A Comparative Study of Forest Mapping Methods/algorithms: Towards Optimal Solutions for Operational Global Forest Mapping/Monitoring

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Introduction

With the growing concern over an alarming rate of deforestation and loss of forest biodiversity worldwide, the need for accurate and up-to-date accessible information at regional and global scales has been recognized by the LCLUC (Land Cover Land Use Change) program initiated by NASA and GOFC (Global Observations of Forest Cover). Among pilot project themes identified by the GOFC, mapping of forest cover characteristics and changes is considered as the most critical and but challenging of the proposed themes, and the need for developing operational forest cover monitoring techniques and algorithms is acknowledged.

Most commonly utilized forest mapping methods include vegetation indices and multispectral classification of satellite imagery. Unmixing, neural network, and decision tree classification algorithms are most commonly utilized for forest mapping along with maximum likelihood classification algorithm.

Even though it is important to understand the strength and weaknesses of different mapping and monitoring algorithms/methods and how these different mapping algorithms can be effectively utilized for monitoring different characteristics of forests, the inter-comparison of different algorithms and addressing technical/conceptual issues involved in forest cover mapping using these algorithms has never been done before.

Goals and Objectives of the Project

The goal of the project is to compare and evaluate different algorithms and methods for forest cover mapping and monitoring at regional and global scales. By comparing and evaluating different forest mapping and monitoring algorithms and approaches through collaborative efforts among LCLUC science team members, we will be able to provide an objective evaluation of existing algorithms and methods and may be able to reach a consensus towards optimal solutions for implementing operational forest monitoring systems. While comparing and evaluating different forest mapping algorithms and methods, I will perform this project with one eye to finding and implementing an alternative, simple and robust mapping/monitoring algorithm that may lead towards operational forest monitoring systems.

The project has three specific objects:

- Comparing and evaluating different forest mapping/monitoring algorithms and methods using TM data of different regions of the world (Africa, China, Southeast Asia, Russia, and US) based on a common framework
- Addressing conceptual/technical issues involved in different mapping algorithms
- Acquiring optimal solutions for developing operational forest monitoring systems based on the evaluation results

Expected Contributions

Expected contributions of the project include: (i) The results of the project will significantly enhance our understanding of different forest mapping algorithms and how these algorithms can be effectively utilized for mapping different forest characteristics in different ecoregions through collaborative efforts among LCLUC science team members; (ii) The results of the project will contribute to the LCLUC program and NASA's effort for developing operational forest monitoring systems; (iii) The project will demonstrate the unique role of Landsat TM data in mapping and monitoring forest cover characteristics. With new ETM+ data available to users, this project will provide timely experimental results to the remote sensing and global change communities.

Also the findings of this investigation would benefit the forest mapping and deforestation assessment in general and it may provide agreeable forest mapping method for Kyoto Protocol implementation.

Collaborators

As of September 2000, collaborators of the project include the following LCLUC science team members:

- Ruth DeFries, University of Maryland
- Jiague Qi, Michigan State University
- Guoqing Sun, University of Maryland
- Paul Desanker, University of Virginia

Besides the LCLUC Science team members listed above, 2-3 more teams may join the project.

Comparison and Evaluation of Forest Mapping Algorithms

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

(i) Accuracy of the mapping/monitoring results

- Overall accuracy
- Categorical accuracy
- Misclassification costs

(ii) Computational/operational efficiency

- Computational and operational resources required for classification/monitoring

(iii) 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?

Timetable

Time period	Task
7/1/2000-6/30/2001	• Develop a common framework for inter comparisons: classification methods, identifying forest classes, strategies for identifying and locating reference sites, etc. • Identifying and locating reference sites and ground truth information for the first year project areas: China and Miombo areas • Classifications using different methods (decision tree, spectral angle, maximum likelihood) • Comparisons of classification results • Publish the evaluation results
7/1/2000-6/30/2002	• Identifying and locating reference sites and ground truth information for the second year project areas: Southeast, US • Classifications, comparisons, and evaluations
71/2002-6/30/2003	• Identifying and locating reference sites and ground truth information for the third year project areas: Russia • Classifications, comparisons, and evaluations • Workshop for discussing final evaluation results • Publish and report final evaluation results