle else it is bigger.

$$MSI = \frac{\left(\sum_{tesela} Perímetro / Area\right)_{AJUSTADO\ PARA\ CIRCULOS\ ESTANDAR}}{NUMP}$$

(McGaril and Marks 1994).

2- **Mean Perimeter-Area Ratio** (MPAR)
It measure complexity as well.

$$MPAR = \frac{\sum_{tesela} Perímetro / Area}{NUMP}$$

INFORMATION DIVERSITY INDEXES

1-Shannon Index

$$H = -\sum_i p.\log(p)$$

2-Evenness Index

$$EI = \frac{H}{\log(n)}$$

CLASS DISTRIBUTION 2006 PHOTOGRAM

	Clase 1	Clase 2	Clase 3	Clase 4	Total
CA	173.68015	235.31783	149.352928	155.468596	713.823257
TLA	713.823257	713.823257	713.823257	713.823257	713.823257
patch density and size metrics					
NUMP	106044	197985	214839	57247	576192
MPS	0.00163781	0.00118856	0.00069519	0.00271575	0.00123886
MEDPS	5.9224E-05	0.00005	0.00005	5.0095E-05	0.00005
PSCOV	2248.38777	2755.9155	2082.35527	3027.68131	2986.01058
PSSD	0.03682437	0.03275582	0.01447623	0.08222428	0.0369926
edge metrics					
TE	1520499.7	2912517.51	2273387.3	897773.417	7604425.31
ED	2130.07868	4080.16617	3184.80418	1257.69707	10653.0927
MPE	14.3383851	14.7107988	10.5818185	15.6824535	13.197728
shape metrics					
MSI	1.40518768	1.41106216	1.4118214	1.42055258	1.41120116
AWMSI	9.30199484	15.4164001	9.0212298	10.2486023	11.4650429
MPAR	62493.4644	65761.5899	67498.5202	68587.5815	66090.9481
diversity metrics					
SDI					1.36905124
SEI					0.85063936

CLASS DISTRIBUTION 2004 PHOTOGRAM

	Clase 1	Clase 2	Clase 3	Clase 4	Total clases
CA	166.871793	131.644558	91.3201434	124.756322	514.592817
TLA	514.592817	514.592817	514.592817	514.592817	514.592817
patch density and size metrics					
NUMP	57734	146032	138687	36017	378470
MPS	0.00289036	0.00090148	0.00065846	0.00346382	0.00135967
MEDPS	0.0001	0.0001	0.0001	0.0001	0.0001
PSCOV	2342.23615	1567.31167	999.666889	2685.37981	2956.99059
PSSD	0.06769895	0.01412896	0.00658243	0.09301666	0.0402052
edge metrics					
TE	1034561.07	1728346.9	1392845.09	689089.04	4844842.1
ED	2010.446	3358.66891	2706.69361	1339.09572	9414.90425
MPE	17.9194421	11.8353984	10.0430833	19.1323275	12.8011258
shape metrics					
MSI	1.35684277	1.33272392	1.31347268	1.36749644	1.33265782
AWMSI	9.00501664	6.05364794	3.96070988	8.43032064	7.21549418
MPAR	39100.1298	37810.8875	37416.3925	37590.736	37842.046
diversity metrics					
SDI					1.36431007
SEI					0.98414168

INDEX COMPARISON

	2004	2006
CA	514.592817	713.823257
TLA	514.592817	713.823257
patch density and size metrics		
NUMP	378470	576192
MPS	0.00135967	0.00123886
MEDPS	0.0001	0.00005
PSCOV	2956.99059	2986.01058
PSSD	0.0402052	0.0369926
edge metrics		
TE	4844842.1	7604425.31
ED	9414.90425	10653.0927
MPE	12.8011258	13.197728
shape metrics		
MSI	1.33265782	1.41120116
AWMSI	7.21549418	11.4650429
MPAR	37842.046	66090.9481
diversity metrics		
SDI	1.36431007	1.36905124
SEI	0.98414168	0.85063936

Class 1: Wood area

	2004	2006
CA	166.871793	173.68015
TLA	514.592817	713.823257
patch density and size metrics		
NUMP	57734	106044
MPS	0.00289036	0.00163781
MEDPS	0.0001	5.9224E-05
PSCOV	2342.23615	2248.38777
PSSD	0.06769895	0.03682437
edge metrics		
TE	1034561.07	1520499.7
ED	2010.446	2130.07868
MPE	17.9194421	14.3383851
shape metrics		
MSI	1.35684277	1.40518768
AWMSI	9.00501664	9.30199484
MPAR	39100.1298	62493.4644

