Object Based Imagery Exploration with SPRING

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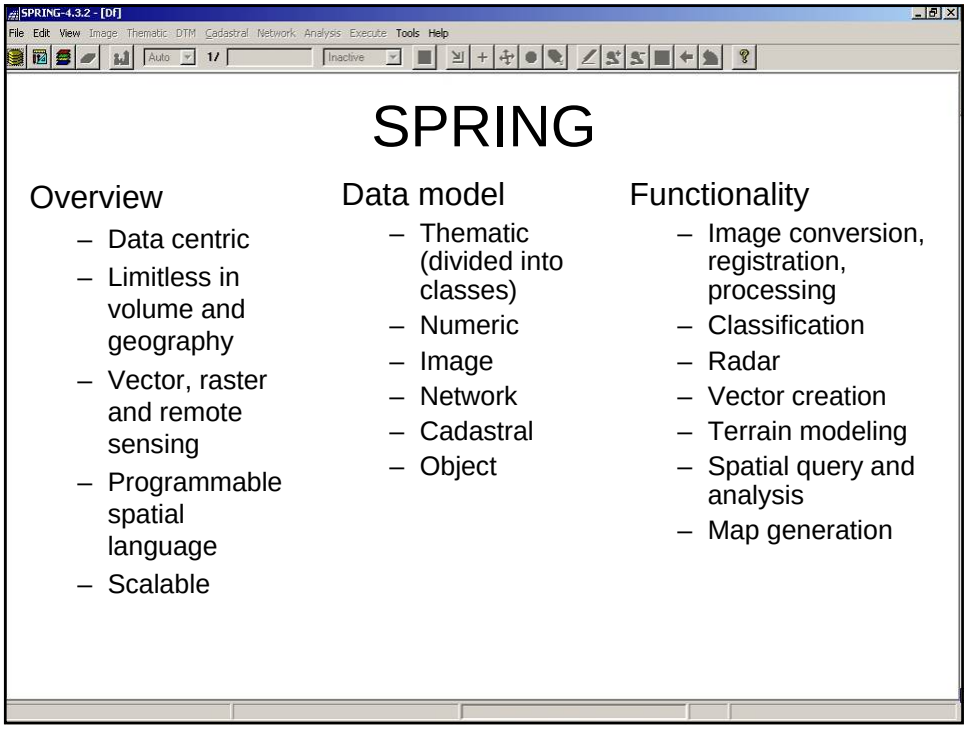
Outline

- Overview
- Getting Started
- Processing and Derivatives
- Object-oriented classification
  - Literature review
  - Demo

Object Orientation

- Classification based on spatial properties (shape) as well as spectral properties (brightness) as with traditional pixel methods
- Multi-resolution segmentation allows for classification techniques using sub-super object relationships



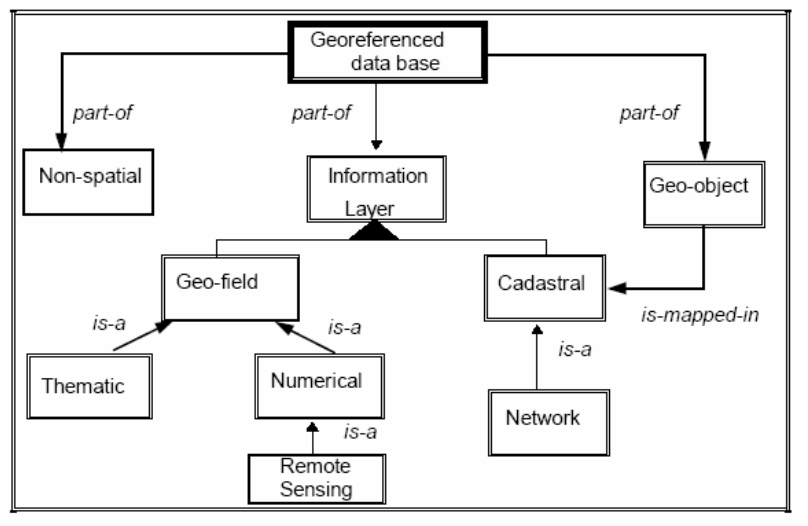
SPRING

Overview
- Data centric
- Limitless in volume and geography
- Vector, raster and remote sensing
- Programmable spatial language
- Scalable

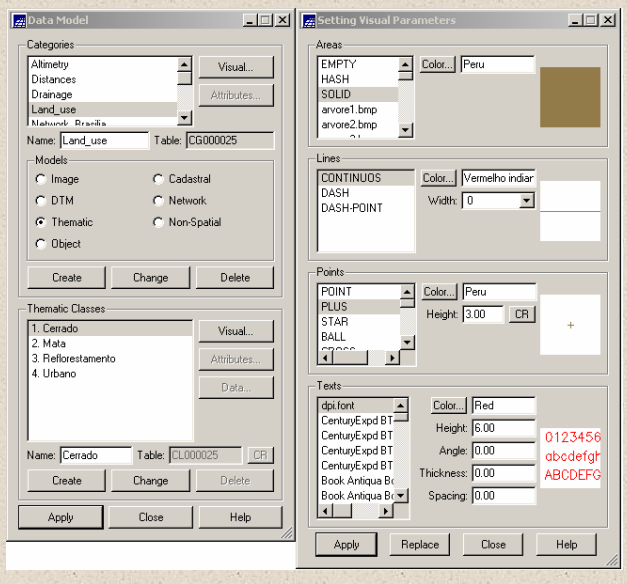
Data model
- Thematic (divided into classes)
- Numeric
- Image
- Network
- Cadastral
- Object

Functionality
- Image conversion, registration, processing
- Classification
- Radar
- Vector creation
- Terrain modeling
- Spatial query and analysis
- Map generation

