Towards Methodologies for Global Monitoring of Forest Cover Characteristics with Coarse Resolution Data

Second Year Progress Report

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Background

This project addresses the need to develop prototype methodologies for global monitoring of forest cover with coarse resolution data in the context of the Global Observations of Forest Cover activities. The project builds on previous research to improve methodologies for characterizing forest cover and changes in forest cover independent of the often varying thresholds of canopy cover considered to be "forest." By developing a training and validation data set based on in situ measurements as well as high resolution Landsat data, we are developing a prototype product for the conterminous United States using 250m and 500m MODIS data. The methodology for combining in situ, high resolution, and coarse resolution data serves as a prototype that can be extended to other parts of the world. We are also examining the ability of the methodology to identify changes in forest cover by applying it to individual years and assessing the extent to which differences represent actual change. This aspect of the project necessarily relies on AVHRR data as a time series of MODIS data has not yet been acquired. We are also addressing the need within GOFC for methodologies that are automated and repeatable. A number of techniques such as automated noise reduction for training data, feature selection, and enhancements to decision tree classifiers are being assessed for their potential to automate the procedures.

Key words:
Research fields: Deforestation, Forest conversion, Land cover classification
Geographic area/biome: Global
Remote sensing: AVHRR, Landsat, MODIS
Methods/scales: Global scale, mixture modeling

Themes and Questions Addressed in this Project

This project addresses the LCLUC long-term goal of reliable, verifiable and repeated global monitoring of land-cover and land-use processes from space and addresses the question "what are the changes in land cover and/or land use?"

The project does not address the human dimensions directly, though monitoring of anthropogenic land cover change is crucial to understanding the causes of the change.

The theme addressed in the project is GOFC (100%).

Objectives for the Project

The objectives of the project are to:

- Establish a prototype methodology for characterizing global tree cover as proportional coverage with coarse resolution (250m - 100m) data based on in situ measurements

- Develop and test automated procedures for mapping tree cover at repeated intervals from coarse resolution data

- Develop and test the prototype methodology for a number of years to assess the capability for identifying locations undergoing rapid changes in forest cover

- Provide the prototype data sets and descriptions of the methodologies to the GOFC community through the Global Land Cover Facility at the University of Maryland.

To begin to meet these objectives in the first year of the project, we developed improved methods to identify percent tree cover using regression tree methods, developed plans and protocols for field work to be carried out in the summer of the second year, and derived preliminary percent tree products from MODIS data for the eastern United States.

Progress during this Reporting Period

Progress has been made in a number of areas during the second year:

1) field work to validate and calibrate percent tree cover algorithms - During summer 2002, we carried out extensive field work in five sites around the coterminous United States to obtain in situ measurements of percent tree cover. Sites were in the upper Midwest, eastern US, Pacific northwest, southern California, and Arizona. Following the protocol established in the first year, measurements of percent tree cover were obtained across transects selected as representative of the varying coverage within the Landsat scene. The measurements were then used in conjunction with high resolution IKONOS and Landsat data to characterize percent tree cover for these areas. These data provide important calibration data for validating and assessing the accuracy of the coarse resolution percent tree cover estimates.

2) percent tree cover product from MODIS data – During this reporting period, we have applied the algorithms and training data developed in the first year to multitemporal MODIS 250m data for coterminous United States (data available at the Global Land Cover Facility at http://glcf.umiacs.umd.edu). The methodology applies training data of percent tree cover, derived from interpretation of Landsat scenes, in a regression tree. Input to the algorithm are multitemporal metrics representing the spectral response and phenology of the vegetation. Currently, this method is being extended to the globe using MODIS 500m data. Following the objectives of the project, the method is automated and requires very little subjective judgment.

3) assessing change in percent tree cover from a time series of AVHRR data – Because a significant time series of MODIS data is not yet available, to test the applicability of the percent tree cover method for identifying change in forest cover requires the use of AVHRR data. Previously, we applied the methodology to two years of 1km AVHRR data. However, the noise in the data made it difficult to identify real differences. Instead, we applied the methodology to the 8km AVHRR time series (1982-2000). We compared these results with Landsat analysis for those regions were such analysis has been carried out. Results are encouraging in that major areas of change are identified from the time series. We are currently preparing a publication on these results.

Plans for Coming Year

The third year of the project will focus on several activities:

1) Validation of percent tree cover estimates with field measurements - A major activity in the coming year will to carry out detailed interpretation of the field measurements to validate the MODIS-derived percent tree cover estimates in those locations.

2) Develop and distribute a global percent tree cover product from MODIS data – We are currently deriving a global percent tree cover product based on 500m MODIS data. In the final year of this project, we expect to complete this activity and make it available to the community through the Global Land Cover Facility.

3) Changes in percent tree cover for 1982-2000 – In the final year of the project, we will publish results from the AVHRR analysis. We are also applying these results to improve estimates of carbon fluxes from deforestation (see submitted publication below). After publication, we plan to make this product available to the community.

Conclusions

Global monitoring of forest cover is a key goal for the Global Observations of Forest Cover. Results from the project to date indicate that MODIS data provides greatly improved abilities to characterize forest cover. The methodology developed in previous projects and improved in this project provides a largely-automated approach for monitoring forest cover through time.

Publications and Presentations

Peer-review journals:
Hansen, M., DeFries, R., et al. in press. Estimating Percent Tree Cover in Western Zambia with MODIS data: calibration and validation using high resolution satellite data and ground measurements. Remote Sensing of the Environment.

Hansen, M.C., **DeFries**, R.S., Townshend, J.R.G., Sohlberg, R., DiMiceli, C., and Carroll, M. , in press, Towards an operational MODIS continuous field of percent tree cover algorithm: Examples using AVHRR and MODIS data. *Remote Sensing of Environment*.

DeFries, R., Houghton, R., Hansen, M., Field, C. Skole, D., and Townshend, J. submitted. Carbon emissions from tropical land use change based on satellite observations for the 1980s and 90s. Science.

Hansen, M.C. and DeFries, R. in preparation. Global Changes in Percent Tree Cover from 1982-2000.

Conference abstracts and presentations:
Hansen. M.C., Chan, J. C.-W., Pagis, J., DeFries, R., Luo, D. 2001. *Long term change detection using continuous fields of tree cover from 8km AVHRR data for the years 1982-2000*. First International Workshop on the Analysis of Multitemporal Remote Sensing Images. September 13-14, 2001, Trento, Italy.

DeFries, R. *Measuring the Human Footprint on Ecosystem Function*. invited presentation to American Geophysical Union, fall meeting 2001, San Francisco.

Hansen, M., DeFries, R. et al. *Using Continuous Fields of Tree Cover Maps from Satellite Data to Assess Degradation within Ecoregions, an Example from South America*. presented at American Geophysical Union spring meeting 2001.

Hansen, M., DeFries, R. et al. *Development of a MODIS Validation Tree Cover Data Set for Western Zambia and its Use in Testing MODIS Data*. presented at American Geophysical Union spring meeting 2001.

DeFries, R. and Hansen, M. 2001. *Using MODIS Data to Assess Regional Forest Degradation from Human Activity*. presented at 2001 Ecological Society of America meeting, Madison, Wisconsin, August 2001.

DeFries, R. and Hansen, M. *Continuous Fields of Vegetation Properties Derived from Remotely Sensed Data*, Invited presentation to Association of American Geographers, April 2000.