

A photograph of a dense forest with tall, thin trees and lush green undergrowth. The sunlight filters through the canopy, creating a dappled light effect. The text is overlaid on the center of the image.

Operational Forest Mapping Systems

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Collaborators

- Guoqing Sun, University of Maryland
- William Clerke, USDA Forest Service, Southern Region, Atlanta, Georgia
- Robert White, USDA Forest Service, Eastern Region, Warren, Pennsylvania
- Expected future collaborator
 - Janet Franklin, San Diego State University
 - Ruth DeFries, University of Maryland
 - Peng Gong, University of California, Berkeley
 - Jiague Qi, Michigan State University
 - Paul Desanker, University of Virginia

Objectives

Comparing and evaluating different forest mapping and monitoring algorithms and approaches through collaborative efforts among LCLUC science team members

Provide optimal solutions for implementing operational forest monitoring systems

Demonstrate the unique role of Landsat TM data in mapping and monitoring forest cover characteristics.

- Spectral, spatial, and radiometric resolutions of TM data: effectively designed for regional scale mapping
- Provide links between site, regional and global scale mapping
- One of the most reliable multispectral image data sources

Comparison and Evaluation of Forest Mapping Algorithms

Evaluation of different forest mapping/monitoring algorithms will be based on:

- Accuracy of the mapping/monitoring results
 - Overall accuracy
 - Categorical accuracy
 - Misclassification costs
- Computational/operational efficiency
 - Computational and operational resources required for classification/monitoring
- Robustness of the mapping algorithms in terms of assumptions required and technical/conceptual issues involved
 - Does the algorithm conceptually sound to be applied to multispectral remote sensing data for mapping forest characteristics?
 - What kind of technical issues are involved?
 - How robust to spectral variations caused by sensor mechanisms, atmospheric, topological effects, etc. and to noise?
 - Does the algorithm consistently produce robust results with different classification schemes, different data, and in different regions?

Test Sites

- Changbai Mountain, Northeastern China
- Allegheny National Forest, Pennsylvania
- Oconee National Forest, Georgia
- Clarion, Pennsylvania
- Tropical, and subtropical regions (Future)

Classification Methods/Algorithms Tested

- Supervised, Unsupervised, Semisupervised Approaches
- Maximum likelihood, Decision Tree, Spectral Angle Classifiers
- ANN

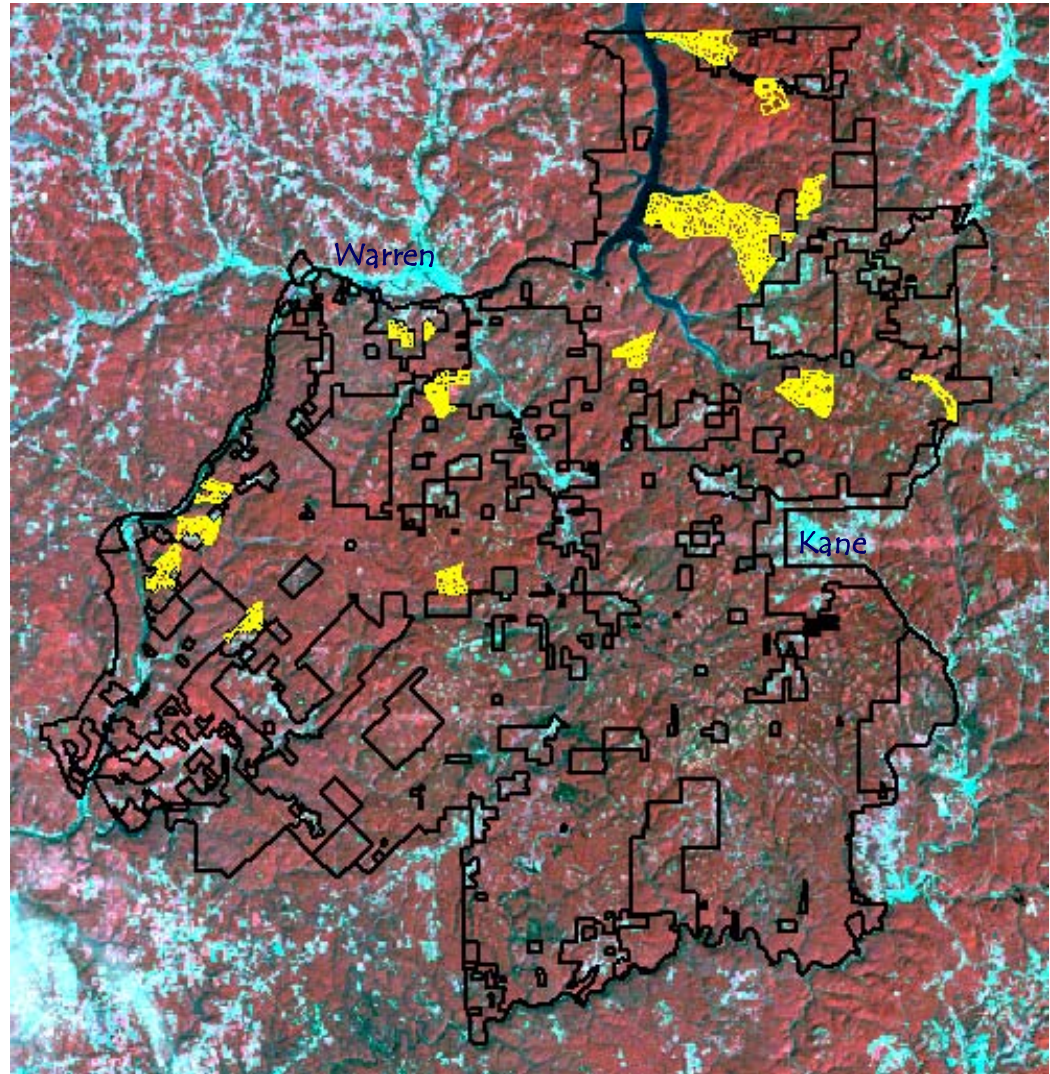
- Fundamental premise of the remote sensing of land cover/use: Every surface object has its own unique distribution of reflected, emitted, and absorbed radiation
- The same type of surface objects show "similar" spectral response patterns