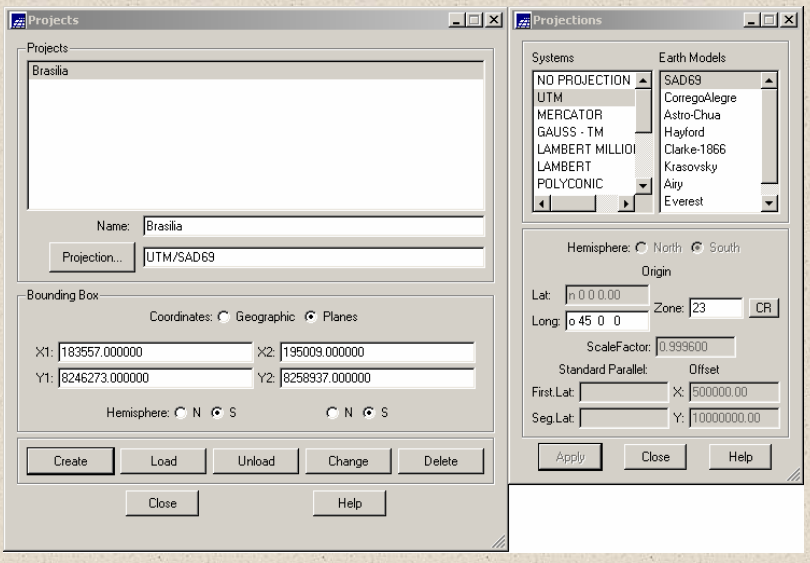
SPRING Data Model

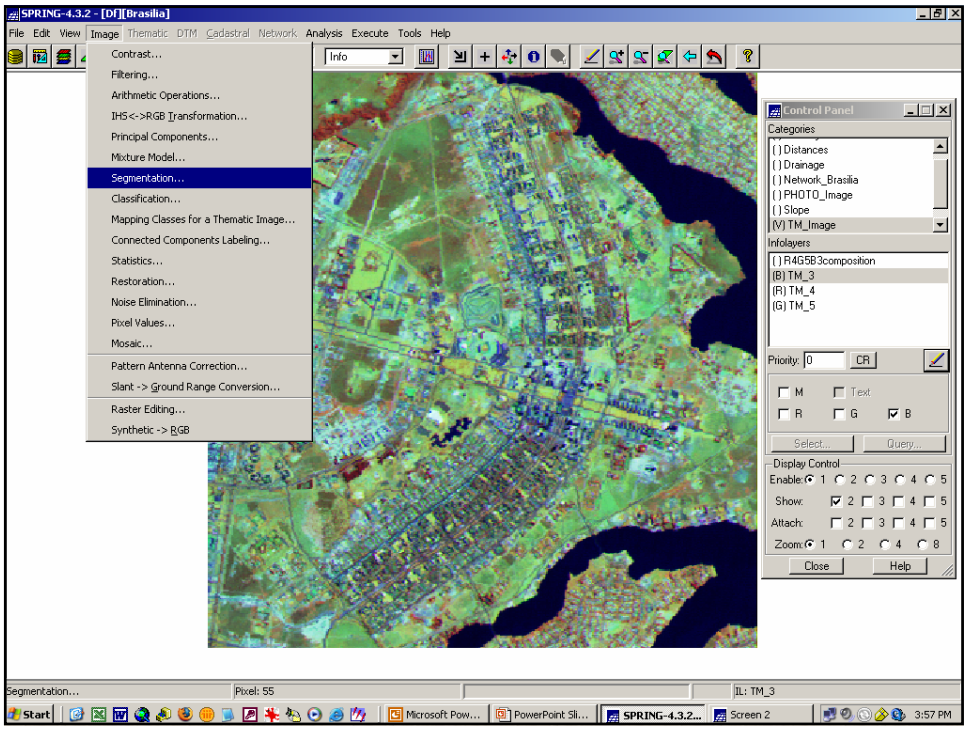


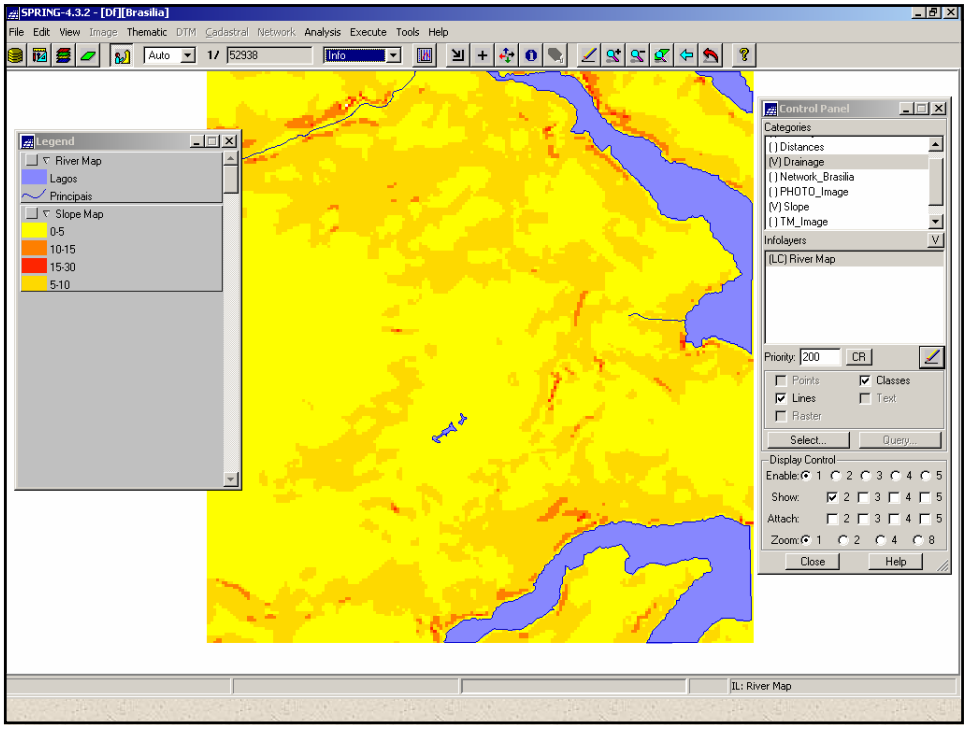
SPRING Data Model



SPRING Projects






SPRING-4.3.2 - [Df][Brasilia]
File Edit View Image Thematic DTM Cadastral Network Analysis Execute Tools Help
Legend
River Map
Lagos
Principais
Slope Map
0-5
10-15
15-30
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Control Panel
Categories
( ) Distances
(V) Drainage
( ) Network_Brasilia
( ) PHOTO_Image
(V) Slope
( ) TM_Image
Infolayers
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Priority: 200
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Points
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Select...
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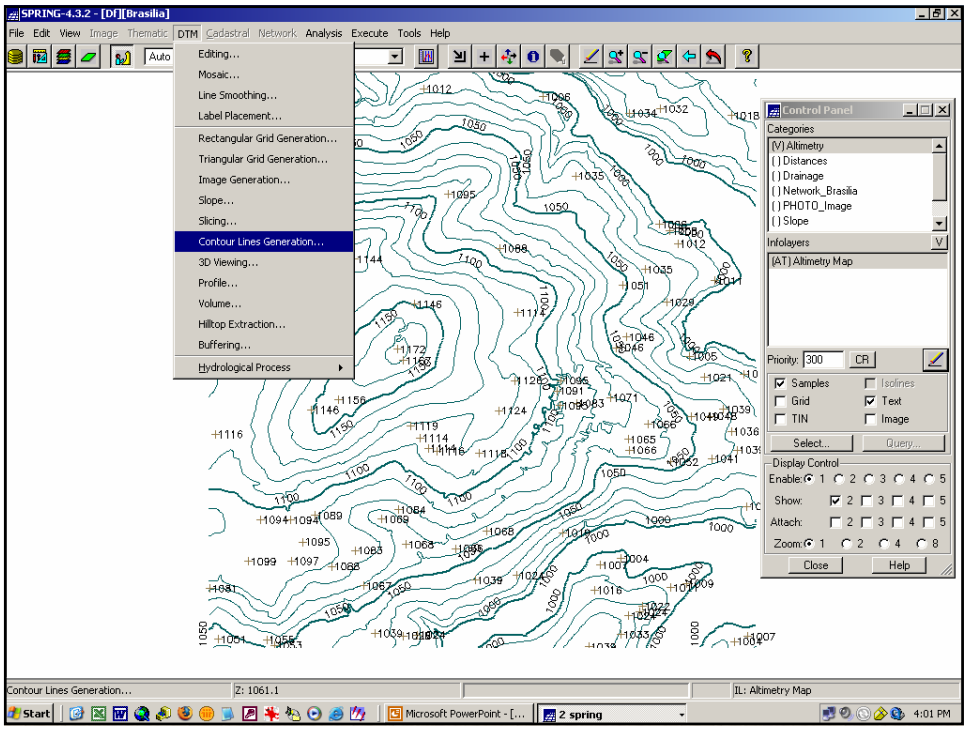
IL: River Map


SPRING-4.3.2 - [Df][Brasilia]
File Edit View Image Thematic DTM Cadastral Network Analysis Execute Tools Help
Editing...
Mosaic...
Line Smoothing...
Label Placement...
Rectangular Grid Generation...
Triangular Grid Generation...
Image Generation...
Slope...
Slicing...
Contour Lines Generation...
3D Viewing...
Profile...
Volume...
Hilltop Extraction...
Buffering...
Hydrological Process
Control Panel
Categories
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( ) Network_Brasilia
( ) PHOTO_Image
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Contour Lines Generation...
Z: 1061.1
IL: Altimetry Map
Start
Microsoft PowerPoint - [...
