



Spatial and Temporal Dimensions of Contemporary U.S. Land Cover/Land Use Change and Implications for Carbon Dynamics

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Land Cover Trends/Carbon Implications Research Team

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 - **Terry Sohl** - Change Analysis, Sampling
 - **Kristi Saylor** - Change Analysis, Biophysical Variables
 - **Alisa Gallant** - Change Analysis, Landscape Pattern Analysis
 - **Greg Zylstra** - Biophysical Variables, Radiometry
 - **Darrell Napton (SDSU)** - Driving Forces, Consequences
 - **Steve Stehman (SUNY Syracuse)** - Sampling, Accuracy Assessment
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Research Objectives

Land Cover Change Assessment - Document the types, geographic distribution, and rates of 1970's to 2000 U.S. land use and land cover change in order to answer the following:

- What are the spatial and temporal dimensions of land use and land cover change?
- What are the regional driving forces of contemporary land use and land cover change?

Research Objectives

Carbon Dynamics Assessment – Isolate and identify the explicit role of local land use/land cover change in affecting contemporary regional and national carbon dynamics across the U.S.

- What are the spatial and temporal distributions of carbon sources and sinks?
 - What are the mechanisms that cause these distributions?
 - What are the uncertainties in carbon dynamics related to LU/LC change?
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Methodology

■ Spatial Framework

- ◆ Omernik ecoregions; probability sample of 20 km by 20 km blocks allocated by ecoregion

■ Land Cover Assessment

- ◆ Analyze change for each sample using 1973, 1980, 1986, 1992, and 2000 Landsat MSS, TM, ETM+.
 - ◆ Hybrid contextual change vector/manual interpretation approach.
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Sampling Strategy

- Random selection of 20 km by 20 km blocks for each ecoregion.
- Sample size of approximately 800 blocks based on:

$$k = 1 / (1/k_0 + 1/K)$$

k = planned sample size

K = number of blocks in ecoregion

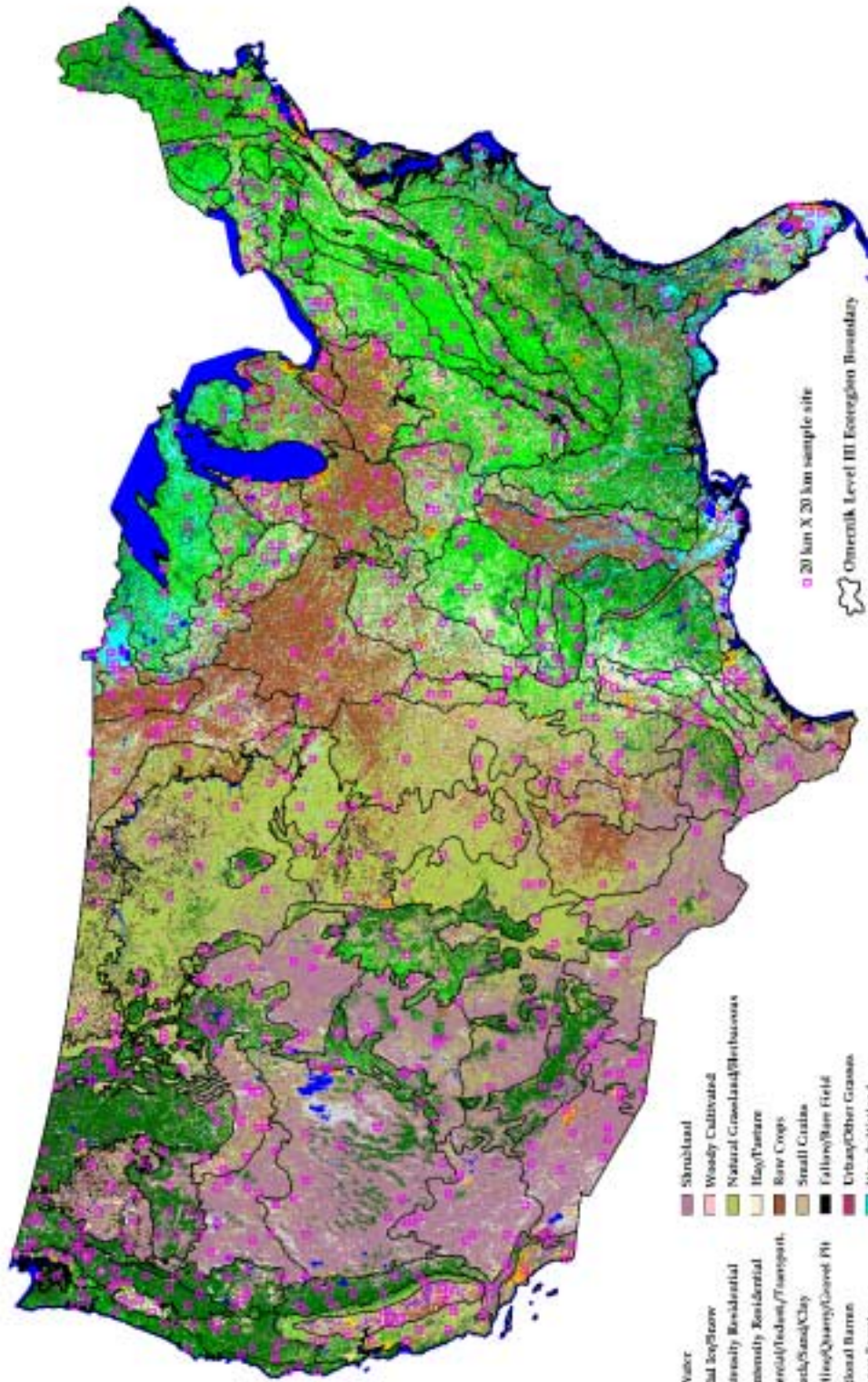
$k_0 = (z \cdot \sigma / m)^2$ with:

z = percentile from the normal distribution (0.85)

σ = StDev of the number of change pixels per block

m = margin of error ($\pm 1.0\%$)

United States Land Cover Trends



- Open Water
- Perennial Ice/Snow
- Low-Intensity Residential
- High-Intensity Residential
- Commercial/Industrial/University
- Baro. Bark/Sand/Clay
- Strip Mine/Quarry/Coastal Pt
- Traditional Barren
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrubland
- Woody Cultivated
- Natural Grassland/Herbaceous
- Hay/Pasture
- Rare Crops
- Small Cattle
- Fallow/Bare Field
- Urban/Other Grasses
- Woody Wetland
- Herbaceous Wetland

20 km X 20 km sample site

Obrecht Level III Ecoregion Boundary

U.S. Geological Survey
National Mapping Division
EROS Data Center
Reston, VA 20192



Land Cover Variables

- General land cover types
 - ◆ Developed/built-up
 - ◆ Agriculture
 - ◆ Forest and woodland
 - ◆ Rangeland/grassland
 - ◆ Wetland
 - ◆ Water bodies
 - ◆ Snow and ice
 - ◆ Natural barren
 - ◆ Mined lands
 - ◆ Mechanical disturbed or transitional
 - ◆ Non-mechanical disturbed or transitional

