

Monitoring Forest Change In Northeastern China With MODIS And LANDSAT

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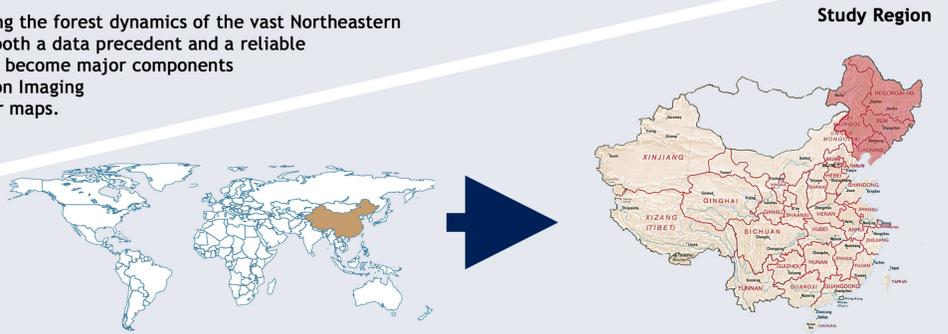
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Introduction

The objective of this project is to develop an operational database system for monitoring the forest dynamics of the vast Northeastern China region. Initial elements of the operational system included the establishment of both a data precedent and a reliable methodology for forest cover mapping and change detection, the products of which will become major components within a Geographic Information System (GIS) database. Landsat and Moderate Resolution Imaging Spectroradiometer (MODIS) data were used to produce current land use and forest cover maps. Given the brevity of historical MODIS time series data, Landsat-7 ETM+ (circa 2000) and Landsat-5 TM (circa 1990) data were used for the change detection analysis. The results of this project are intended to support the GOCF (GOLD) mission; the system may serve as a future node in a northern forest network. This poster presents the generated base map as well as the forest change detection results.

Northeastern China
 Our study area consists of Jilin, Liaoning, Heilongjiang, and the NE portion of Inner Mongolia. See region in red.



Part 1: Base Map Development

Data

Field observations and forest maps

- Tree species, DBH, and height were recorded for each tree in the sample plots at the Changbai Mountain and Daxinganlin study sites.
- 1:50,000 forest maps surveyed in 1999 and 2000 and associated data files were acquired from several forest bureau across the region. Each data file contains 85 entries for each management unit (ranging in area from 1 to 50 ha) including species composition, age, average DBH, height, and timber volume.

Remotely Sensed Data

Landsat Data - Covering forested areas within the region:

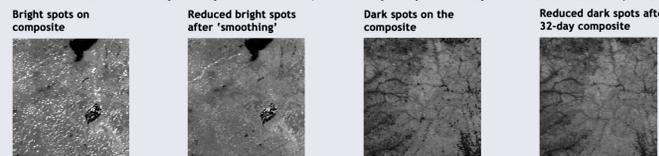
- Landsat 7 ETM+ data -- 70 Level 1G+ (terrain corrected) images acquired between 1999-2002.
- Landsat 5 TM data -- approximately 50 images acquired between 1985-1995.

MODIS Data - Covering entire study region

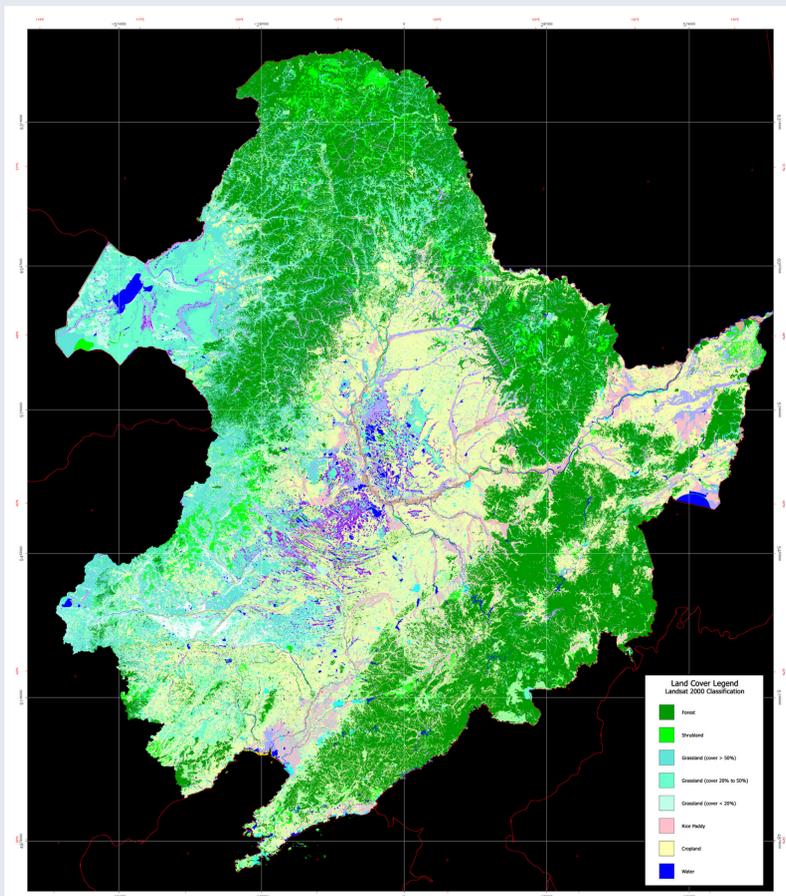
- All MOD13A1 MODIS data (500m 16-day composite) available from day 161, 2000 to day 257, 2002 have been requested, reprojected into Lambert Conformal Conic Projection and mosaicked (using seven 10-degree tiles).

