

Operational Forest Monitoring using Thematic Mapper (TM) Data

Youngsinn Sohn, Geography & Environmental Systems, University of Maryland Baltimore County (UMBC)

Collaborators

- Jiaguo Qi, Michigan State University
- Curtis Woodcock, Boston University
- John Rogan, San Diego State University
- Guoqing Sun, University of Maryland, College Park
- John Townsend, University of Maryland, College Park



1. Project Summary

- Evaluation of the different forest mapping algorithms and methods based on the accuracy of mapping results, operational efficiency for forest monitoring at regional scales, and the robustness of the mapping algorithm.
- Presentation of optimal solutions for implementing forest monitoring system at regional scale
- The results of this inter-project comparison will significantly enhance our understanding of different forest mapping algorithms and methods, and how these algorithms can be effectively utilized for mapping and monitoring different forest characteristics in different ecoregions through collaborative work among LCLUC Science Team members.
- The evaluation results of the proposed project will: (1) contribute to NASA's ESE LCLUC Program and NASA's effort for developing operational forest monitoring systems at regional and global scales, and (2) demonstrate the unique role of Landsat TM data in mapping and monitoring forest cover characteristics.

2. Global Forest Mapping/Monitoring

- AVHRR (Advanced Very High Resolution Radiometer)
- MODIS (Moderate Resolution Imaging Spectroradiometer)
- Products derived from AVHRR & MODIS
 - Composite Images
 - Normalized Difference Vegetation Index Maps
 - Continuous Vegetation Cover Field Maps (0-100%)
 - Global Land Cover Maps



3. Strength and Limitations of Global Monitoring using AVHRR and MODIS

- Provide near-real time & general observations of Earth events: forest fires, floods, vegetation vigor & greenness, ice melt, storms, etc.
- NDVI – an indication of vegetation vigor and greenness but not a quantitative measure of biomass
- Land cover/use map – too general
- Continuous vegetation field – percentage of vegetation cover ranges from 0-100%
- Information is too general for climate change modeling, biomass estimation, understanding carbon cycle and sequestration

4. Thematic Mapper (TM) Characteristics

- Spectral bands – located appropriately for earth surface observations
- Spatial resolution, 30m – ecologically meaningful observation unit
- When resampled using 250, 500m spatial resolution – the file size reduced significantly while maintaining spectral integrity
- These characteristics make operational forest monitoring using TM data effective

5. Evaluation/Comparison of Mapping Algorithms

- Different classifiers were evaluated using the same set of training signatures in different ecoregions
- According to the evaluation results, spectral angle classifier consistently generate 10-20% more accurate classification results compared to maximum likelihood, ANN, decision tree classifiers
- Among different mapping approaches, a hybrid spectral pattern matching approach seems most promising for operation forest mapping/monitoring

6. Spectral Angle Classifiers

- The fact that spectra of the same type of surface objects are *approximately* linearly scaled variations of one another due to the atmospheric and topographic effects allows the spectral angle to be used as a metric for measuring "angular distances" in feature space
- Spectral angle classifier rests on the shape of the spectral pattern, while conventional classifiers rest on the statistical distribution pattern in feature space. So when the shape of the pattern is more important than the statistical distribution pattern, as in mapping land cover/land use using the multispectral satellite image data, the spectral angle classifier is expected to perform better classifications
- Spectral angle classifiers do not require the data to be normally distributed and insensitive to data variances and to the size of the training data set as well
- Spectral angle classifier is less sensitive to gain factors related to topographic illumination and atmospheric effects



7. Operational Forest Monitoring Feasible?

- Test results indicate that operational forest monitoring is feasible at least at regional scale
- The successful implementation of operational forest monitoring at continental, global scale will be depending upon:
 - Preparation of seamless, radiometrically corrected, same season TM data at continental, global scale
 - Identifying and maintaining training sites for mapping meaningful categories of forest types by physiographic region

8. Future Plan

- Implementing operational forest monitoring system at regional scale
- Investigation of optimal solutions for implementing operational forest monitoring system at continental scale



9. Publications

- Y. Sohn and S. Rebello, 2002. Supervised and Unsupervised Spectral Angle Classifiers, Photogrammetric Engineering & Remote Sensing, 68 (12): 1271-1280.
- Y. Sohn and J. Qi, Analytical Mapping of Biotic Communities in the Upper San Pedro Valley in Arizona (in progress)
- Y. Sohn, J. Qi, C. Woodcock, J. Rogan, G. Sun, and J. Townsend, Multispectral Image Classification: Review and Evaluation of Various Mapping Algorithms and Approaches (in progress)
- Y. Sohn, Operational Forest Mapping and Monitoring at Regional Scale (in progress)