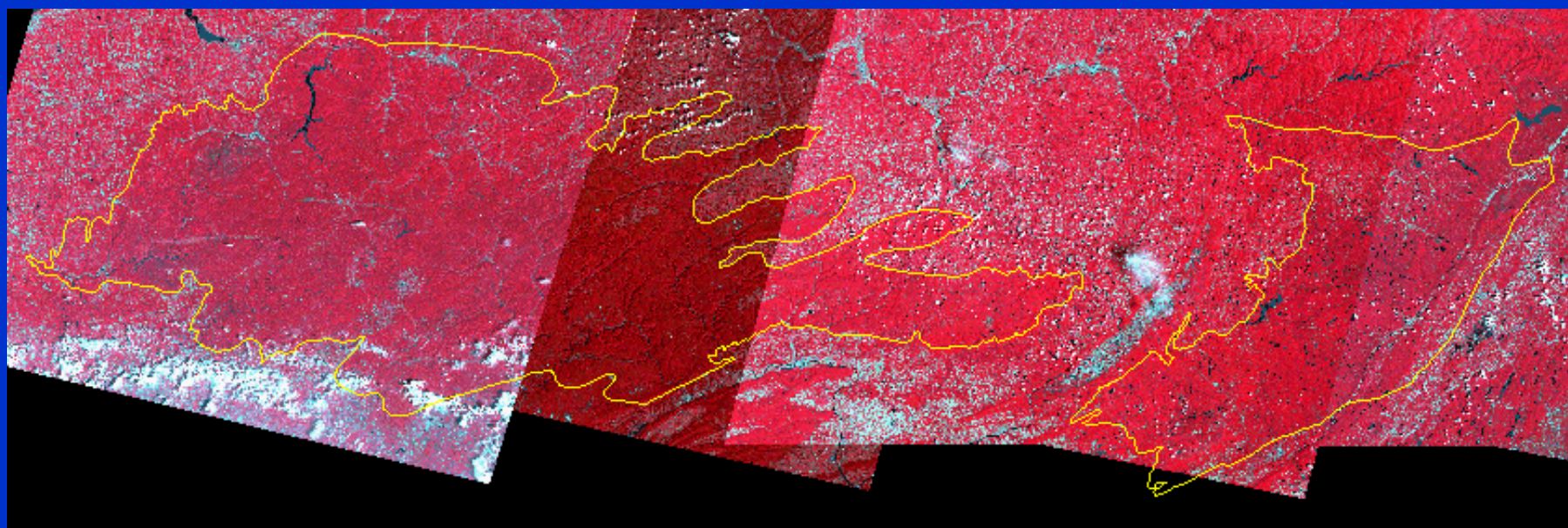
Methods, Carbon Assessment

- Carbon Dynamics Assessment
 - ◆ Develop land cover, land use, soils, and climate data sets for each 20x20 km sample block.
 - ◆ Apply cohort-statistical-simulation (CoSim) method to develop joint frequency distributions for CENTURY model parameters.
 - ◆ Apply CENTURY model to estimate carbon dynamics for each sample site, assess the variability of carbon responses to land use change, and determine confidence limits on simulated results.
 - ◆ Summarize ecoregion-wide carbon dynamics.
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Data Requirements