Data Anomalies

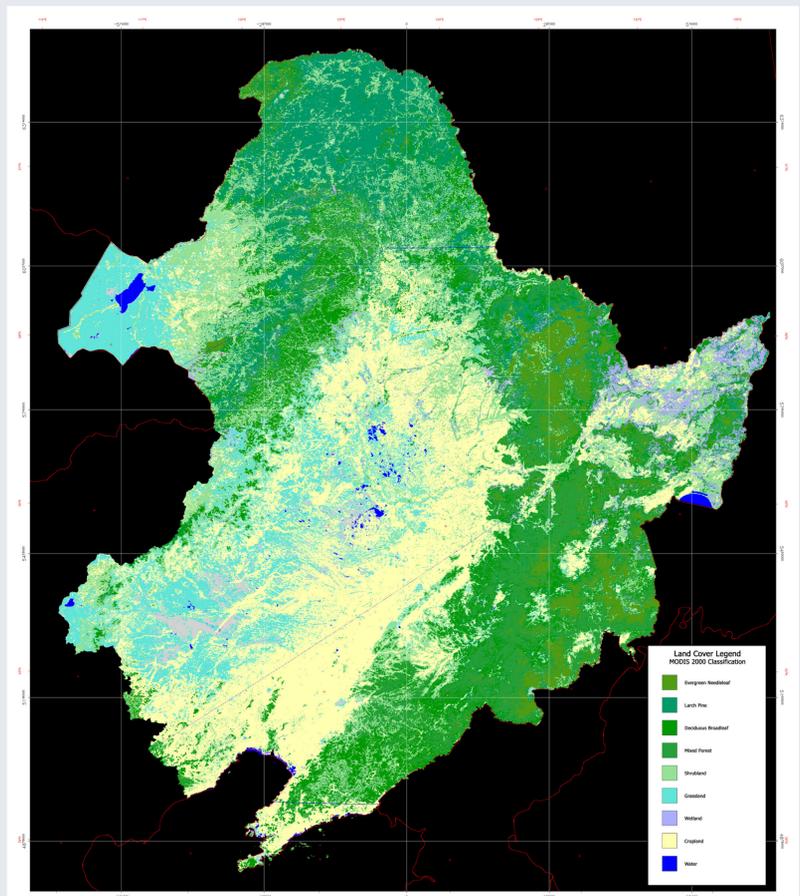
The MODIS 16-day composite data from 2000 and 2001 often contained bright and/or dark spots. To rectify these anomalies, a 'smoothing' method was used to reduce the bright spots. This procedure involved comparing the NDVI value of the composite in question with that of the composites compiled immediately before and after, if the pixel value in question was 20% or more higher, an average of the before and after pixel values was used instead. The dark spots may be from clouds, so a 32-day composite was performed to reduce it (see two examples).



Land use and forest maps from L-7 ETM+ and MODIS data



Land use map from Landsat-7 ETM+ data - manually interpreted from Landsat 7 ETM+ images acquired in 1999 and 2000. Interpretation accuracy has been reported as 98.7% [1]. The classification system includes two levels: 6 classes at level 1, and each has 25 sub-classes in level 2. This map shows 18 classes combined from original classes.