- In conventional classification algorithms, similarity is measured as "distance" and classification is based on the "nearest prototype or cluster center" rule
- ISODATA, Minimum Distance, Mahalanobis, Maximum Likelihood, Fuzzy, etc

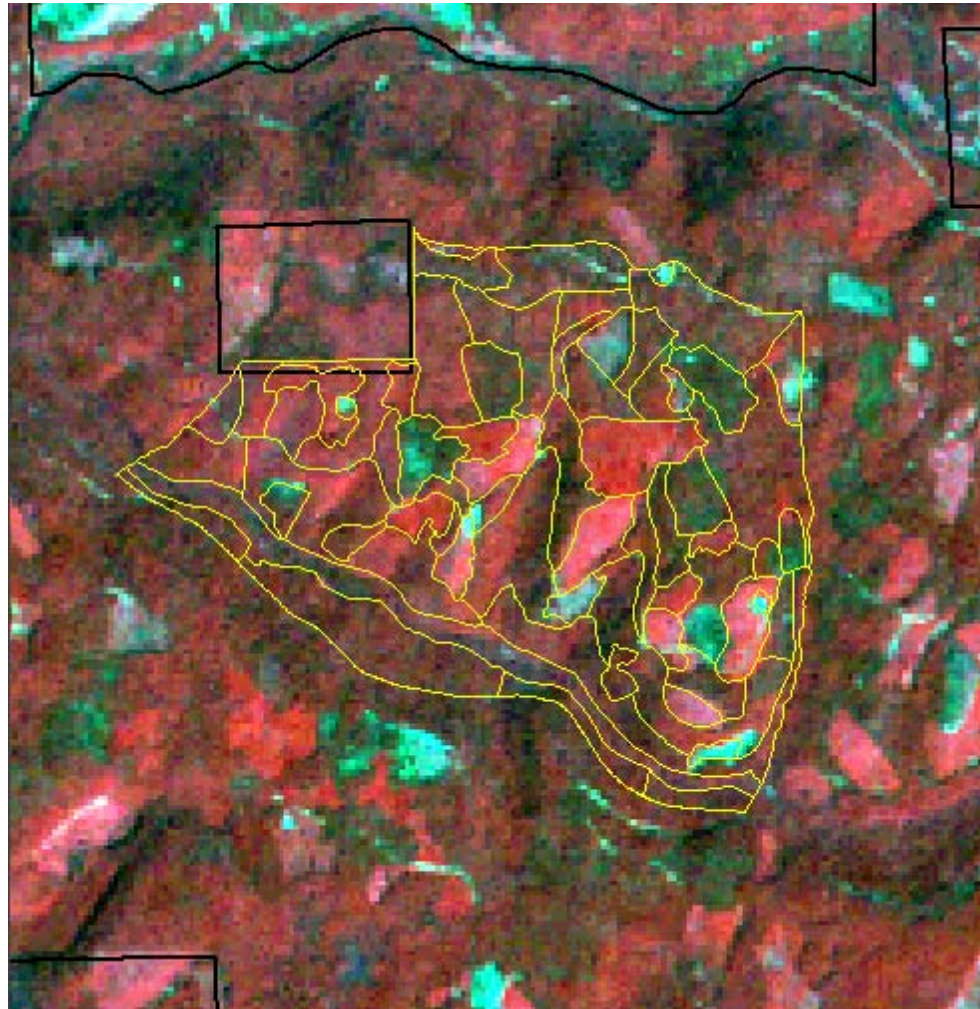
- Decision trees, neural nets classifiers based on Hypersurfaces as Discriminants
- Patterns are classified in accordance whether they are on one side or another of a hypersurface or of a set of hyperplanes
- Similarity of patterns is still measured based on the closeness (distance) to the prototypes defined by hyperplanes

- Currently all available classifiers relate "similarity" to "distance"
- When we accept the fact that objects alike show approximately linearly scaled variations in spectral pattern (i.e. show similar shape of pattern), we can use "spectral angle" as a metric for measuring "similarity" in spectral shape across the spectral bands

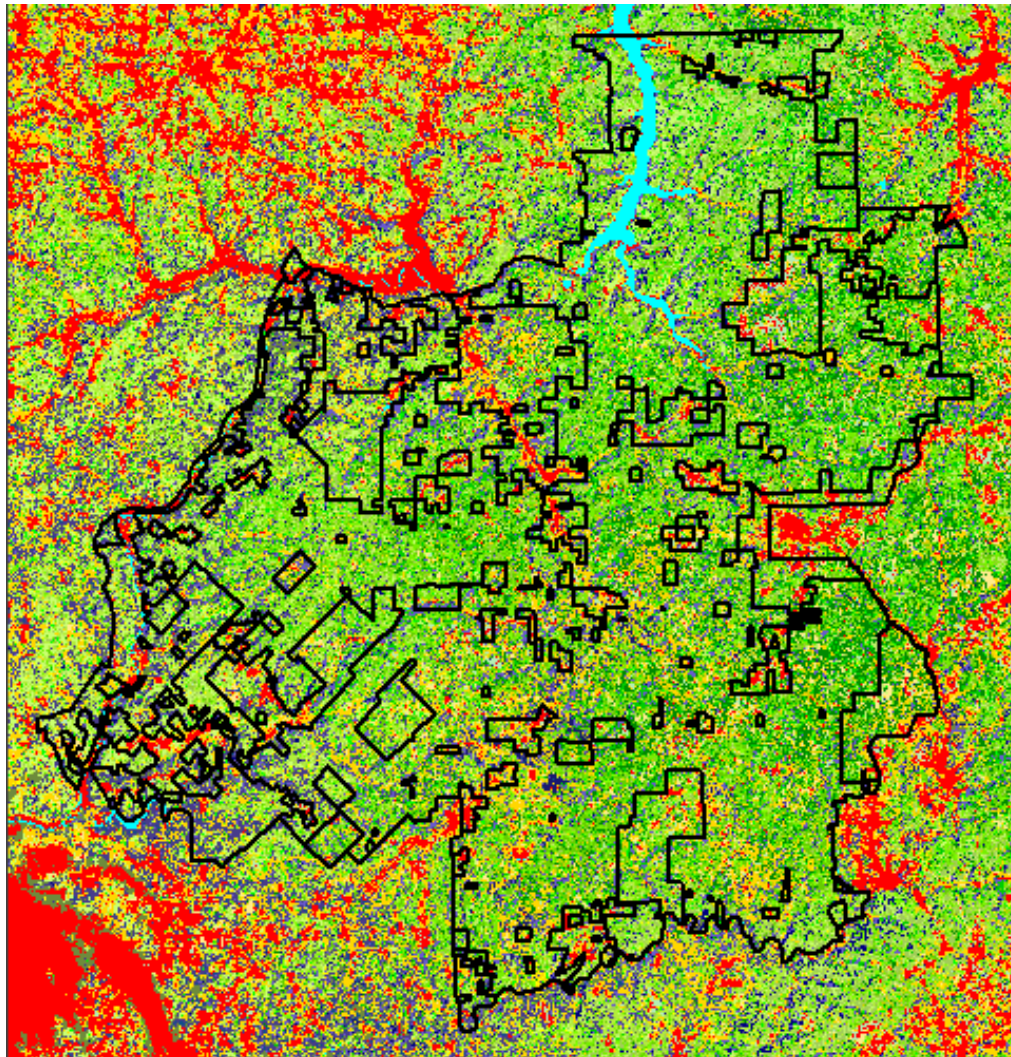
Allegheny National Forest Boundary and Compartment Locations