- Landsat Data
 - 1973, 1980, 1986, 1992 MSS (NALC)
 - 1992 TM, 2000 ETM+ (MRLC)
 - County Statistics
 - ♦ Population
 - ♦ Agricultural characteristics
 - ♦ Employment by economic sector
 - ♦ Housing (e.g., total units, occupied units)
 - STATSGO soil polygons, attributes
 - National Climate Data Center - precipitation and temperature data
 - National Atmospheric Deposition Program – atmospheric nitrogen
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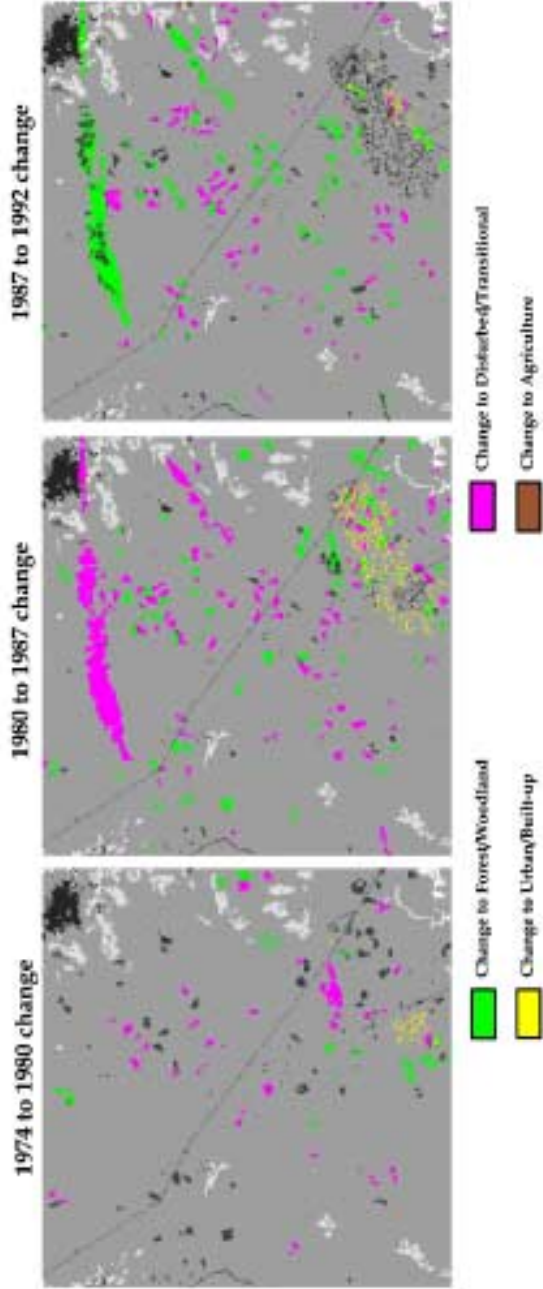
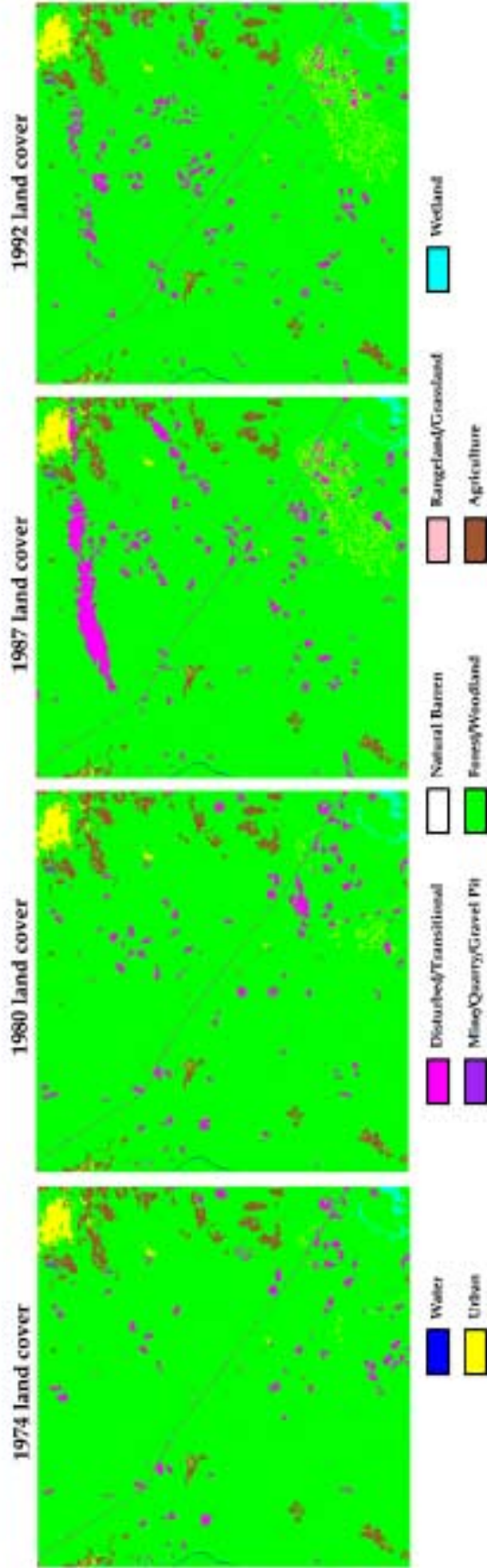
North Central Appalachians Ecoregion