Class 2: Spare trees and shrubs

	2004	2006
CA	131.644558	235.31783
TLA	514.592817	713.823257
patch density and size metrics		
NUMP	146032	197985
MPS	0.00090148	0.00118856
MEDPS	0.0001	0.00005
PSCOV	1567.31167	2755.9155
PSSD	0.01412896	0.03275582
edge metrics		
TE	1728346.9	2912517.51
ED	3358.66891	4080.16617
MPE	11.8353984	14.7107988
shape metrics		
MSI	1.33272392	1.41106216
AWMSI	6.05364794	15.4164001
MPAR	37810.8875	65761.5899

Class 3: Stones and bushes

	2004	2006
CA	91.3201434	149.352928
TLA	514.592817	713.823257
patch density and size metrics		
NUMP	138687	214839
MPS	0.00065846	0.00069519
MEDPS	0.0001	0.00005
PSCOV	999.666889	2082.35527
PSSD	0.00658243	0.01447623
edge metrics		
TE	1392845.09	2273387.3
ED	2706.69361	3184.80418
MPE	10.0430833	10.5818185
shape metrics		
MSI	1.31347268	1.4118214
AWMSI	3.96070988	9.0212298
MPAR	37416.3925	67498.5202

Class 4: Neat surface and water

	2004	2006
CA	124.756322	155.468596
TLA	514.592817	713.823257
patch density and size metrics		
NUMP	36017	57247
MPS	0.00346382	0.00271575
MEDPS	0.0001	5.0095E-05
PSCOV	2685.37981	3027.68131
PSSD	0.09301666	0.08222428
edge metrics		
TE	689089.04	897773.417
ED	1339.09572	1257.69707
MPE	19.1323275	15.6824535
shape metrics		
MSI	1.36749644	1.42055258
AWMSI	8.43032064	10.2486023
MPAR	37590.736	68587.5815

CONCLUSSIONS

- A positive change has appeared from 2004 to 2006.

- River surface has been increased, and spare tree and shrub areas have been which have the largest increased amount

- From 2004 to 2006, wood river areas have been decreased and their mean patch size has been reduced as well

UNSUPERVISED METHOD: ISODATA

Foundations:

- Groups are made by proximity and similar classes have similar component bands.

- It is an no control procedure therefore some times results are difficult to understand.

UNSUPERVISED METHOD PHASES

- 1st PHASE: Variables selection

- 2ND PHASE: Set a procedure to calculate distance: Euclidean, Manhattan, Mahalanobis

- 3RD PHASE: Set a procedure to make clusters: Nearest neighbours, farthest neighbours

PHASE 1st: Variable selection

- Origin images: RGB, SPOT123, TM432

- Composition bands: PC, Artificial bands

- Euclidean distance

$$D_{a,b} = \sqrt{\sum_{1}^{m}(ND_{a,k} - ND_{b,k})^2}$$

Da,b: Distance between pixels a to b.

ND a,k; ND b,k: digital levels for k bands.

m: number of bands.

FASE 3: ISODATA Clustering procedure

Steps:

- i) Set a determined number of centre of classes selected by the user

- ii) Each point joins in with the nearest class

- iii) Recalculation all centre of classes

- iv) Each group is merged with the nearest others

- v) Reiteration until convergence of groups

5 arbitrary cluster means in two-dimensional spectral space
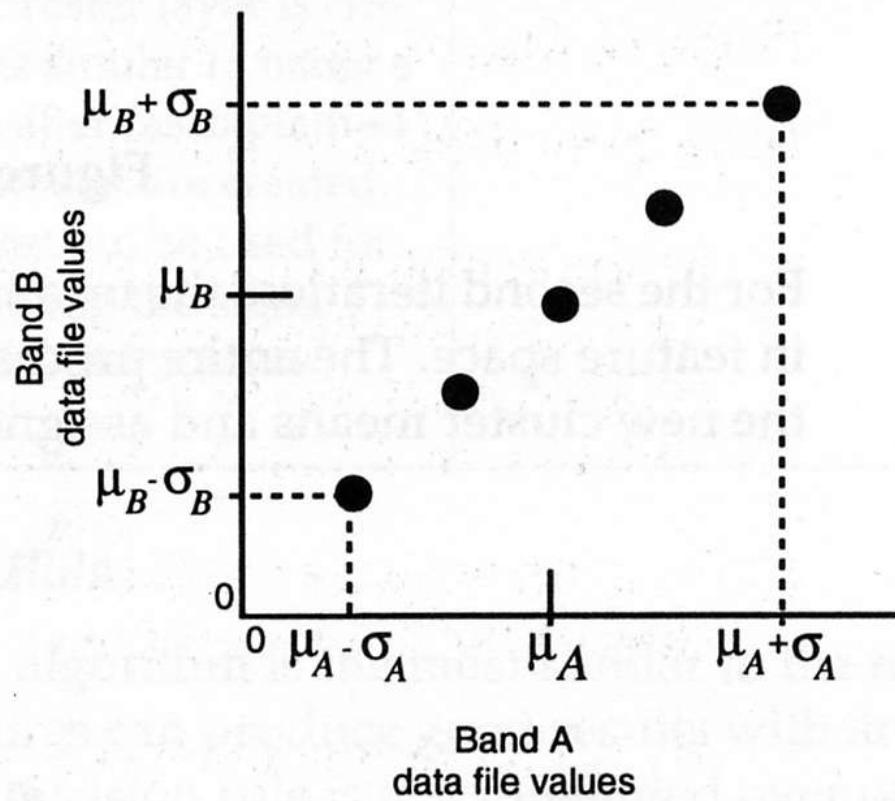
Figure 91: ISODATA Arbitrary Clusters
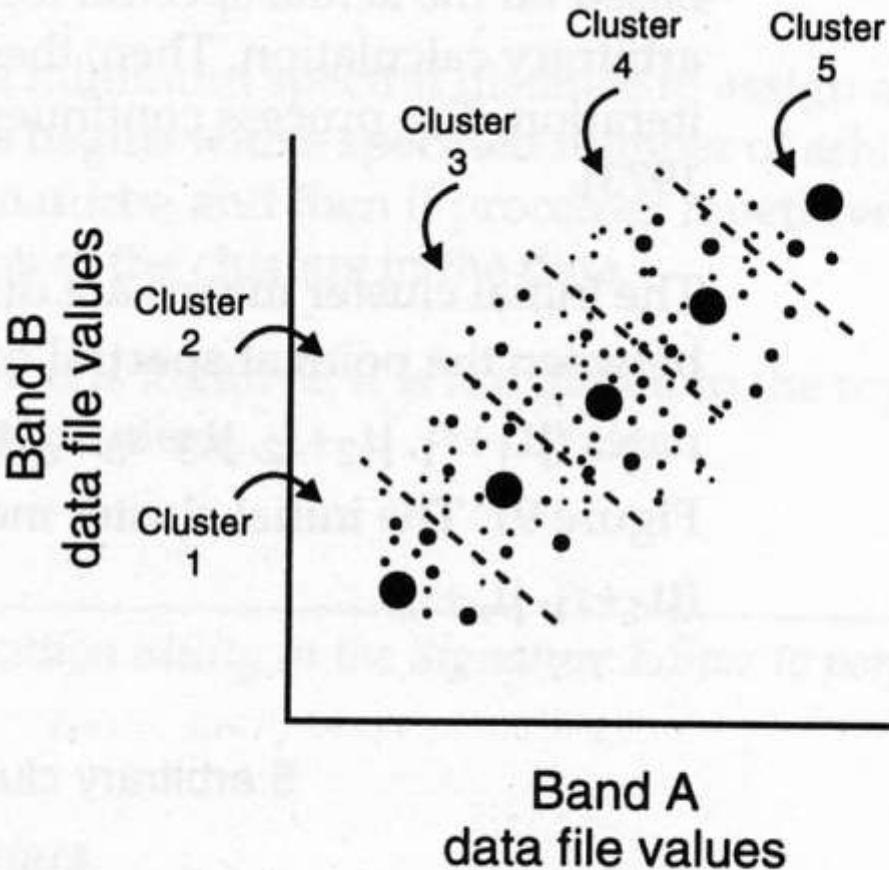
Figure 92: ISODATA First Pass
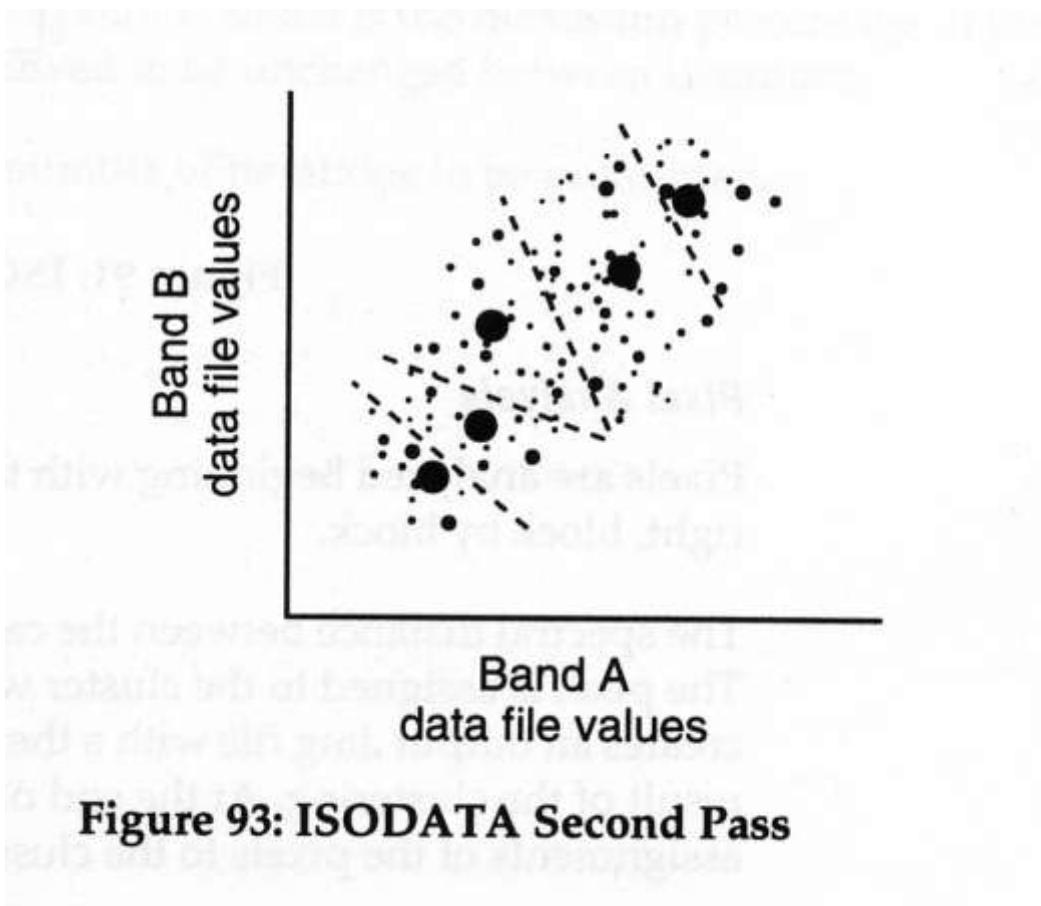
Figure 93: ISODATA Second Pass