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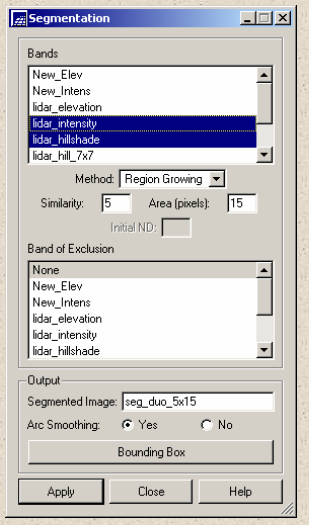
4:01 PM

FWS Get Started

- Project set up
- Import image
- Segmentation
- Training
- Classification
- Thematic Map
- Export/Import

Segmentation

- To extract relevant objects of interest
- Region growing technique for grouping spatially adjacent data
- Similarity based on Euclidian distance of average pixel values
- Area restricts size of regions



Literature Search

Keywords = object, object-oriented, segmentation, texture, classification, remote sensing, land cover, eCognition, SPRING, …

Brennan, R. and Webster, T.L. 2006. Object-oriented Land Cover Classification of LiDAR Derived Surfaces. *Canadian Journal of Remote Sensing*, Vol. 32, No. 2, pp. 162-172.

Review

- Objective: Identify as many land cover classes as possible
- Restricted to LiDAR data alone (elevation, intensity and derivatives)
- Four surfaces created
  - Digital Surface Model (DSM), non-ground
  - Normalized height (DSM – bald earth)
  - Intensity from all returns
  - Echo, record of multiple returns
- Four level segmentation hierarchy
- Ten Classes
  - bright/dark structures, intertidal veg, arid veg, coniferous, deciduous, roads, intertidal, saturated veg, water
- Rule based classification
- Accuracy = 94.31%

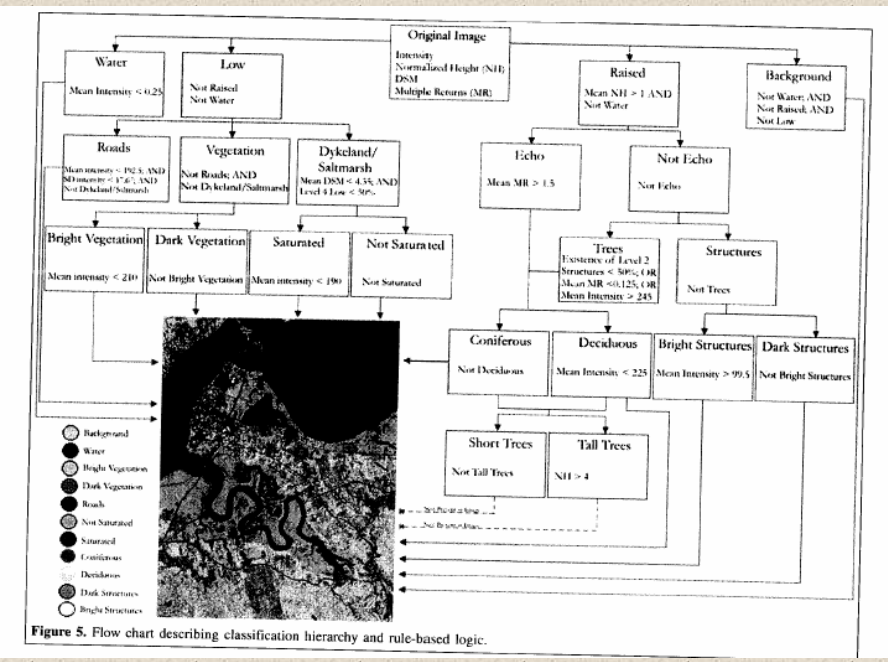


Figure 5. Flow chart describing classification hierarchy and rule-based logic.

SPRING for LiDAR

Can SPRING do this?

