Characterizing Land Cover Heterogeneity and Land Cover Change from Multisensor Satellite Data

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Background

The research conducted under this project addresses the need to develop improved regional and global land cover products that incorporate spatial and temporal heterogeneity of vegetation based on satellite data. The research focuses on both conventional land cover classification products and alternative approaches to depict land cover heterogeneity and land cover changes over large areas. The applications of these products are primarily regional and global biosphere-atmosphere model. In previous reporting periods, accomplishments were: developing a global land cover training set derived from a global network of high resolution imagery; publication and distribution of a global land cover classification based on 8km AVHRR data; and developing alternative approaches to describing spatial heterogeneity to estimate proportional cover of vegetation types. In this reporting period, the effort has focussed on: 1) global land cover classification from 1km AVHRR data for 1992-93; 2) application of method to derive continuous fields of vegetation characteristics to 1km AVHRR data and the full time series of AVHRR 8km data; 3) distribution of products through the University of Maryland Global Land Cover Facility; and 4) application of products in biosphere-atmosphere models.

1km Global Land Cover Classification

In this reporting period, we have finalized and distributed a global land cover classification based on the 1km AVHRR data for 1992-93. The classification includes the land cover types defined by the International Geosphere Biosphere Program. The method for deriving the classification was based on successful classification of 8km AVHRR data earlier in the project. The method uses a global network of training data derived from analysis of over 150 Landsat scenes to identify training pixels. The training data are used in a decision tree classifier.

The 1km classification complements the global land cover product produced under the auspices of the IGBP (IGBP DISCover). The product also serves as an at-launch land cover layer to be used in the generation of MODIS land products. Efforts will be carried out in the final stages of the project to produce a revised 1km classification that includes additional land cover classes required for generating some of the MODIS land products.

Continuous Fields of Vegetation Characteristics

As an alternative approach to the traditional classification schemes with discrete numbers of vegetation types, we have proposed "continuous fields" of vegetation properties that more realistically describe gradients and heterogeneity of the vegetated land surface. A linear mixture model is applied to estimate proportional cover for three important vegetation characteristics: life form (percent woody vegetation, herbaceous vegetation, and bare ground); leaf type (percent needleleaf and broadleaf), and leaf duration (percent evergreen and deciduous). In previous reporting periods, we applied the approach to AVHRR 1km data and the AVHRR PAL data for the full time series (1982-94). The intent of applying the method individually to each year in the time series was to determine whether the approach can detect interannual variability in land cover due to climate variability and anthropogenic land cover change when calibration between years cannot be assumed. We found that changes in woody cover of greater than approximately 10% can be detected with this method.

In this reporting period, we also derived and distributed a global data set of % tree cover from 1km AVHRR data. This product was derived by combining the 1km land cover classification and the results of the mixture model.

In the remainder of the project, we intend to enhance the method for deriving continuous fields by 1) determining % cover from high resolution images to be used for calibrating and validating the algorithm, 2) combining a linear mixture model and decision tree approach to depict percent cover according to stratification of the spectral space, and 3) developing methods for using in situ measurements of % canopy cover for calibration and validation.

Distribution of Land Cover Products

During this reporting period, we have worked closely with the University of Maryland Global Land Cover Facility to distribute the products developed in this project. The Global Land Cover Facility (PI; J. Townshend) provides the digital data sets, documentation, subsetting capabilities, and user support. The data sets can be accessed through http://www.glcf.umiacs.umd.edu.

Application in Biosphere-Atmosphere Models

A number of efforts have been undertaken to explore the use of the land cover products in biosphere-atmosphere models. We have worked with developers of the CASA global terrestrial carbon model to incorporate the continuous fields in the algorithm that allocates net primary production to wood, leaves, and roots. The use of continuous fields appears to improve estimates of above ground biomass. We have also worked with developers of BIOME-BGC to use continuous fields for scaling estimates of NPP. In addition, we have investigated the impact of misclassification of land cover type on parameter estimates, using SiB2 as an example.

Currently, we are working with members of the IDS team on Biosphere-Atmosphere Interactions (PI: I. Fung) to develop approaches for incorporating continuous fields in the coupled SiB2-GCM model.

Future Plans

Over the next period of this project, we plan to:

- Derive a revised version of the global 1km classification to include classes used in derivation of MODIS products

- Develop an improved training data set from high resolution imagery for calibrating and validating the continuous fields

- Develop an enhanced approach to combine linear mixture modeling with decision tree classifiers to derive improved estimates of continuous fields of vegetation properties

- Develop methods to validate continuous fields products based on in situ measurements

- Work with modelers to apply continuous fields in models

- Work with the UMD Global Land Cover Facility to distribute new products

Publications

The following publications have been generated from this project. Publications from this reporting period are in bold:

Hansen, M., DeFries, R., Townshend, J.R.G. and Sohlberg, R., in press. Global land cover classification at 1km spatial resolution using a classification tree approach. International Journal of Remote Sensing.

Hansen, M. and Reed, B., in press. Comparison of IGBP DISCover and University of Maryland 1km global land cover classifications. International Journal of Remote Sensing.

DeFries, R., Hansen, M., Townshend, J., Janetos, A. and Loveland, T., in press. A new global data set of percent tree cover derived from remote sensing. Global Change Biology.

DeFries, R., Hansen, M. and Townshend, J., 1999. Global continuous fields of vegetation characteristics: A linear mixture model applied to multiyear 8km AVHRR data. International Journal of Remote Sensing, in press.

DeFries, R.S., Townshend, J.R.G. and Hansen, M., 1999. Continuous fields of vegetation characteristics at the global scale at 1km resolution. Journal of Geophysical Research, 104: 16,911-16,925.

DeFries, R.S. and Los, S.O., 1999. Implications of land cover misclassification for parameter estimates in global land surface models: An example from the Simple Biosphere Model (SiB2). Photogrammetric Engineering and Remote Sensing, 65(9): 1083-1088.

DeFries, R., Hansen, M., Townshend, J.R.G. and Sohlberg, R., 1998. Global land cover classifications at 8 km spatial resolution: The use of training data derived from Landsat Imagery in decision tree classifiers. International Journal of Remote Sensing, 19(16): 3141-3168.

DeFries, R., Townshend, J. and Los, S., 1997b. Scaling land cover heterogeneity for global atmosphere-biopshere models. In: D.A. Quattrochi and M.F. Goodchild (Editors), Scale in Remote Sensing and GIS. CRC/ Lewis Publishers Inc., Boca Raton, FL.

DeFries, R. et al., 1997. Subpixel forest cover in Central Africa from multisensor, multitemporal data. Remote Sensing of Environment, 60: 228-246.