SCRM: Size Constrained Region Merged
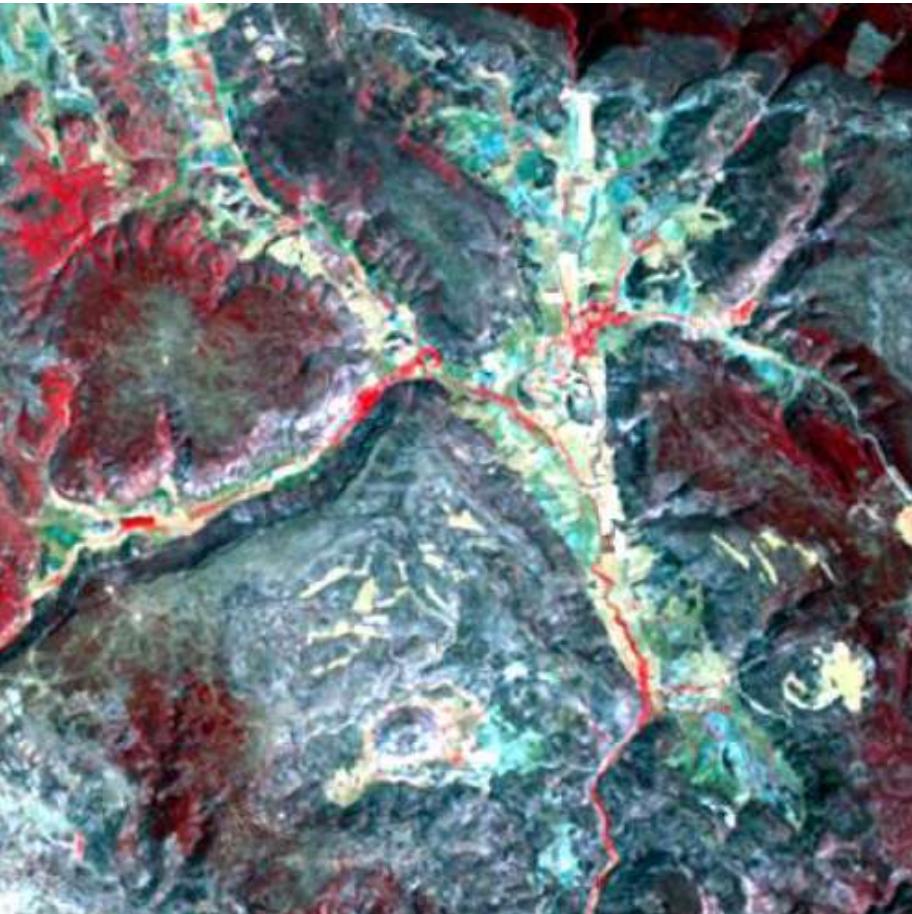
TM RGB 432
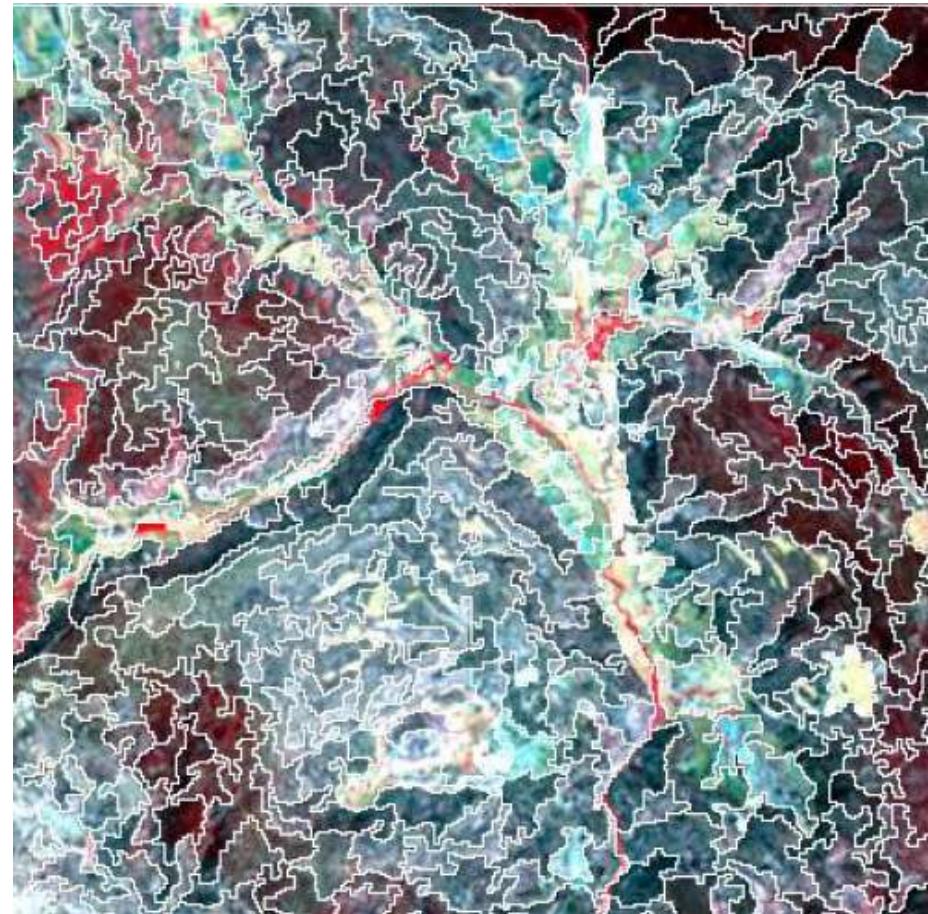