- Stands in a Compartment
- Tally sheet information
 - Species composition
 - Total basal area
 - DBH, Stand age, Density, etc.

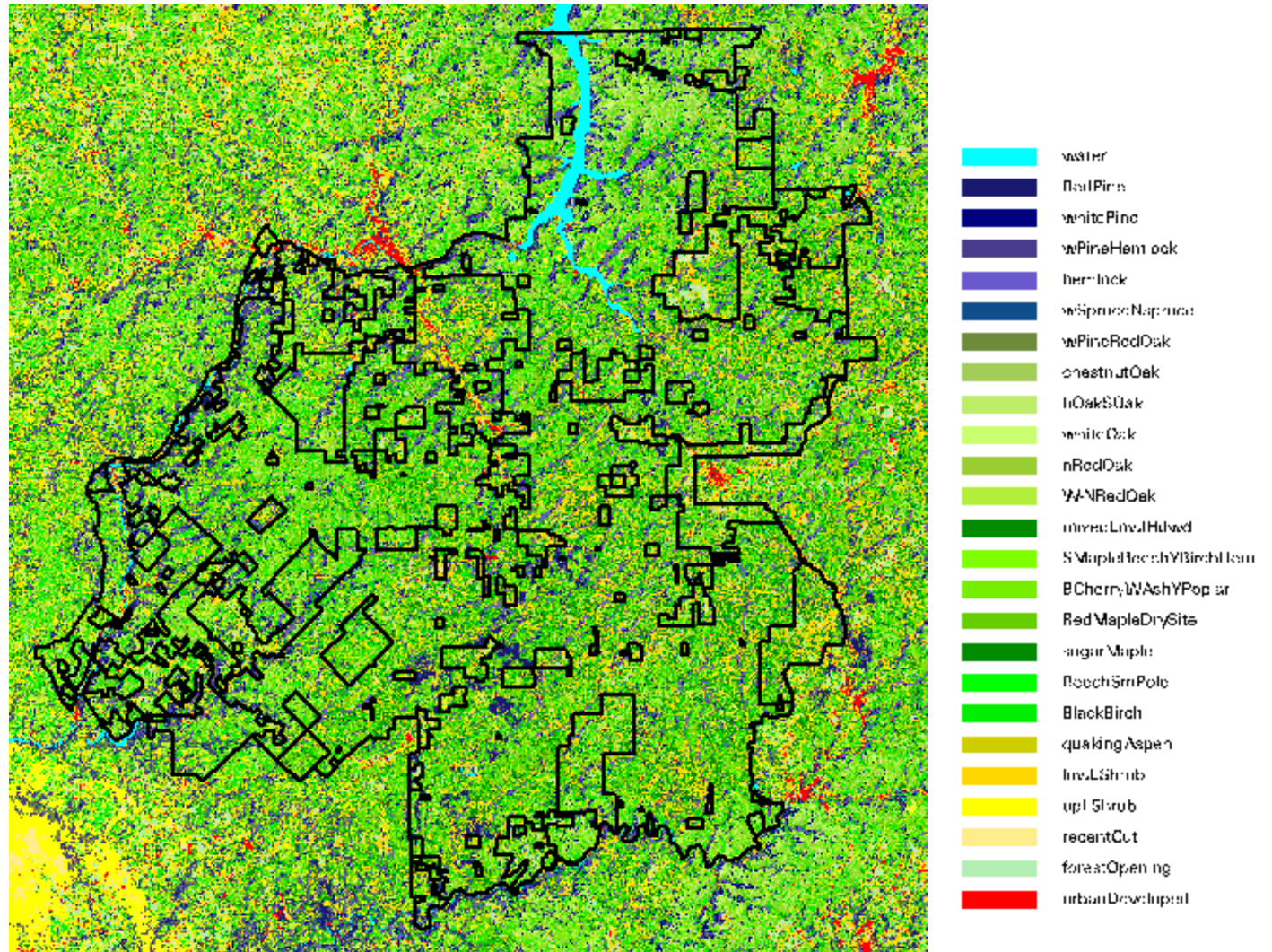


Classification result – Maximum Likelihood classifier



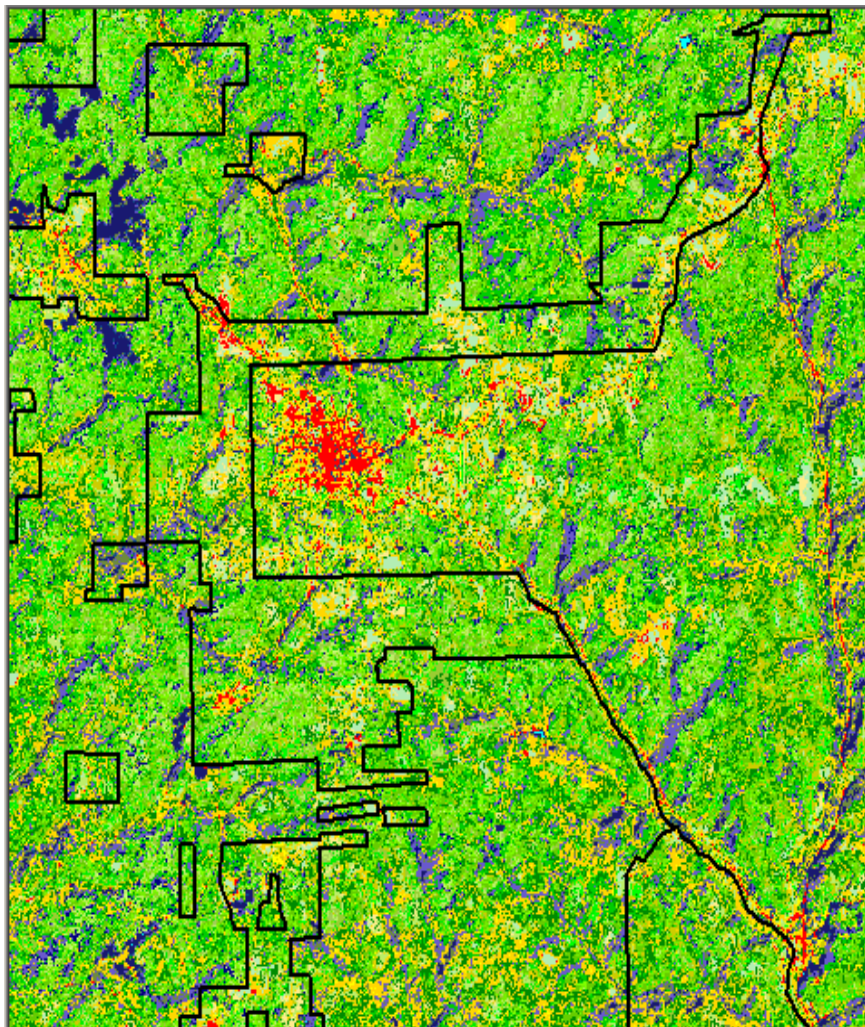
- water
- localPine
- whitePine
- wPineHemlock
- hemlock
- wSpruceNepomuc
- wPineRedOak
- chestnutOak
- lOakSOak
- whiteOak
- nRedOak
- W-NRedOak
- mixedLmJHhwd
- SMapleBeechYBirchLem
- BCherryWASHYPoplar
- RedMapleDrySite
- sugarMaple
- BeechSpruce
- BlackBirch
- quakingAspen
- lmeLShrub
- uplShrub
- recentCut
- forestOpening
- urbanDevelopment