- Processing (surface creation)
- Contour Mapping
- Visualization (hillshade)
- Classification (feature extraction, pattern recognition)

Project Area

- Lower Klamath Lake National Wildlife Refuge, California
- Supporting Aerial Photography August 2005

Raw Data

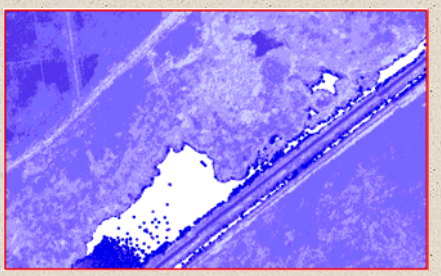
604_4647_CXYZI_v1.txt - Notepad

File Edit Format View Help

```
C,X,Y,Z,I
2,605772.670,4647999.820,1244.510,219
2,605774.190,4647999.740,1244.680,236
2,605773.560,4647998.540,1244.540,221
2,605774.430,4647998.950,1244.680,219
2,605776.210,4647999.040,1244.740,239
2,605775.610,4647997.870,1244.690,244
2,605776.510,4647998.160,1244.740,233
2,605777.170,4647999.420,1244.770,250
2,605779.060,4647999.340,1244.550,225
2,605778.450,4647998.170,1244.530,206
2,605777.870,4647997.050,1244.570,211
2,605778.190,4647996.250,1244.570,212
2,605778.820,4647997.450,1244.530,212
2,605779.440,4647998.630,1244.550,217
2,604605.520,4647020.550,1243.790,64
2,605781.400,4647998.900,1244.500,222
```

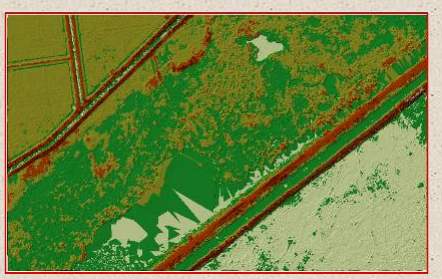
- LiDAR Survey August 2005
- Subset 1,263,780 points, 2km x 1 km, all class 2 returns (ground)

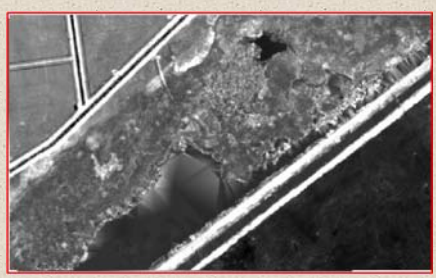
Intensity



- Color ramp on points. No return in open water
- Assumption: Lower intensity = higher moisture content of soil / vegetation
- Inverse Distance Weighted Interpolation, 2 meter cell size

TIN



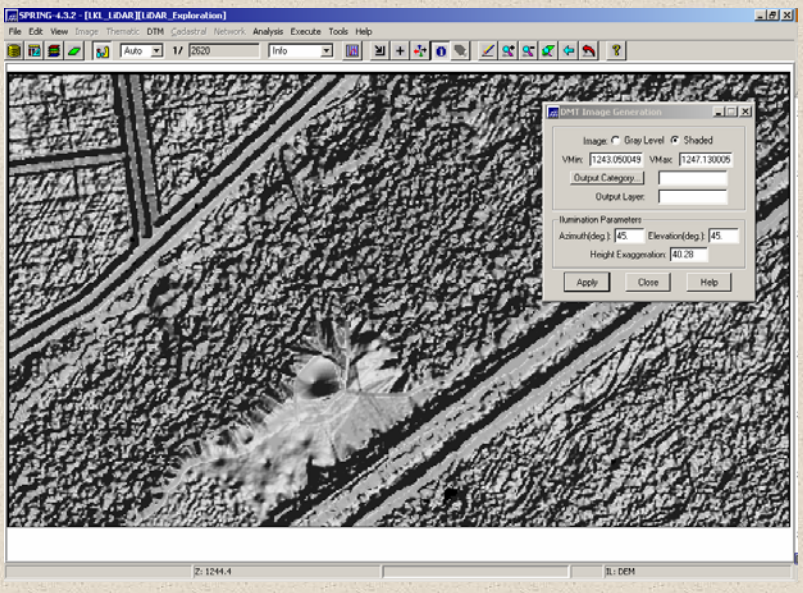


- Dikes and roads higher than wetland units
- Thick emergent vegetation appears higher than open water
- Inverse Distance Weighted Interpolation, 2 meter cell size

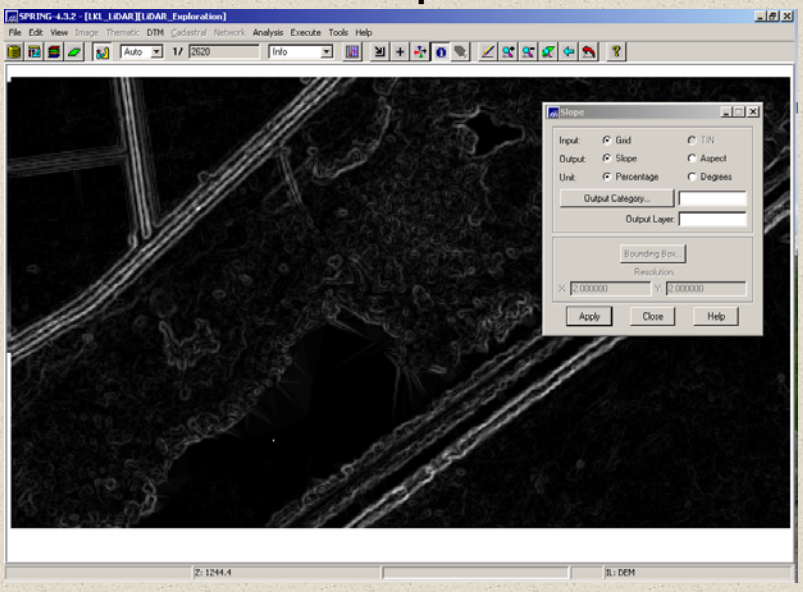
SPRING Processing

- Import elevation as DTM and image
- Import intensity as image
- Create derivatives from DTM