Watershed partition
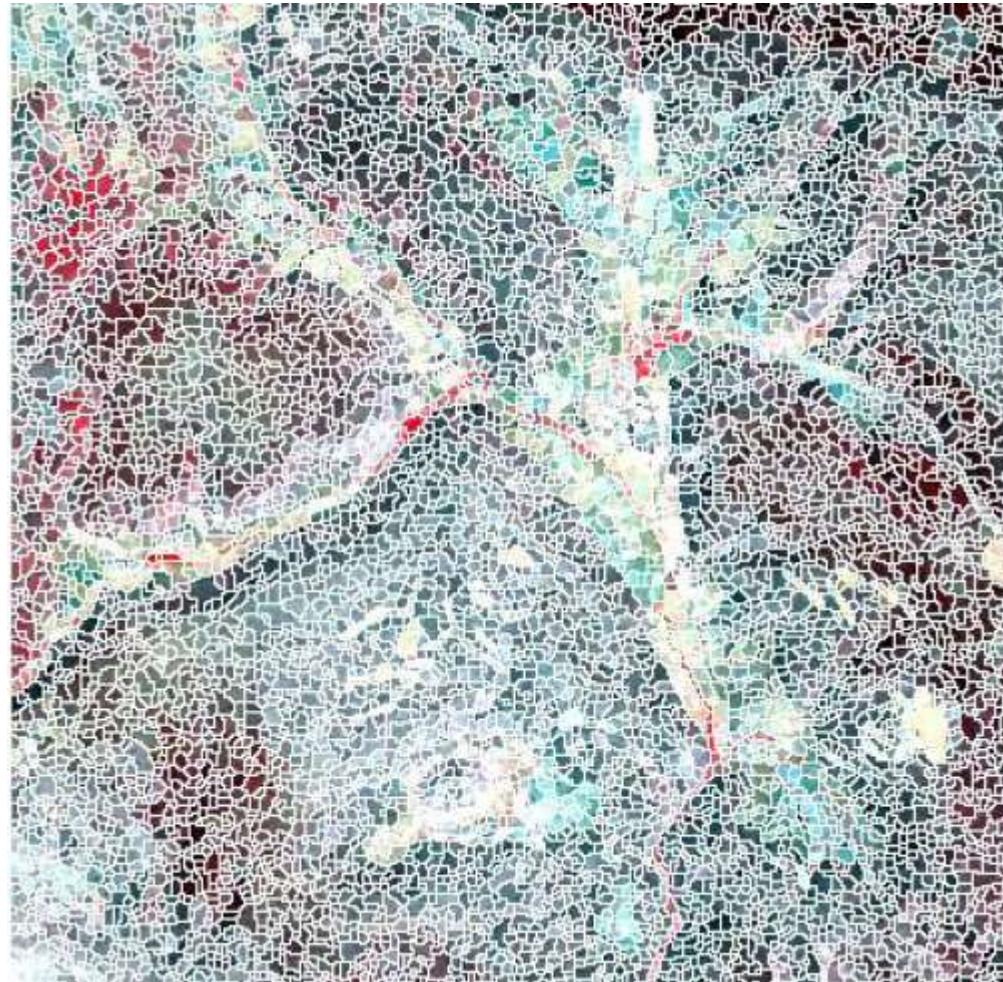
6TM
Low dynamics
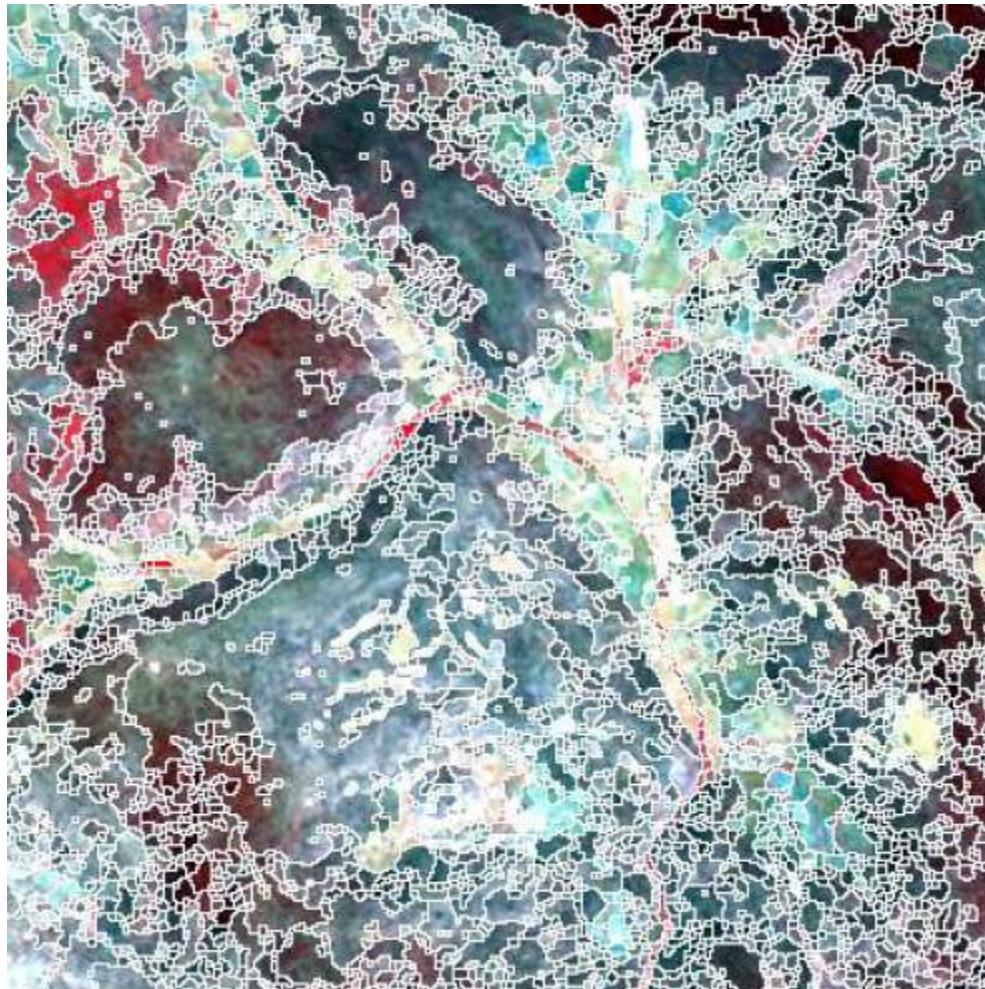