Classification result – Semi Supervised Mapping Method using Spectral Angle

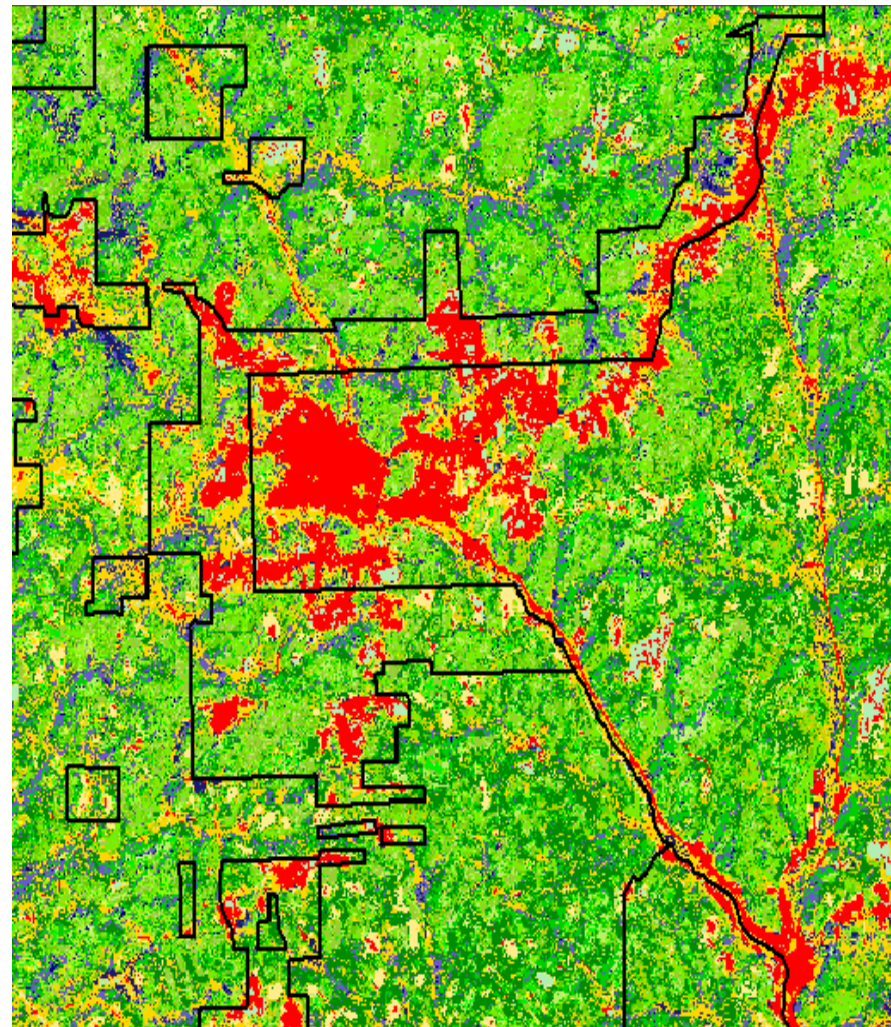


Comparison

(a) Supervised Spectral Angle



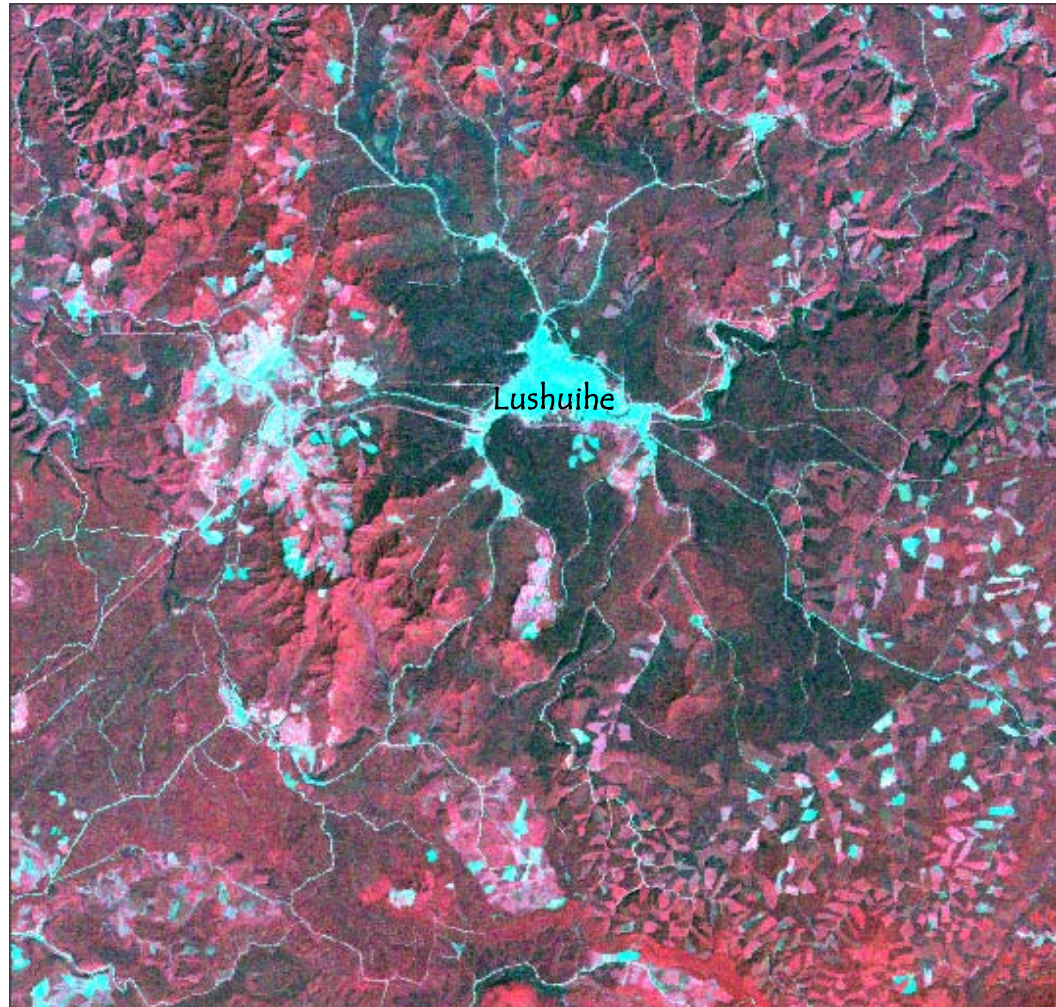
(b) Maximum Likelihood