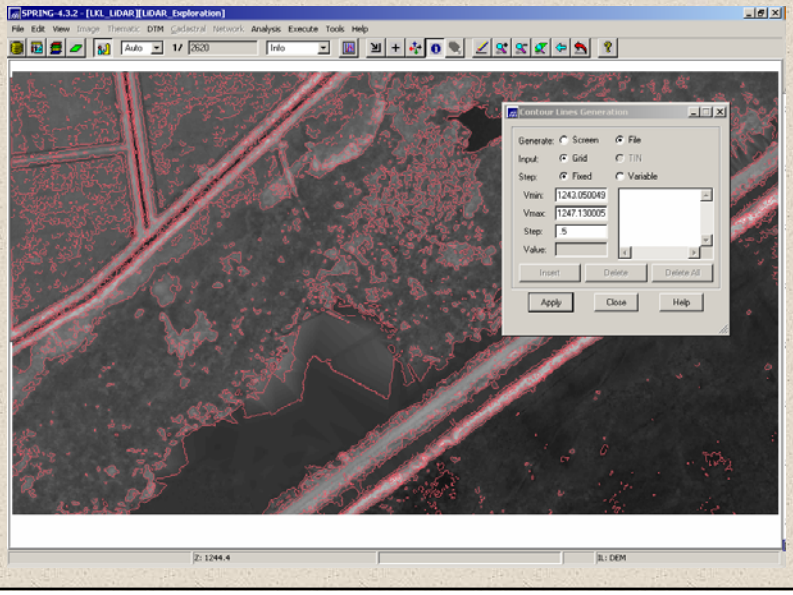
Hillshade



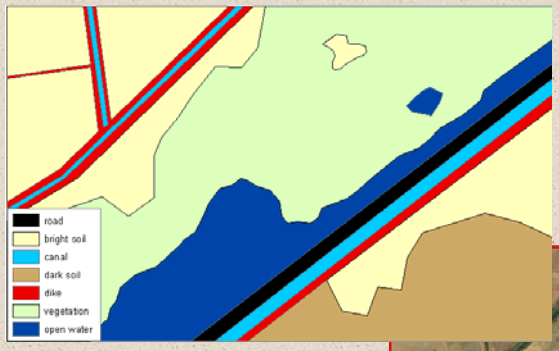
Slope



Contours



Land Use Land Cover

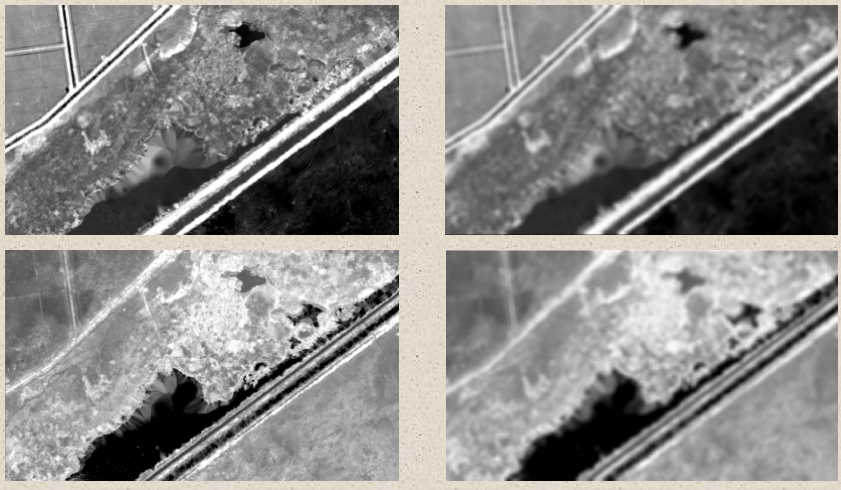


- Photo Interpretation
- On Screen Digitizing

Classification Parameters

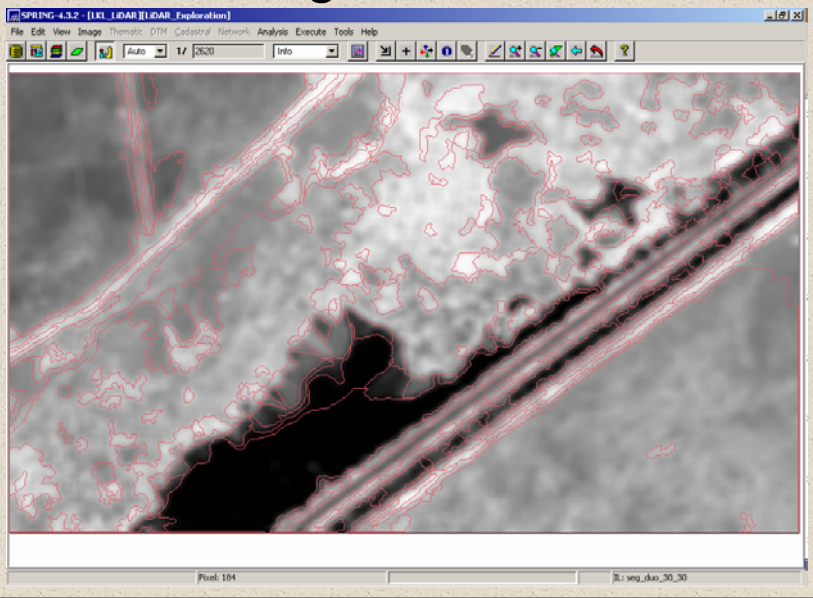
	Elevation	Intensity	Shape	Texture	Slope
Bright Soil	low	high	irregular	medium	nothing
Dark Soil/Veg	low	medium	irregular	medium	nothing
Vegetation	low	low	irregular	rough	irregular
Dike	high	high	long narrow	medium	edges
Road	high	high	long wide	medium	edges
Canal	low	zero	long narrow	smooth	edges
Open Water	low	zero	irregular	smooth	nothing