6TM
Baseline 2Ha
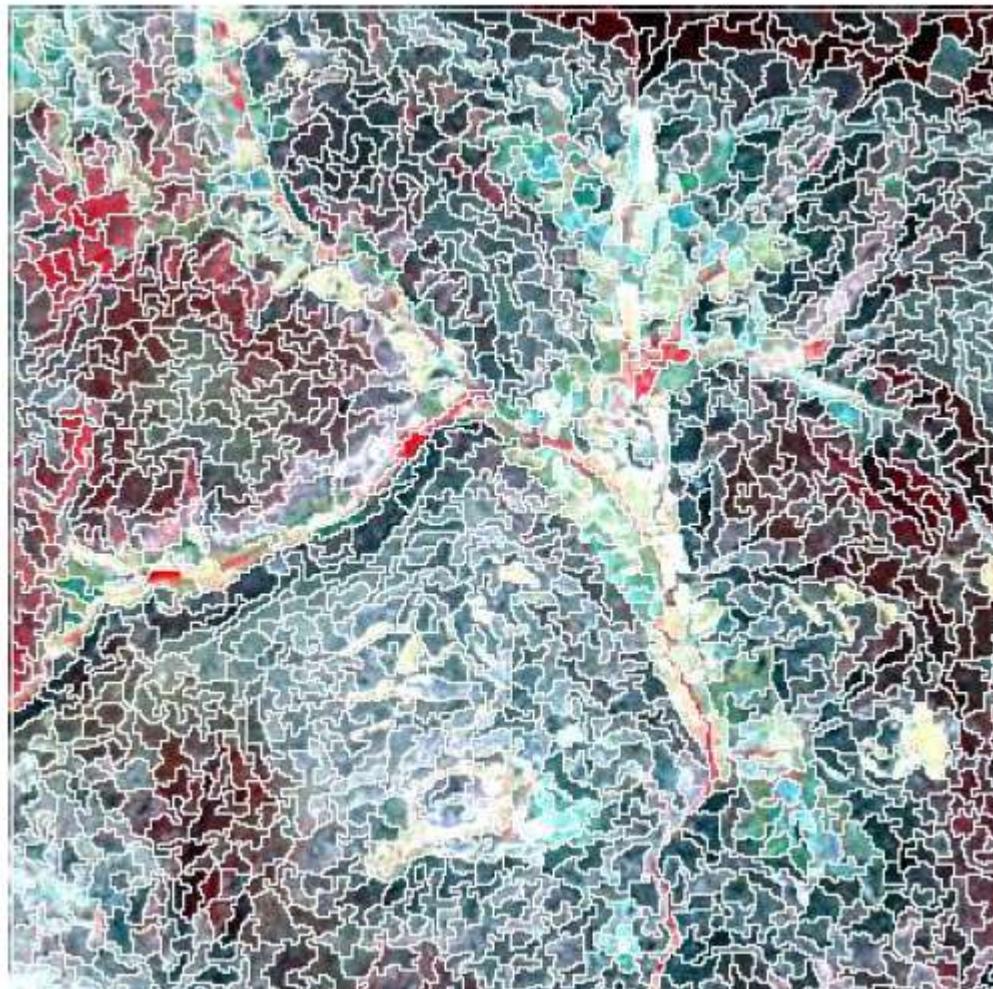
6TM
Baseline 5 Ha
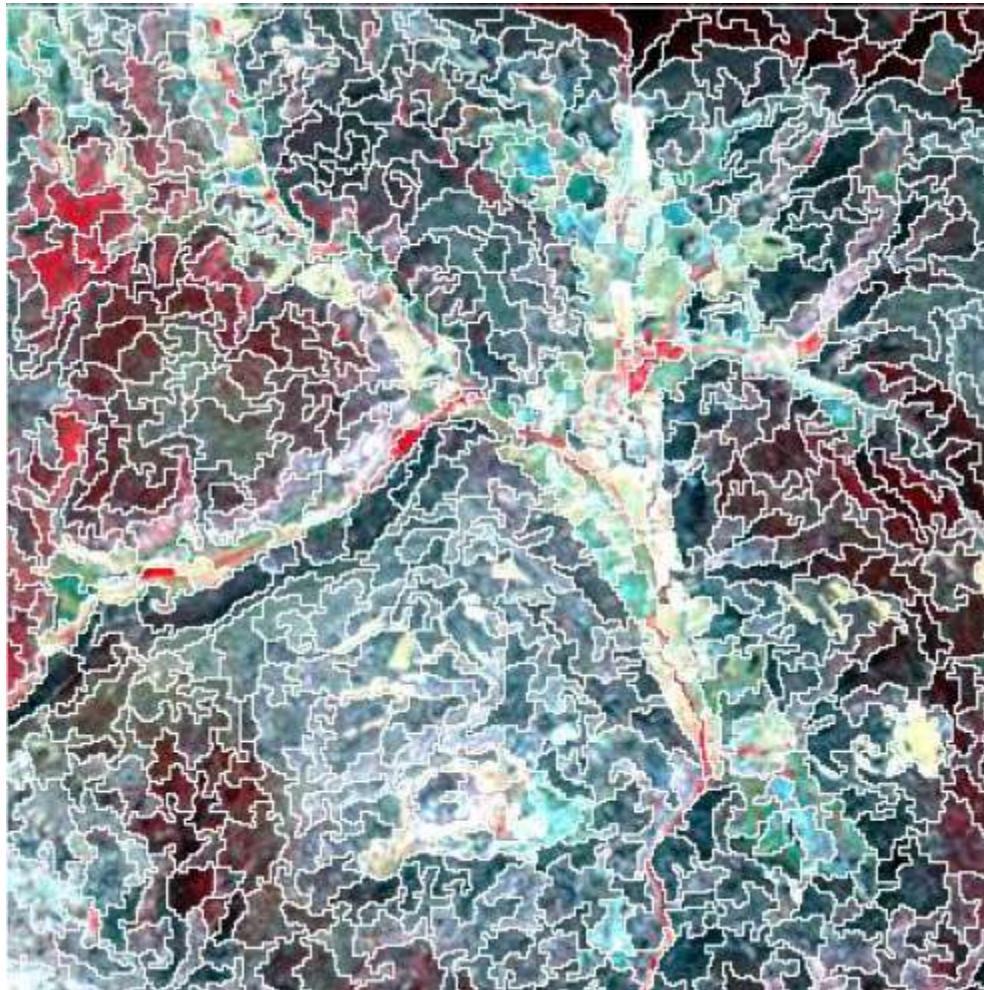