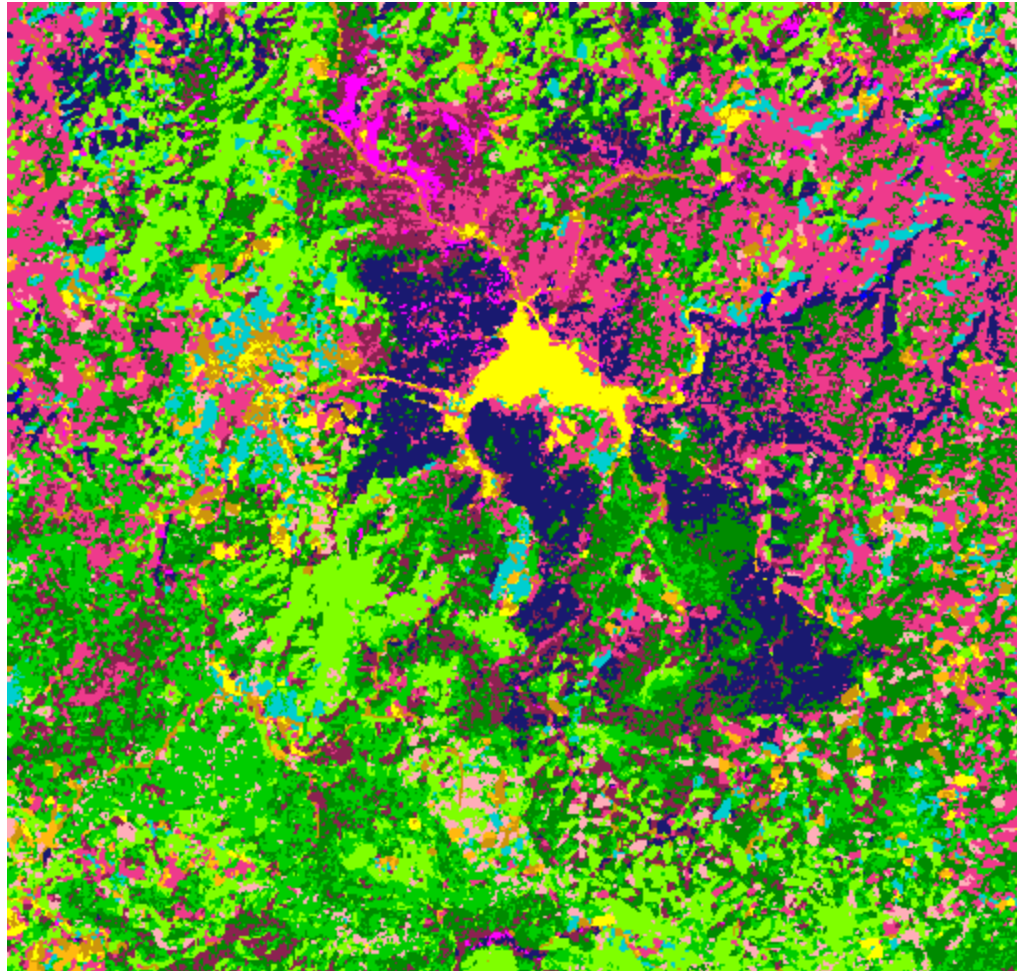


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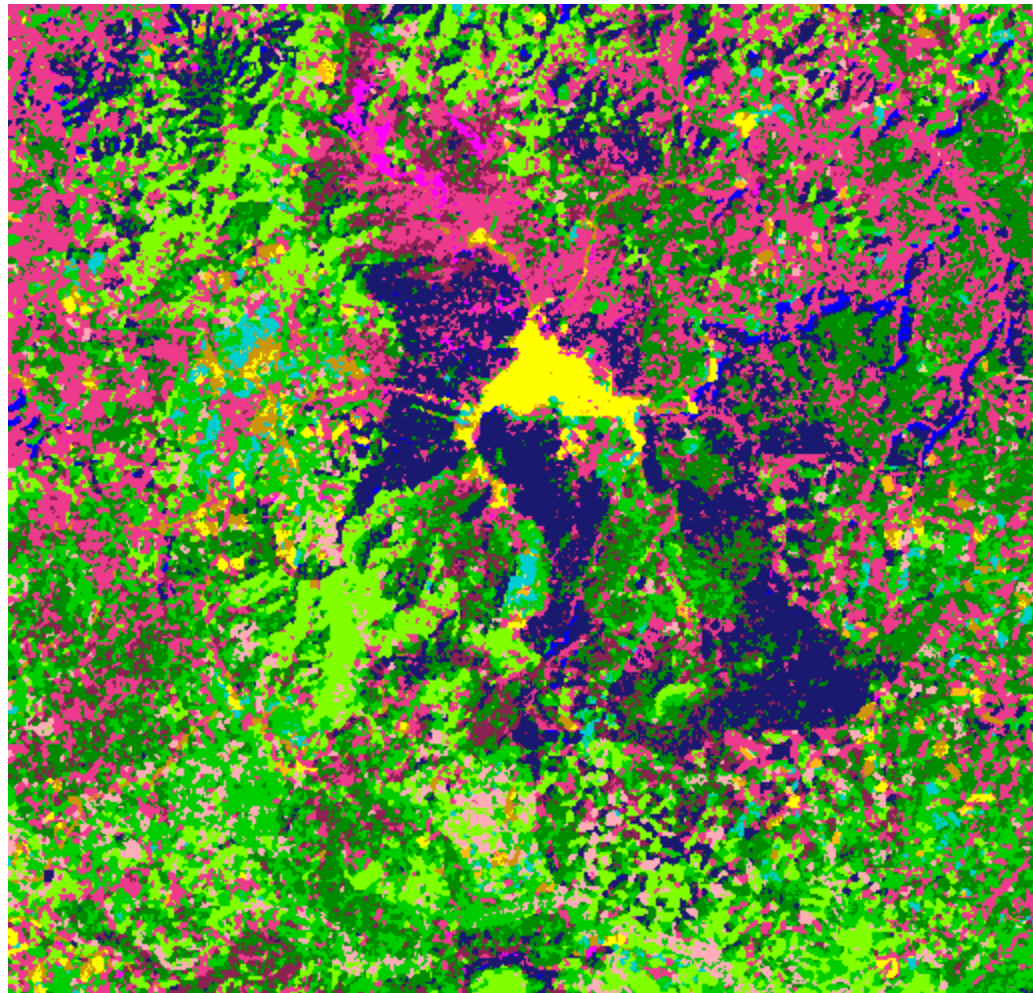
Lushuihe, Changbai Mountain Area, Northeast China





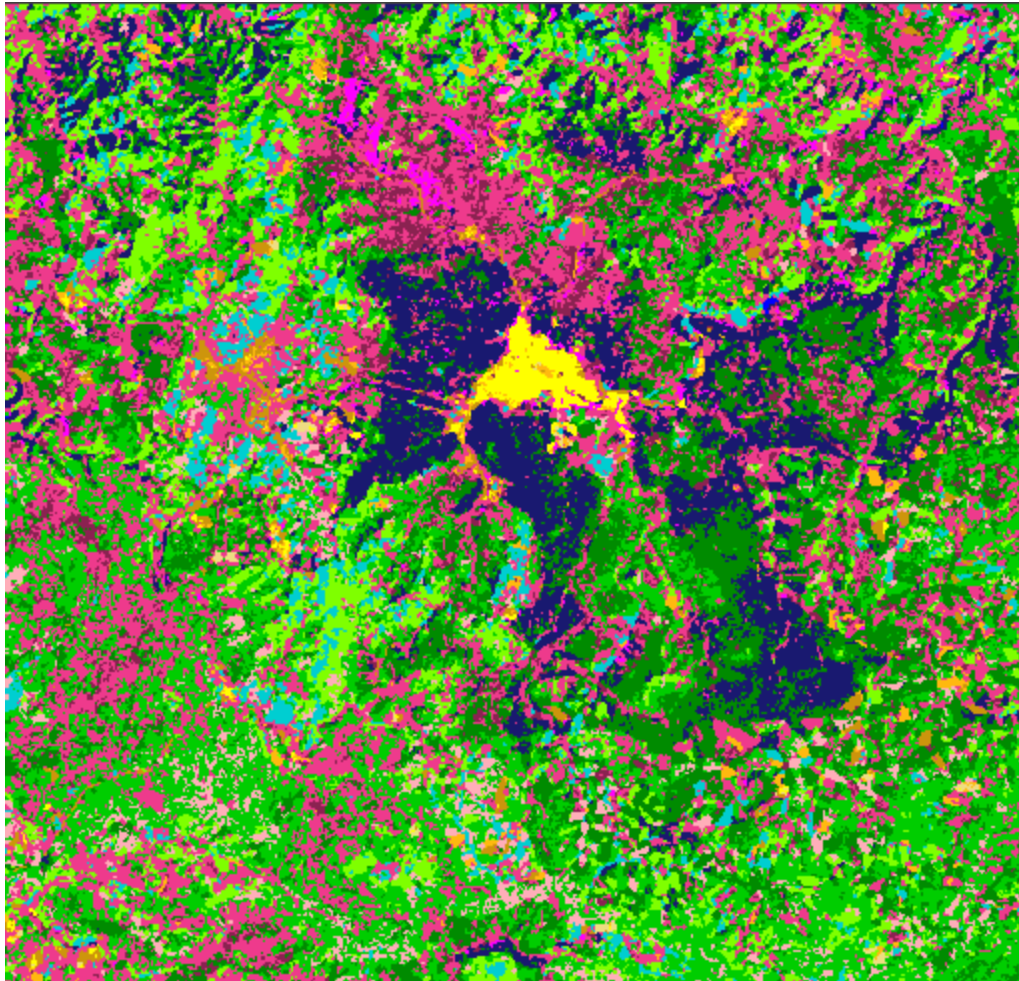
- Old Korean Pine
- Mature Mixed Pine
- Young Korean Pine
- Larch
- Scotch Pine/Spruce
- Korean Pine Populus Birch
- Mature Deciduous
- Poplar
- Mature Mixed Forest
- Open Grass
- Ginseng Field
- Exposed Soil
- Urban