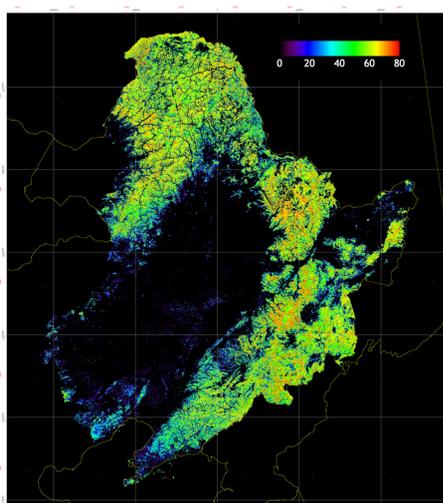
Land use map from MODIS data -- the data from fall of 2000 to fall of 2001 were used to make a first version of forest cover maps in this region. The temporal NDVI data were classified into 255 clusters using ISODATA, and then labeled by referring the 1:50,000 forest maps, Landsat-7 images, the Atlas of Forestry in China (Forest Ministry of China, 1990), and the 1:1000,000 Vegetation Atlas of China (Editorial Board of Vegetation Map of China, Chinese Academy of Sciences, Science Press, Beijing China 2001).

Classification Accuracy Evaluation: Overall accuracy for forests: 79.76%.
 More attention needs to be put in classification of shrubs.

Land Cover	Total Area (ha)	Classified Area	Accuracy
Ever-green Needle	5360145	4965231	0.9263
Deciduous Needle	14288844	11238908	0.7901
Deciduous Broadleaf	14962161	10324220	0.6900
Needle-Broadleaf Mix	12649007	11114832	0.8787
Dense Shrub	23689091	2365969	0.0229
Grassland	13750913	719321	0.5233
Crop Land	33772481	21300849	0.6307
Water	661719	537391	0.8121

Classification accuracy (see table) was evaluated by Prof. Zhang and his graduate students at Northeast Institute of Geography and Agricultural Ecology, Changchun China.

Percent Forest Cover Map



Vigorous methods of calculating global tree cover from coarse resolution data have been studied by DeFries and Hansen, et al. Here we use a simple multiregression model to produce a 'forest coverage' map from MODIS data. A 500-m forest coverage map was first generated from a Landsat-7 interpreted map by quantifying the number of forest pixels in a 500-m by 500-m window. Subsequently, 800 points were randomly selected in each of the three major forest districts in the region (Daxinanlin, Xiaoxinanlin, and Changbai Mountain). The forest percentage and MODIS data were extracted for each of these 2400 points, and the correlation between forest coverage and MODIS data was studied. It was found that there is a significant positive correlation between forest coverage and MODIS NDVI, and a significant negative correlation between forest coverage and MODIS MIR reflectance. Therefore, the multiple regression relation was used to estimate forest coverage from MODIS NDVI and MIR reflectance.

$$F = -0.0594 - 0.5519 * MIR + 0.1352 * NDVI$$

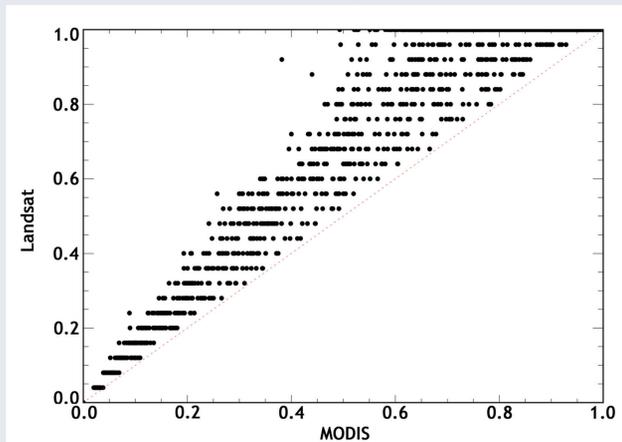
with $R^2=0.5$, F-value = 402.448 and CHISQ = 1374.20

For testing the results, another 2400 points were randomly selected, and the comparison is shown in the above plot.

$$F_{ETM} = 0.042 + 1.159 * F_{MODIS}$$

with $R^2=0.947$

Landsat vs. MODIS-calculated percent forest cover



The forest percentage from the Landsat 7 map is systematically higher than the forest coverage calculated from the MODIS data.

References:

- [1]. Liu, J. Y., X. Z. Deng, M. L. Liu, and S. W. Zhang, Preliminary studies of spatial patterns and driving forces of land use change in Northeast China (draft paper in Chinese).
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- [3]. Editorial Board of Vegetation Map of China, CAS, 2001, The 1:1000,000 Vegetation Atlas of China, Science Press, Beijing China.