6TM
Baseline 10 Ha
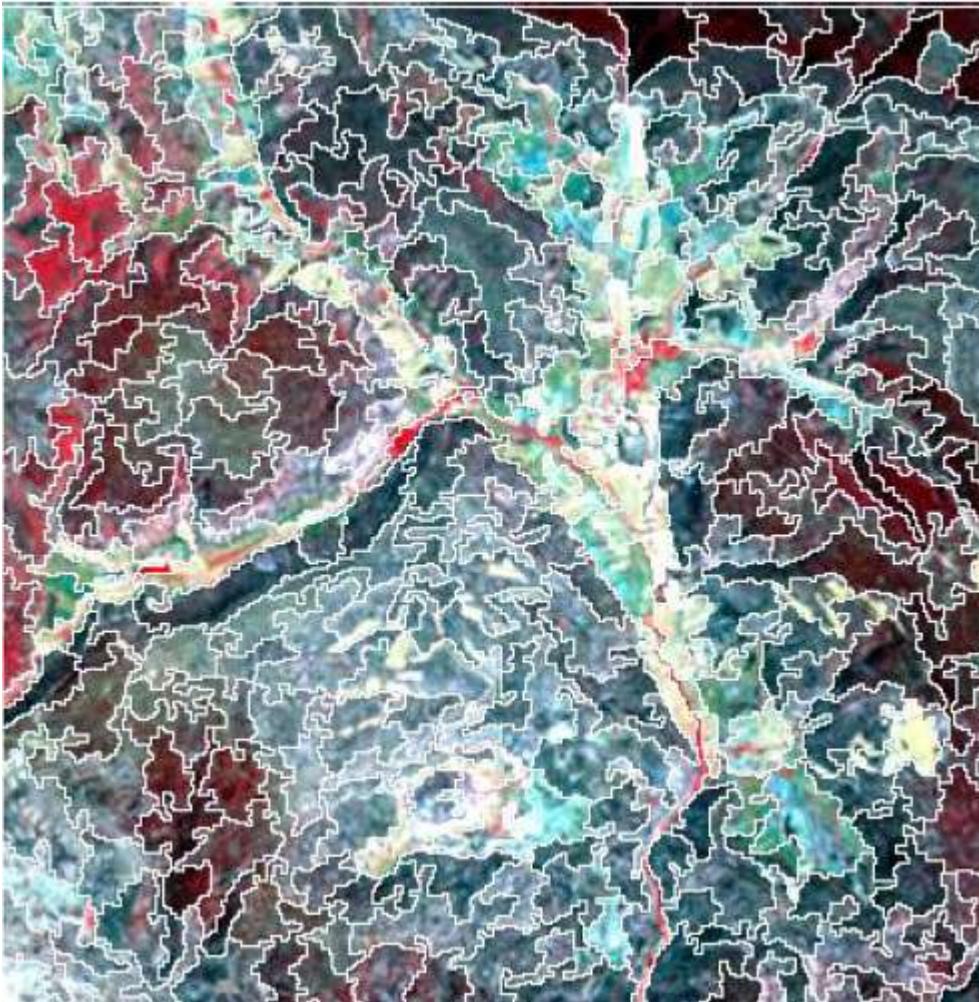
6TM
Baseline 10 Ha

TM PC123
Baseline 10 Ha