Maximum Likelihood



- Old Korean Pine
- Mature Mixed Pine
- Young Korean Pine
- Larch
- Scotchi Pine/Spruce
- Korean Pine Populai Birch
- Mature Deciduous
- Popular
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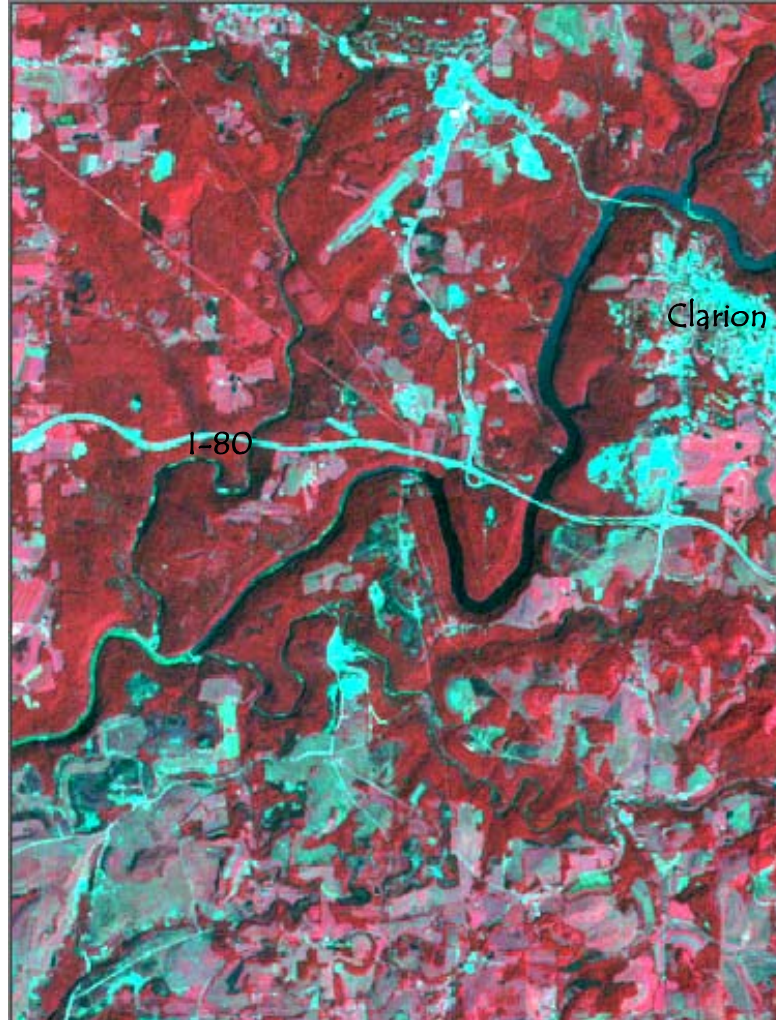
Decision Tree



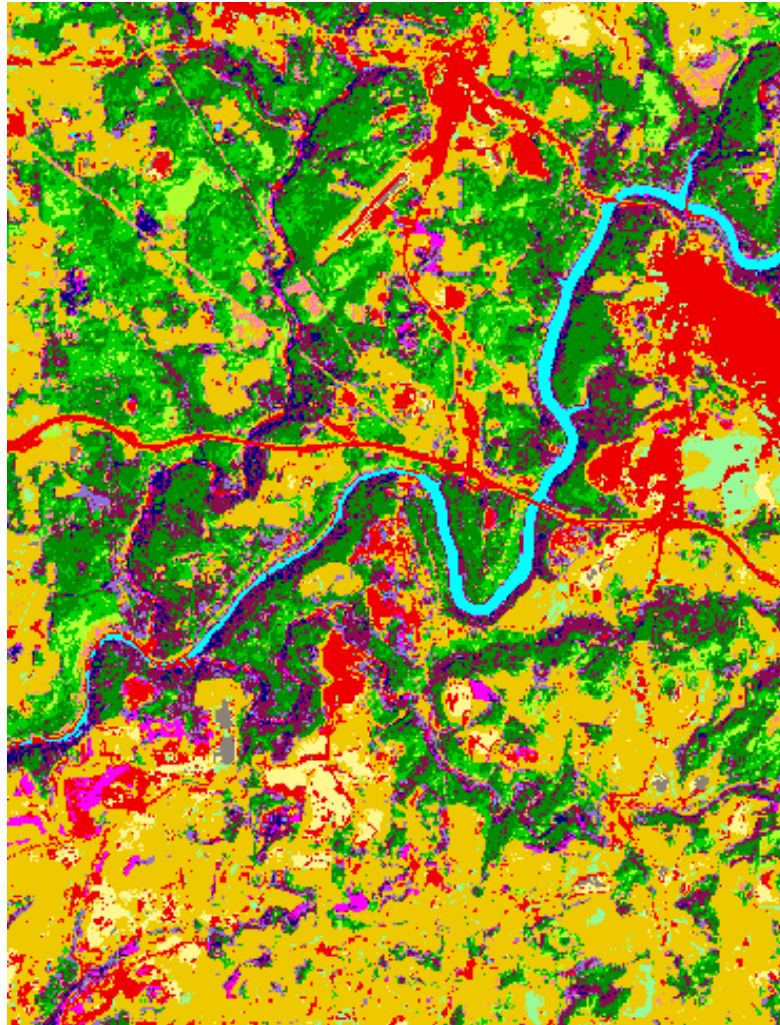
- Old Korean Pine
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- Korean Pine Poplar Birch
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- Poplar
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- Urban