Filtering

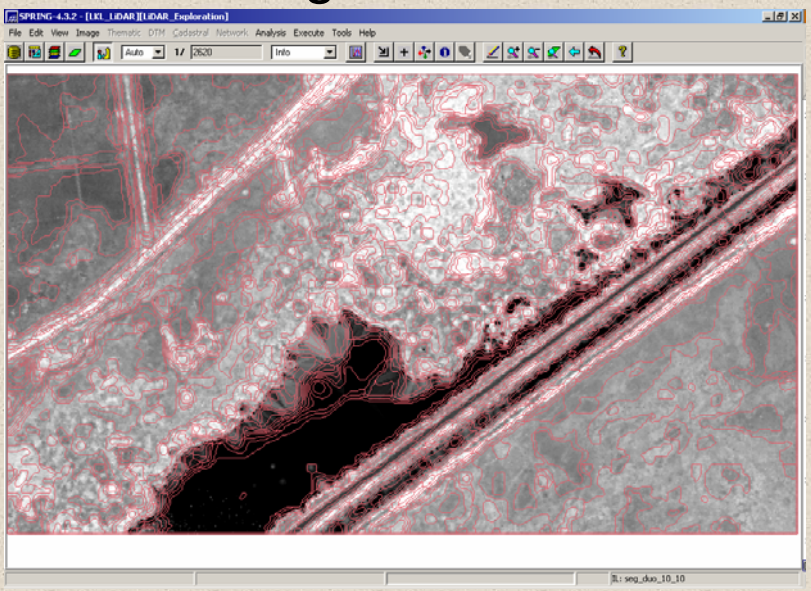


- Elevation 7x7 low pass
- Intensity 7x7 low pass

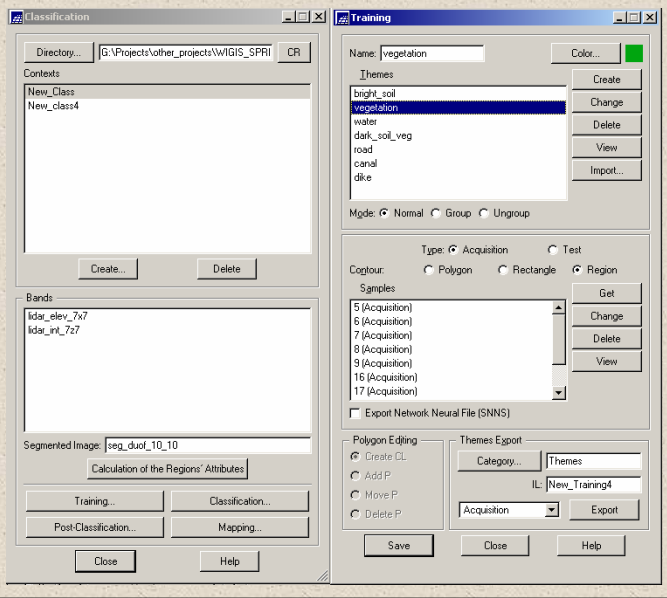
Segmentation



Segmentation



Classification

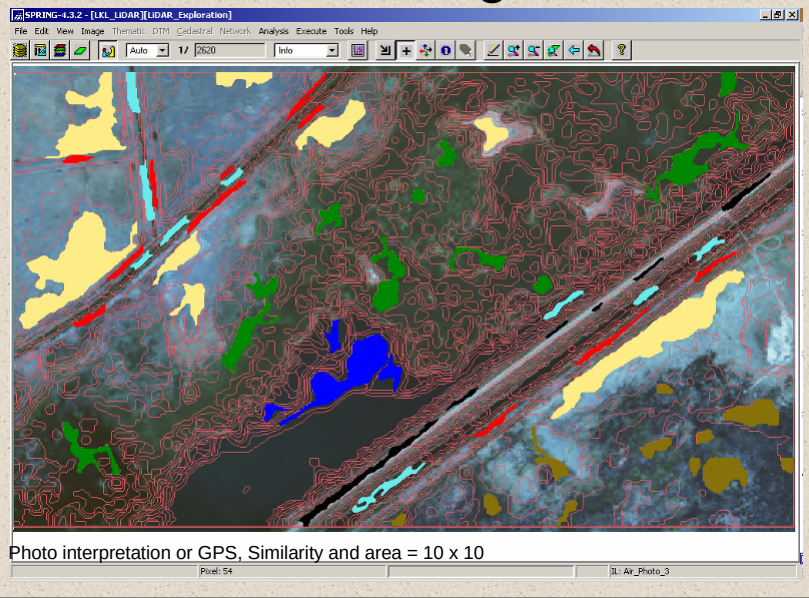


Samples

- Bright Soil = 8
- Dark Soil/Veg = 11
- Vegetation = 10
- Dike = 11
- Road = 7
- Canal = 9
- Open Water = 5

- Total = 61 of 200+?

Training

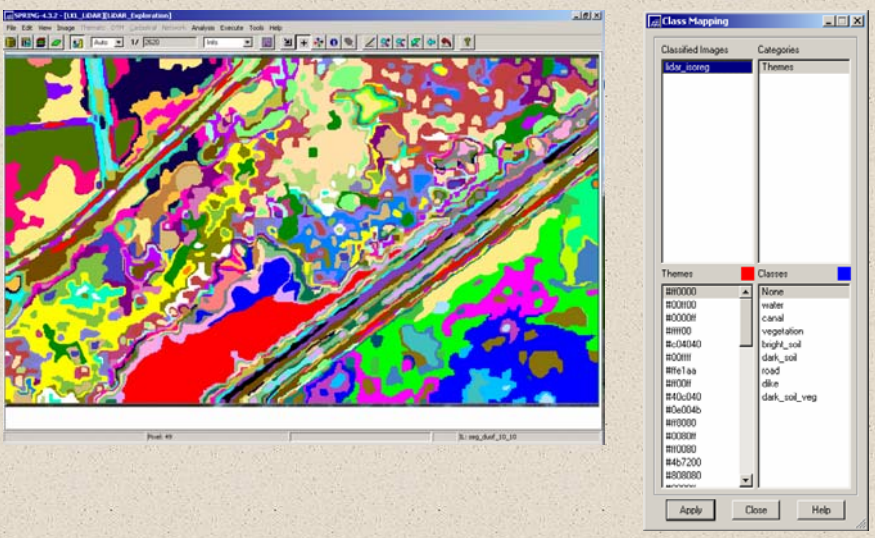


- Photo interpretation or GPS, Similarity and area = 10 x 10

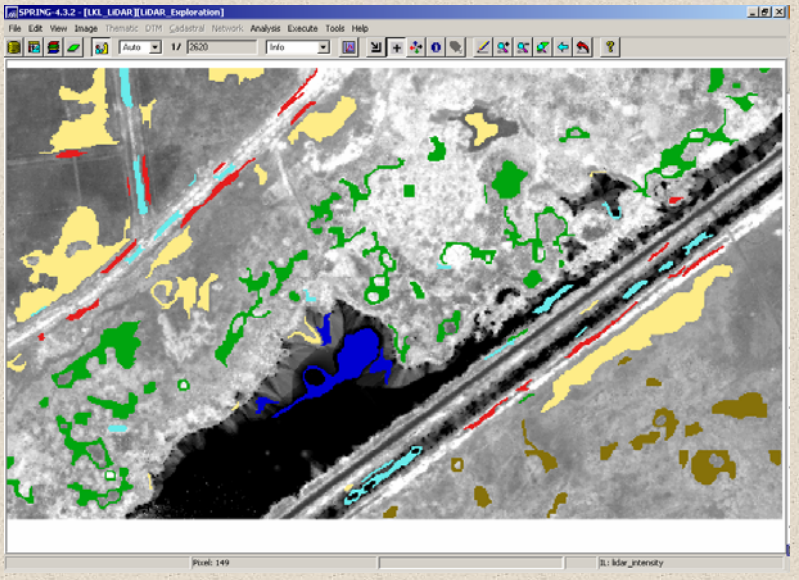
Region Classifiers

- Documented
  - ISOREG - unsupervised
  - Bhattacharya - supervised
  - CLATEX – Mahalanobis distance and texture measures, supervised
- Undocumented
  - Arq. SRN – Simple Recurrent Network (Artificial Neural Network)
  - Histogram - Specify number of themes 2 > 55

