Leaf Area Index Change Detection of Understory Vegetation in the Albemarle-Pamlico Basin Using IKONOS Satellite Data

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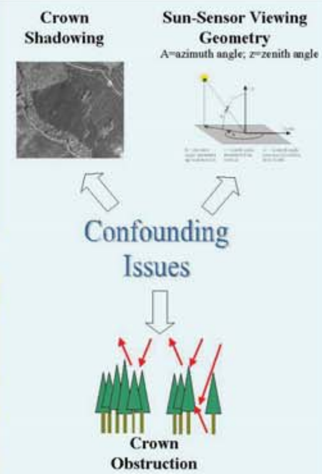
LAI RESEARCH: OVERVIEW

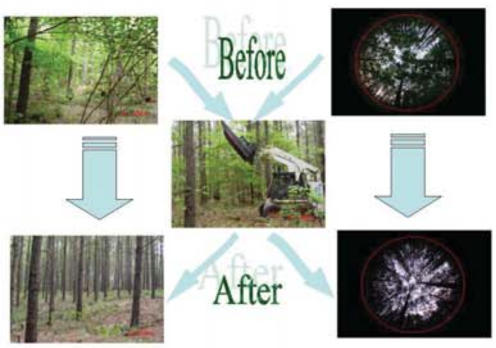
Most ecosystem process models that simulate carbon and hydrogen cycles require Leaf Area Index (LAI) as an input variable. LAI is defined here as one-half the total green leaf area per unit ground surface. Interest in tracking LAI change includes the role forests play in the sequestration of carbon from carbon emissions, the formation of tropospheric ozone from biogenic emissions of volatile organic compounds (BVOC) naturally released into the atmosphere, and the change of global climate over time. LAI is an important parameter in assessing vegetation structure for characterizing forest canopies over large areas at broad spatial scales using satellite remote sensing data. However, there are a number of confounding issues involved in associating LAI with spectral responses from the plant canopy, including vegetation residing under the main canopy, i.e. intermediate and suppressed trees along with bushes, and ground cover. The contribution of this understory vegetation to the overall LAI of a forest stand can be quite large, ranging from 0-40% of the total stand LAI. The confounding effect of understory vegetation contribution to satellite derived estimates of leaf area index (LAI) was investigated on two loblolly pine (Pinus *taeda*) forest stands located in the Albemarle-Pamlico Basin in Virginia and North Carolina. Results from this study will aid in the validation of the 1-km Moderate Resolution Imaging Spectrometer (MODIS) LAI 8-day composite product.

POTENTIAL END-USER: ATMOSPHERIC MODELING DIVISION (EPA)

Researchers from the Landscape Characterization Branch under the auspices of the Environmental Sciences Division along with researchers from the Atmospheric Modeling Division (AMD) are currently evaluating satellite derived LAI as potential input into a number of air quality models. Two local scale AMD models, the Multilayer Model (MLM) and the Multilayer Biochemical Model (MLBC), estimate water vapor and carbon dioxide (MLBC only), along with ozone, SO_2, and nitric acid fluxes across the Clean Air Status and Trends Network (CASTNET). The MLM and MLBC models input a generalized annual LAI profile developed from periodic leaf-on and leaf-off field sampled optical point measurements. Both of these dry deposition models were shown to be highly sensitive to the annual LAI profile parameters generated from these point measurements. On a regional scale, the Community Multiscale Air Quality Model (CMAQ) relies on output from the mesoscale model (MM5) where LAI, a function of solar radiation, root level moisture, air temperature, and air humidity deficit, is input to determine stomatal resistance. LAI inputs from the MODIS LAI product potentially may improve model returns due to the improved spatial and temporal resolution of the MODIS data.



MECHANICAL HARVEST OPERATION



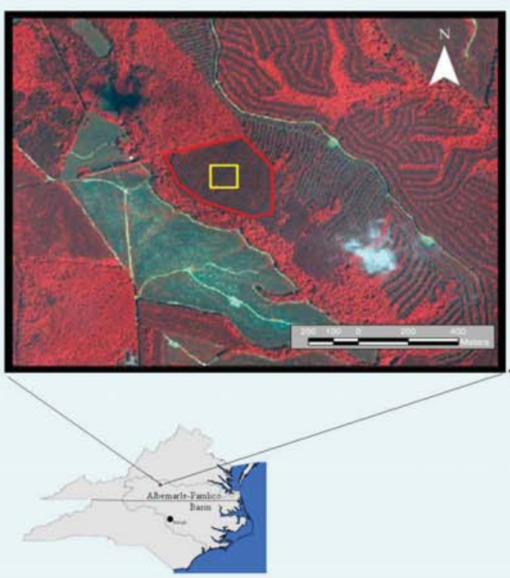
Understory harvest operation, July 2002. Images on right are 180 degree hemispherical photographs.

STUDY DESIGN

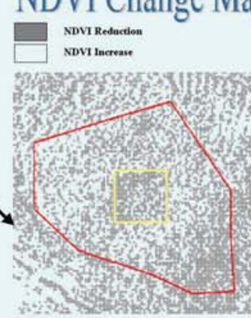
Two 1.0 ha study plots of planted loblolly pine stands (ages 19 and 23) with similar crown closure estimates (70% and 71%, respectively), were studied for spectral response before and after a complete mechanical harvest and herbicide application in late July and early August 2002 Results from only one site (EPA_Appomattox) are presented here. Ikonos (4m spatial resolution, 4 spectral bands) and Landsat Enhanced Thematic Mapper Plus (30m spatial resolution, 6 spectral bands) data were collected both prior and subsequent to understory removal and were evaluated for NIR and VI wavelength response.

QUESTIONS INVESTIGATED

- What vegetation indices best estimate the contribution of understory vegetation?
- Can change be detected at differing spatial resolutions (IKONOS-4m and Landsat ETM+-30m)?
- Can change be detected between different dates of imagery?
- What are the impacts of different sensor viewing geometry and sun azimuth between the two dates of imagery?

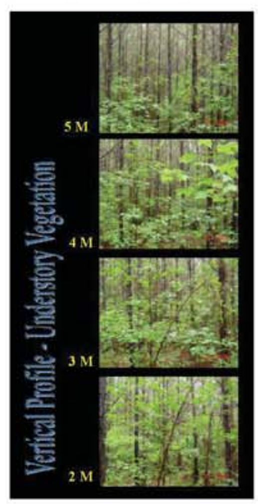


NDVI Change Map



*The Normalized Difference Vegetation Index (NDVI):

NDVI= (Near Infrared band – Red band)/(Near Infrared band + Red Band)



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