Supervised Spectral Angle

Clarion, Pennsylvania

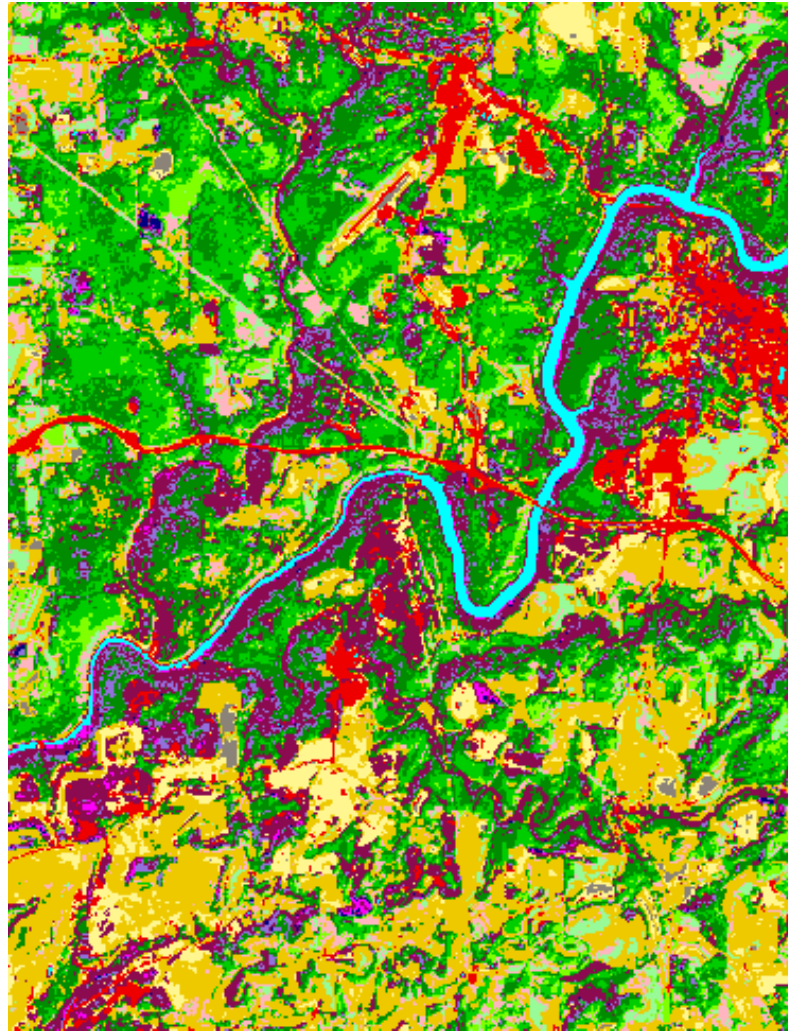


Maximum Likelihood Classifier



- Waterbody
- urban Developed
- Shrub
- managed Grass
- Disturbance
- agriculture (unpaired)
- H Hardwood(30-40 yrs)
- H Hardwood(50-80 yrs)
- N Hardwood(80-100 yrs)
- Hemlock/Mixed Hardwood
- conifer plantation(30-40 yrs)
- pine(5-10 yrs/strip forest)
- bare soil
- conifer/pine mixed (old wood)

Supervised Spectral Angle Classifier



- Waterbody
- urban Developed
- Shrub
- mangrovetrees
- DenseGrass
- sparseloss/impaired
- HFernwood(30-40yrs)
- HFernwood(50-80yrs)
- HFernwood(80-70yrs)
- Hardwood/MixedHardwood
- conifer/hardwood(30-40yrs)
- conifer(0yrs/impaired)
- bareSoil
- conifer/pine/Mixed/road/road

TABLE 1A. Error Matrix for the Classification Result of Supervised Angle Classifier (SSAC)

	Known Land Use/Cover														Row Total	User's Accuracy (%)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Classified Land Use/Cover	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1	9														9	100
2		9													9	100
3			13												13	100
4				10	1										11	90.90
5					14										14	100
6						5							1		6	83.33
7			1				7								8	87.50
8								9							9	100
9									13						13	100
10										9				3	12	75.00
11											4				4	100
12												4			4	100
13													6		6	100
14														6	6	100
Column Total	9	9	14	10	15	5	7	9	13	9	4	4	7	9	124	
Producer's Accuracy (%)	100	100	92.85	100	93.33	100	100	100	100	100	100	100	85.71	65.66		
Overall Accuracy	118/124 = 95.16%														kappa value = 0.947	

1. Water, 2. Urban, 3. Shrub, 4. Managed Grass, 5. Dense Grass, 6. Sparse Grass, 7. Allegheny Hardwood I (30-40years), 8. Allegheny Hardwood II (50-60years), 9. Allegheny Hardwood III (70-80years), 10. Hemlocks, 11. Conifer Plantation, 12. Pine Plantation, 13. Dry Grass, 14. Mixed Forest (White Pine /Allegheny Hardwood)

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8								9							9	100
9									13						13	100
10										9				3	12	75.00
11											4				4	100
12												4			4	100
13													6		6	100
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Future Tasks

Dec 2001-June2002

- Classifications of tropical, subtropical regions including neural net
- Address issues involved in radiometric correction and mosaic of adjacent scenes
- Investigating TM data resampling, scaling-up, and linking to MODIS, AVHRR

July 2002-Dec 2002

- Identify & discuss optimal operational methods involved in each classification procedure with LCLUC team members
 - Data preprocessing
 - Establish classification scheme
 - Identify & locating training sites
 - Classification
 - Accuracy assessment

Jan 2003-Aug 2003

- Finalize optimal operational methods involved in each classification procedure with LCLUC team members
- Publish and report final project results
- Workshop

Spectral Distance vs Spectral Angle in Pattern Space