Land Cover Trends Project

Ecoregion 62, Sample 4

1974 to 1992 change

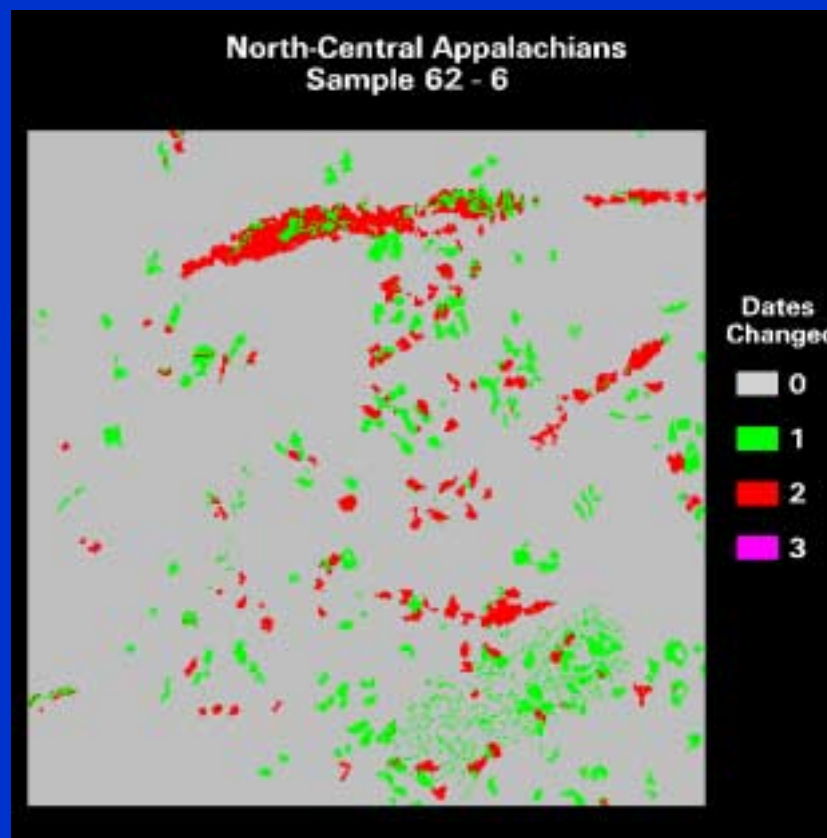


