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

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NASA, EPA, USGS Partnership
Land Cover Trends/Carbon Implications Research Team

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- Kristi Sayler - 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
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?
Methodology

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

- Land Cover Assessment
  - Hybrid contextual change vector/manual interpretation approach.
Sampling Strategy

- Random selection of 20 km by 20 km blocks for each ecoregion.
- Sample size of approximately 800 blocks based on:
  \[ k = \frac{1}{1/k_0 + 1/K} \]
  - \( k \) = planned sample size
  - \( K \) = number of blocks in ecoregion
  - \( k_0 = (z/F/m)^2 \) with:
    - \( z \) = percentile from the normal distribution (0.85)
    - \( F \) = StDev of the number of change pixels per block
    - \( m \) = margin of error (±1.0%)
United States Land Cover Trends
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.
Data Requirements

- Landsat Data
  - 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
North Central Appalachians Ecoregion
Land Cover Trends Project
Ecoregion 62, Sample 4
1974 to 1992 change


- Water
- Urban
- Disturbed/Transitional
- Mine/Quarry/Gravel Pit
- Natural Barren
- Rangeland/Grassland
- Wetland
- Forest/Woodland
- Agriculture


- Change to Forest/Woodland
- Change to Urban/Built-up
- Change to Disturbed/Transitional
- Change to Agriculture
### North Central Appalachia
#### Rates of Land Cover Change

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<tbody>
<tr>
<td>Water</td>
<td>1.6%</td>
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<td>1.6%</td>
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<tr>
<td>Urban/Built-Up</td>
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<td>Forests and Woods</td>
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<tr>
<td>Agriculture</td>
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<tr>
<td>Wetlands</td>
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<td>0.7%</td>
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</tbody>
</table>
Overall, 4.14% of the ecoregion landscape changed between 1972 and 1992.
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
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.