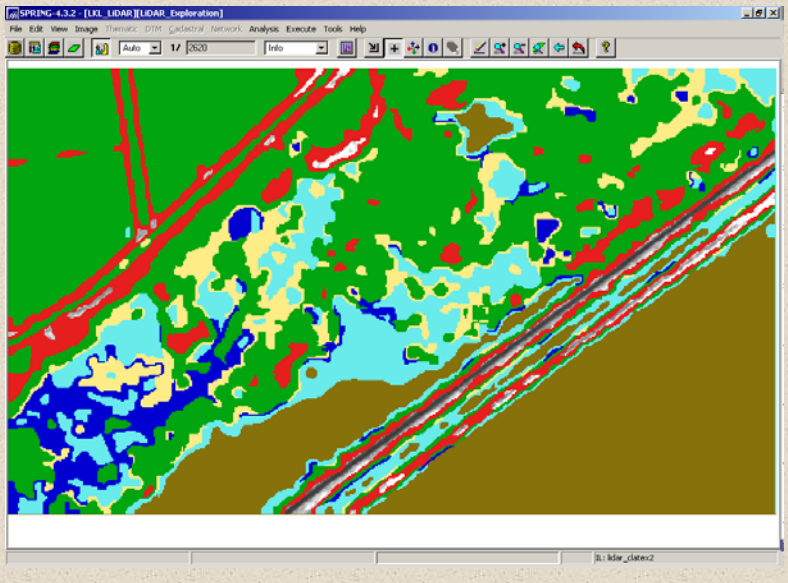
ISOREG Unsupervised



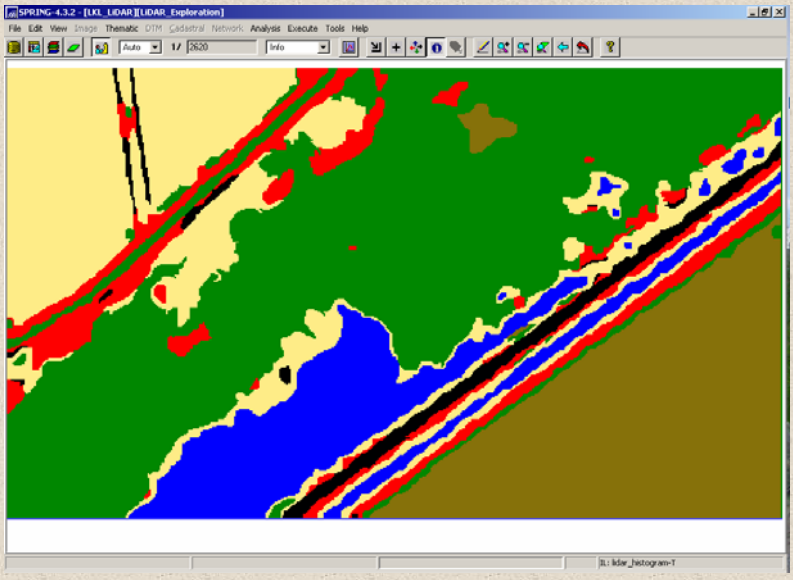
Bhattacharya Supervised



CLATEX Supervised



Histogram

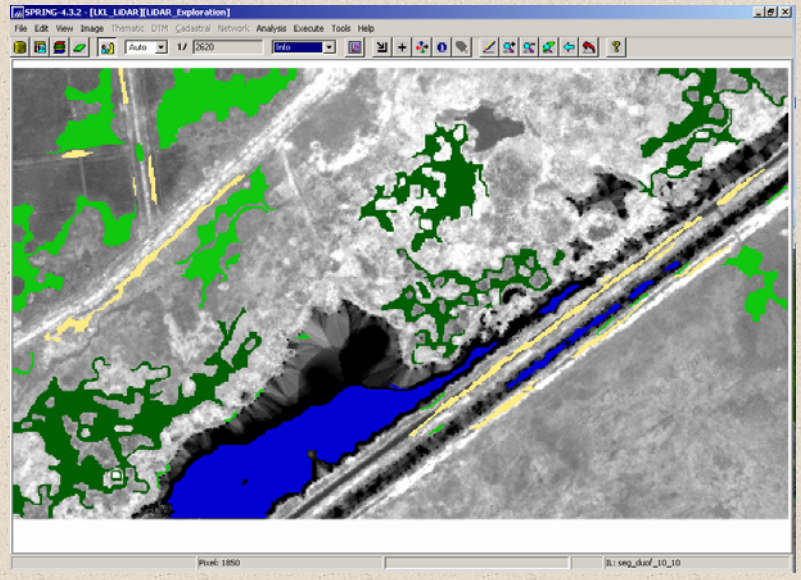


Reduce Classes

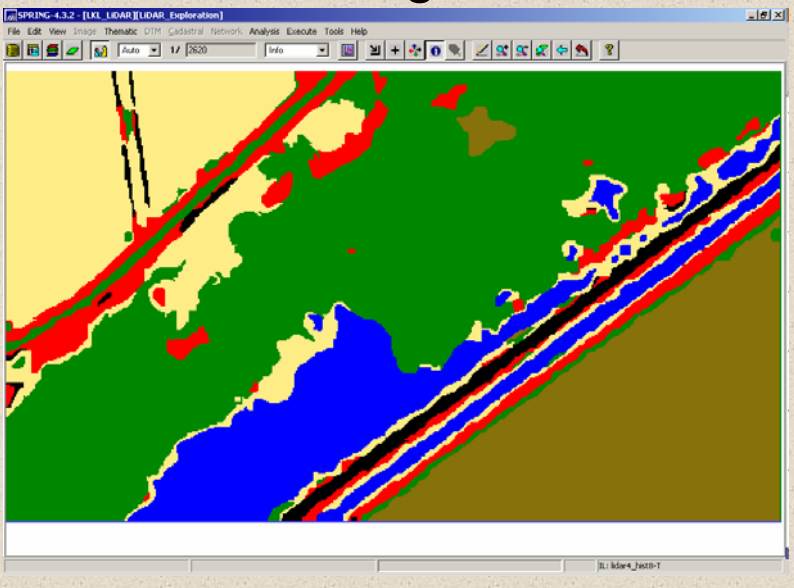
- Open Water = 5
  - Lowest and darkest
- Bare Soil = 11
  - High and bright
- Dry vegetation = 7
  - Low and bright
- Wet vegetation = 5
  - Low and dark

- Total = 38 of 200+?