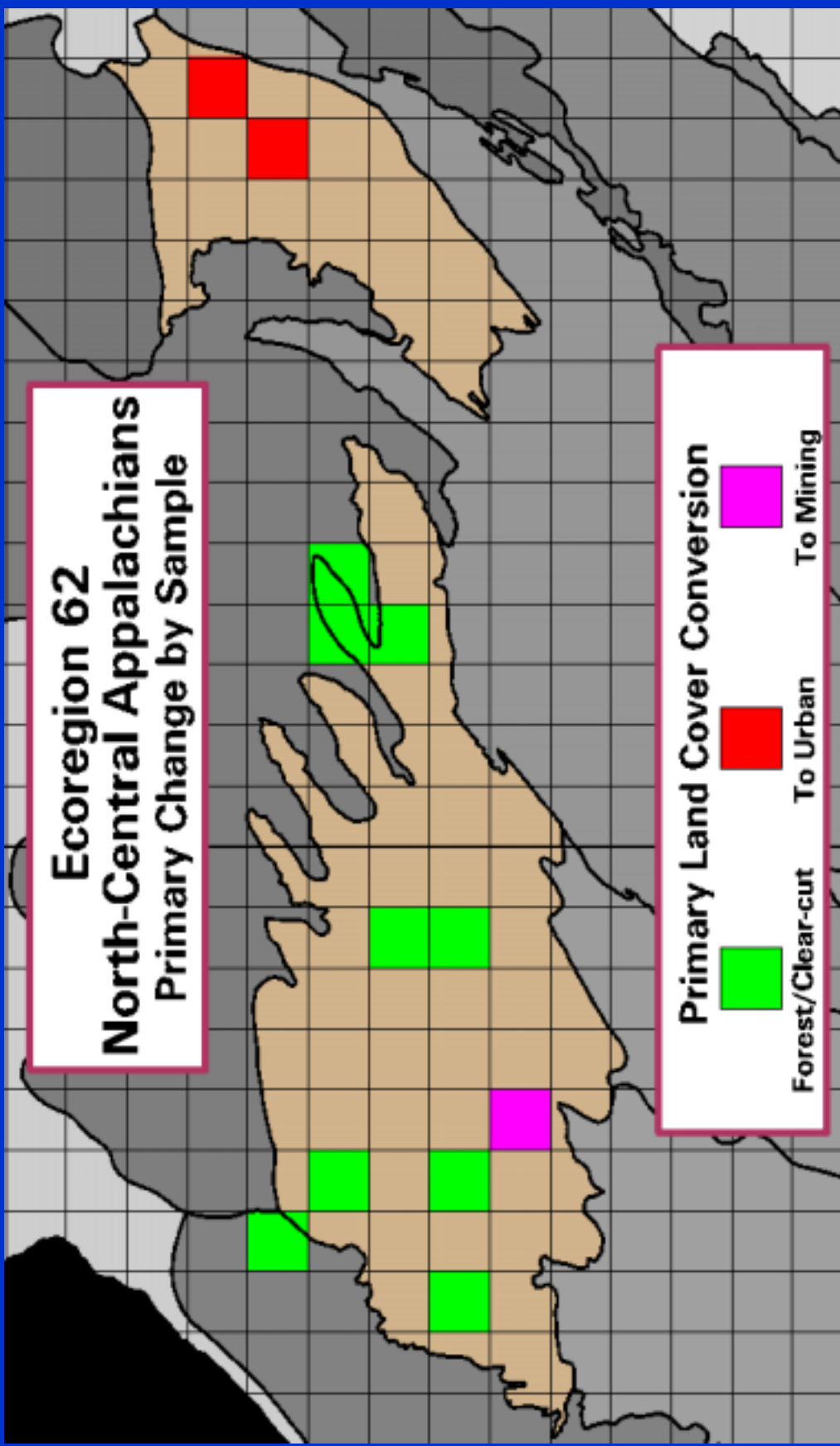
North Central Appalachia Rates of Land Cover Change

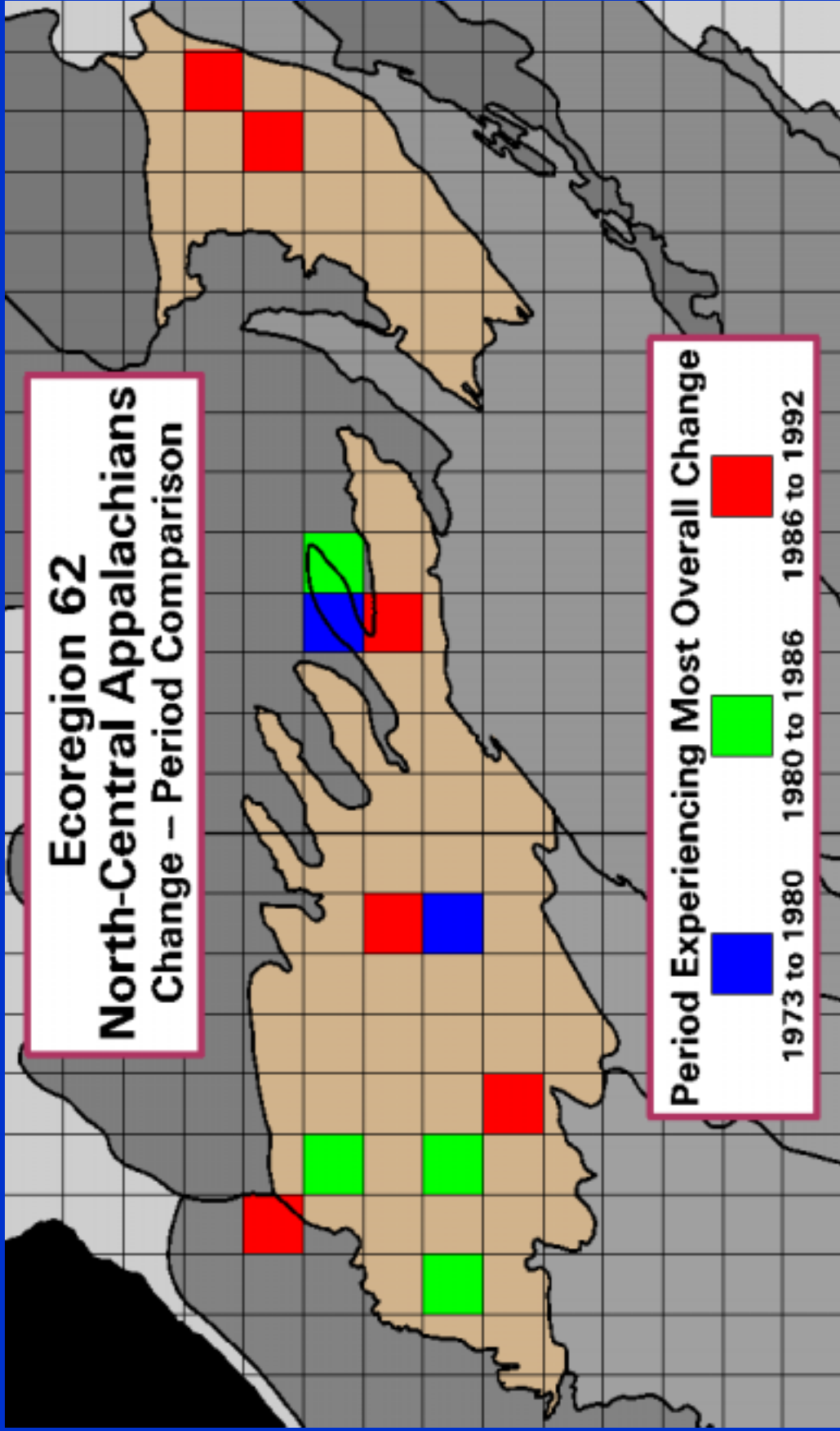
Cover	1973	1980	1986	1992
Water	1.6%	1.6%	1.6%	1.6%
Urban/Built-Up	0.7%	0.8%	0.9%	0.9%
Transitional	1.1%	1.2%	1.4%	1.2%
Mining/Quarries	0.4%	0.5%	0.5%	0.7%
Forests and Woods	91.5%	91.2%	91.1%	91.1%
Agriculture	3.9%	3.9%	3.7%	3.7%
Wetlands	0.7%	0.7%	0.7%	0.7%