Bhattacharya Supervised



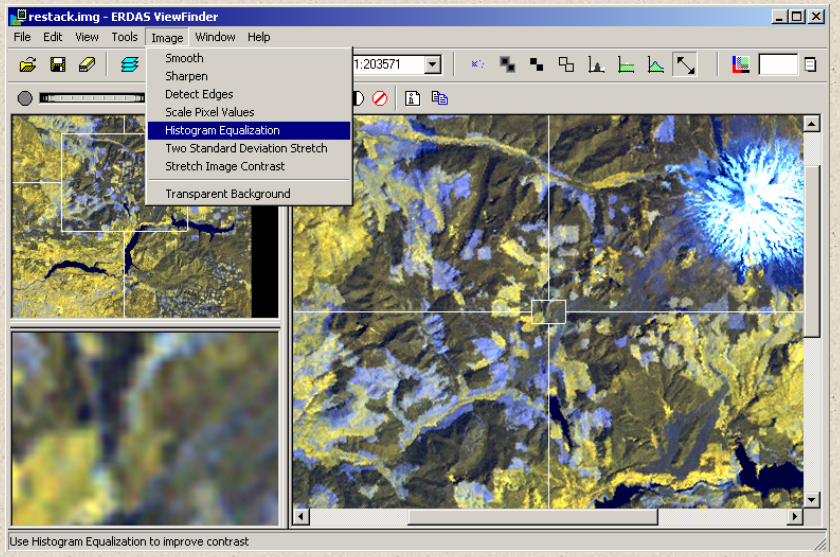
Histogram



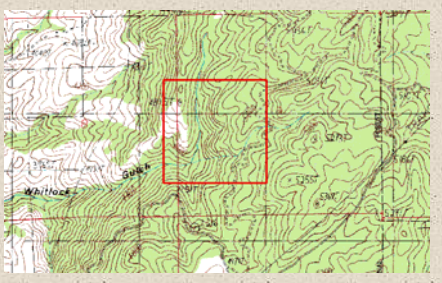
Discussion

- Serious challenges
  - Segmentation only works with single image and derivatives (? ERDAS)
  - Lacks hierarchal region construction and rule based classifier (eCognition)
  - Learning curve (new data model, Portuguese)
- Serious Incentive
  - FREE !
  - Surface generation, derivatives and analysis proven functionality
  - More to discover
- Further research (for use with LiDAR)
  - Data/image management
  - ASCII to TIN with breaklines
  - DTM hydrologic tools and profiles
  - CLATEX Classifier and use of texture
  - Neural Network Classifier – on the way?
  - Export segmented objects for use in other classifiers
  - Accuracy Assessment

ERDAS ViewFinder

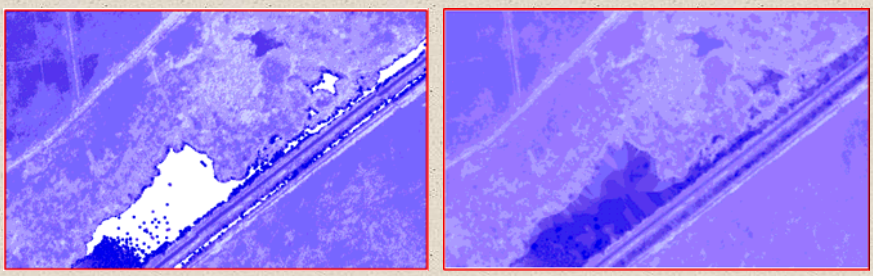


Sample Data



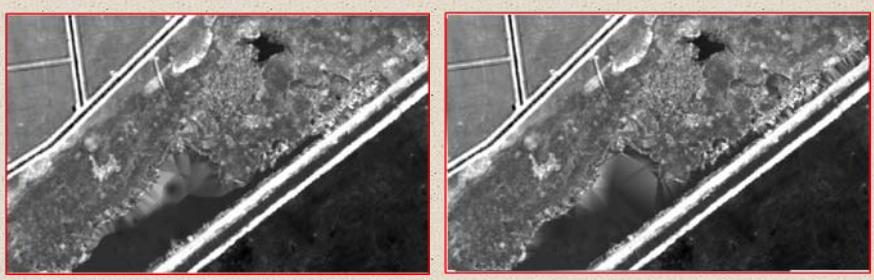
- All returns, not separate, mountainous terrain Idaho
- No intensity data

Interpolate Intensity



- IDW with 2 meter cell size
- All other defaults accepted

DEM



- IDW interpolate on left
- TIN to GRID on right

Land Cover

Simple Recurrent Network

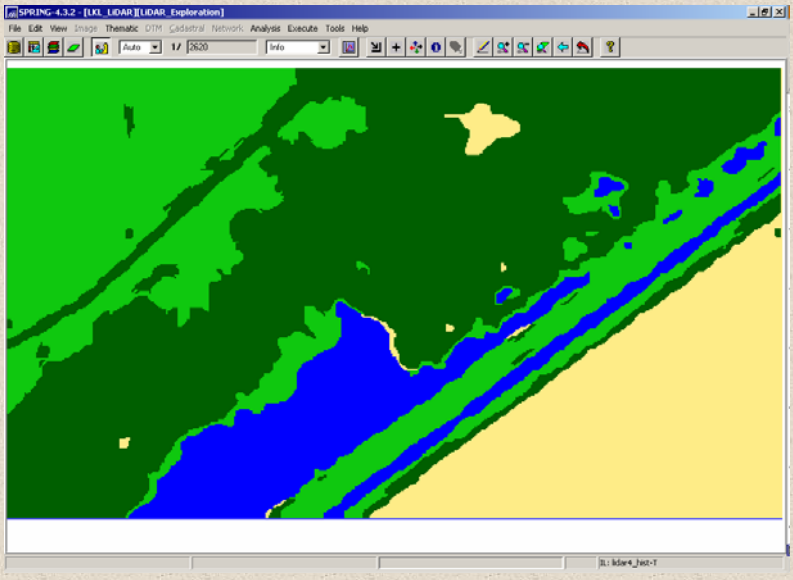
tm_training_SNNS.res - Notepad

File Edit Format View Help

```
SNNS pattern definition file V3.2
generated at 10/ 6/2007
No. of patterns 0
No. of input units : 4
No. of output units : 8

#Input TM3_Sample TM4_Sample TM5_Sample seg-12-15
#Class vegetation
#78,88
0.355469
1.621094
0 0 1 1 1 0 1 0
#78,88
0.503906
1.621094
0 0 1 1 1 0 1 0
#79,83
0.300781
1.621094
0 0 1 1 1 0 1 0
```

Histogram


SPRING-4.3.2 - [LXL_LiDAR][LiDAR_Exploration]
File Edit View Image Thematic DTM Cadastral Network Analysis Execute Tools Help