1972-1992 Cumulative Land Cover Change

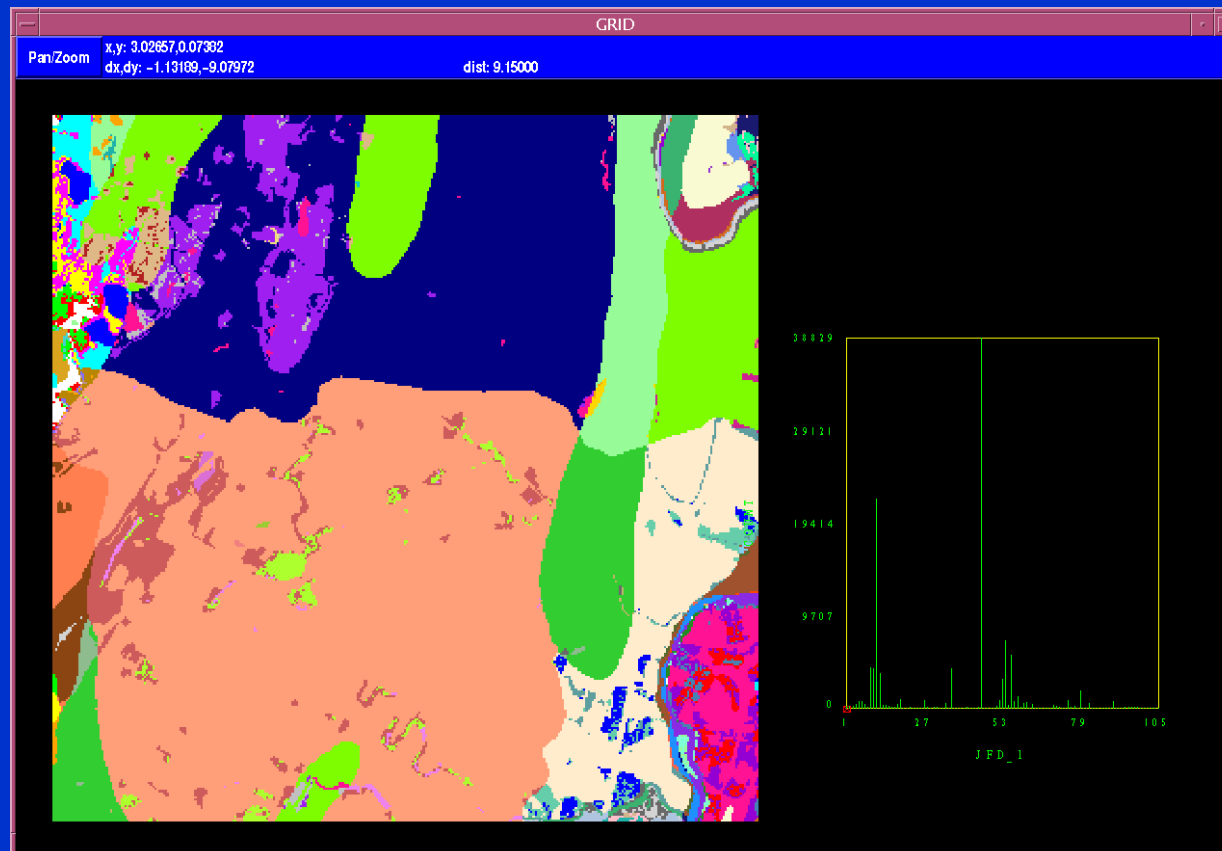
- Overall, 4.14% of the ecoregion landscape changed between 1972 and 1992.







Joint Frequency Distribution of STATSGO MUID, County Boundary, and Land Cover in 1973, 1979, 1987 and 1991 Sample Block 1 in Ecoregion 62



FY2000 Accomplishments

- Land Cover Change Assessment
 - ◆ Land cover change methods developed, tested
 - ◆ Interpretation of 4 ecoregions completed
 - Carbon Dynamics Assessment
 - ◆ Graphic user interface is nearly completed
 - ◆ Methods for extracting STATSGO attributes, Joint Frequency Distribution (JFD) completed
 - ◆ CENTURY linkages to STATSGO, climate data and land cover data has been completed
 - ◆ Testing at Sample Block 1 in Ecoregion 62
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FY 2001 Work Schedule – Land Cover Change Analysis

- Incorporate 2000 Landsat ETM+ data into analysis.
- Complete analysis of 20-30 ecoregions (emphasis on Eastern United States).
- Publish manuscripts on methodology and pilot phase results.

FY 2001 Work Schedule – Carbon Modeling

- Complete all the model-data linkages required for model simulation.
- Finish the development of the graphic user interface (GUI)
- Use the GUI to run model simulations over 10 to 20 ecoregions
- Publish results

Science Implications

- Objective understanding of the spatial and temporal dimensions of 1972-2000 conterminous U.S. LU/LC change.
- Identify local to regional carbon dynamics linkages.
- Demonstrate a framework for large-area land cover/carbon dynamics monitoring.