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# **Forest Cover Monitoring in Northeastern China**

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# Statement of the Problem

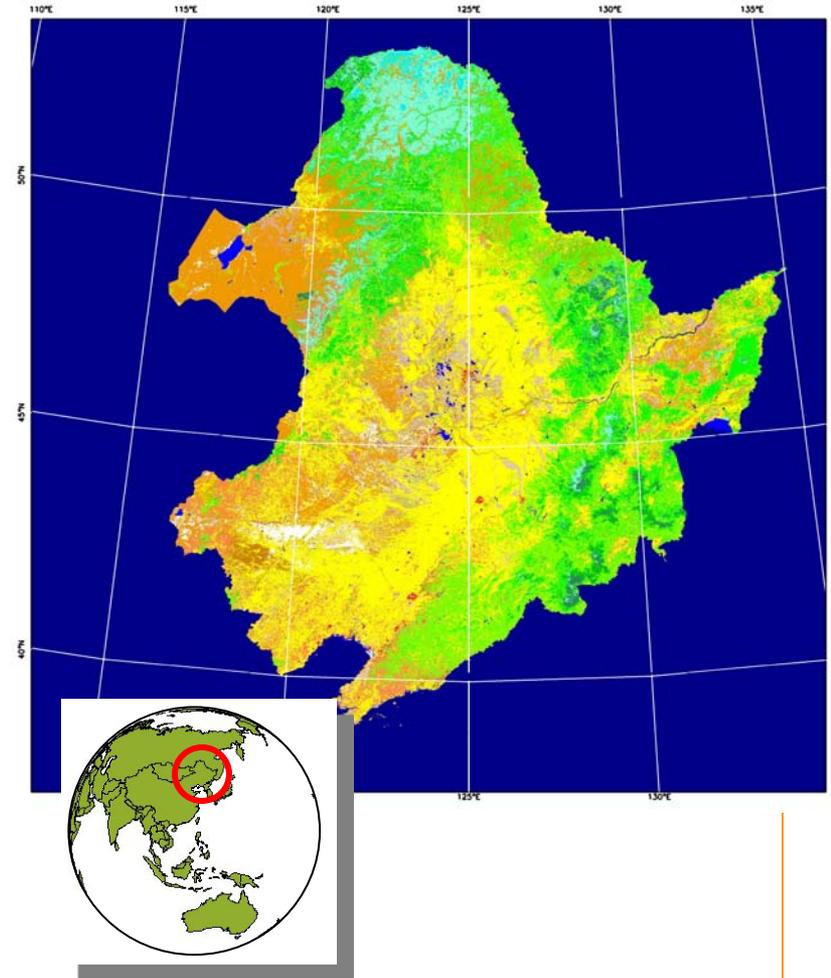


NE China: 1.2% of world's forests,  
30% of China's timber resources

- Forests occupy mountainous perimeter of NE Plains
- North: mixed larch, deciduous
- Central, South: mixed deciduous, needleleaf evergreen

Extent, composition, and cover trends  
not well quantified

Can we improve our knowledge of  
China's Northeastern forests using  
remote sensing resources?



# Research Elements



1. Forest cover mapping from MODIS
2. Forest structural properties from optical remote sensing
3. Carbon budget of 1987 Da Xingan Ling fire
4. Forest Cover Change from Landsat

# 1. MODIS Forest Mapping: Approach



500-meter resolution MODIS MOD13A1 (composite VI/SR) data were assembled into a timeseries:

- *NDVI and NDWI from March 6 – October 25, 2001*
- *15 16-day composites for each*

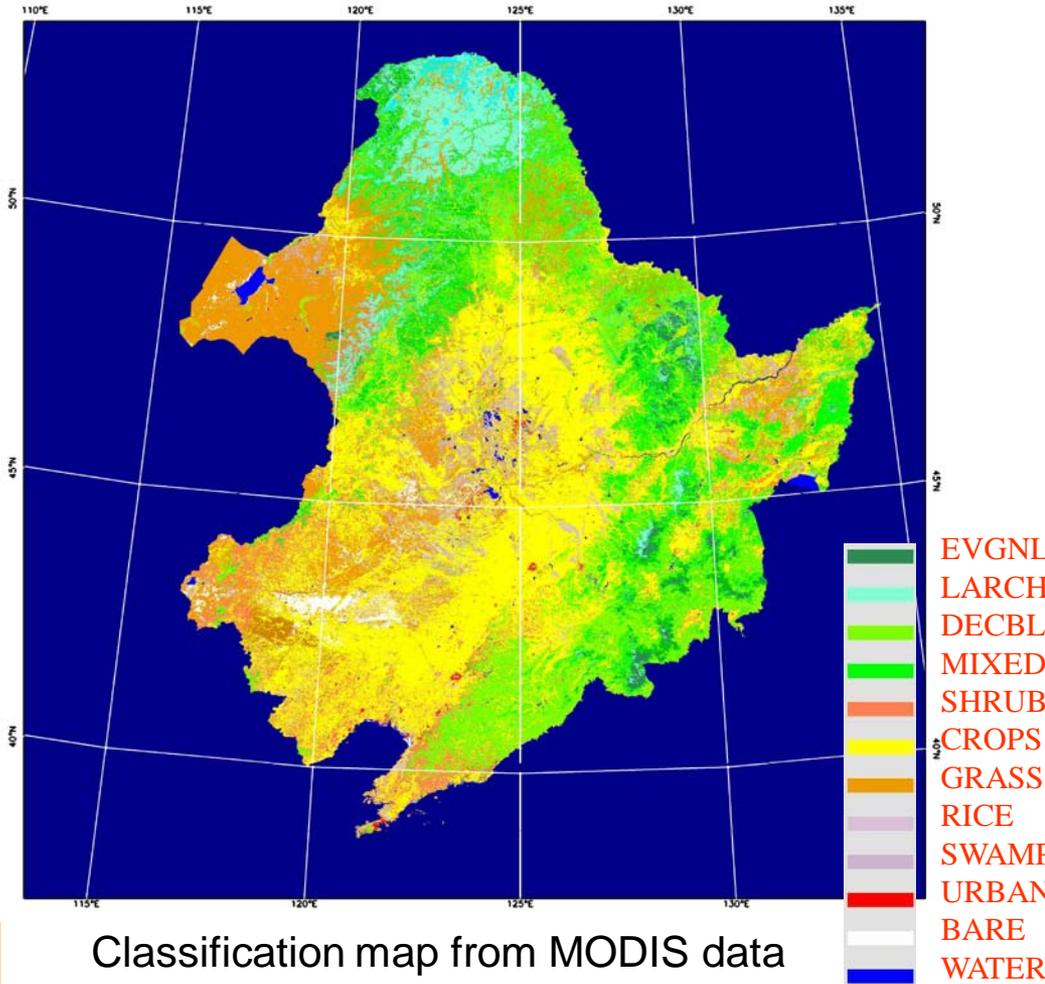
Data were clustered, and clusters then associated with training data Jia and Richards, 2002, 'cluster-space' methodology)

- *training data (94 sites) from Vegetation Atlas of China, Chinese Academy of Sciences, regional forest bureau maps, field observations*

Maps sent to Chinese Academy of Forestry for validation

- *100 check points for each class*

# 1. MODIS Forest Mapping: Results



100 random check points for each type

# 1. MODIS Forest Mapping: Results



Forest mapping accuracy high – 80-95% overall accuracy

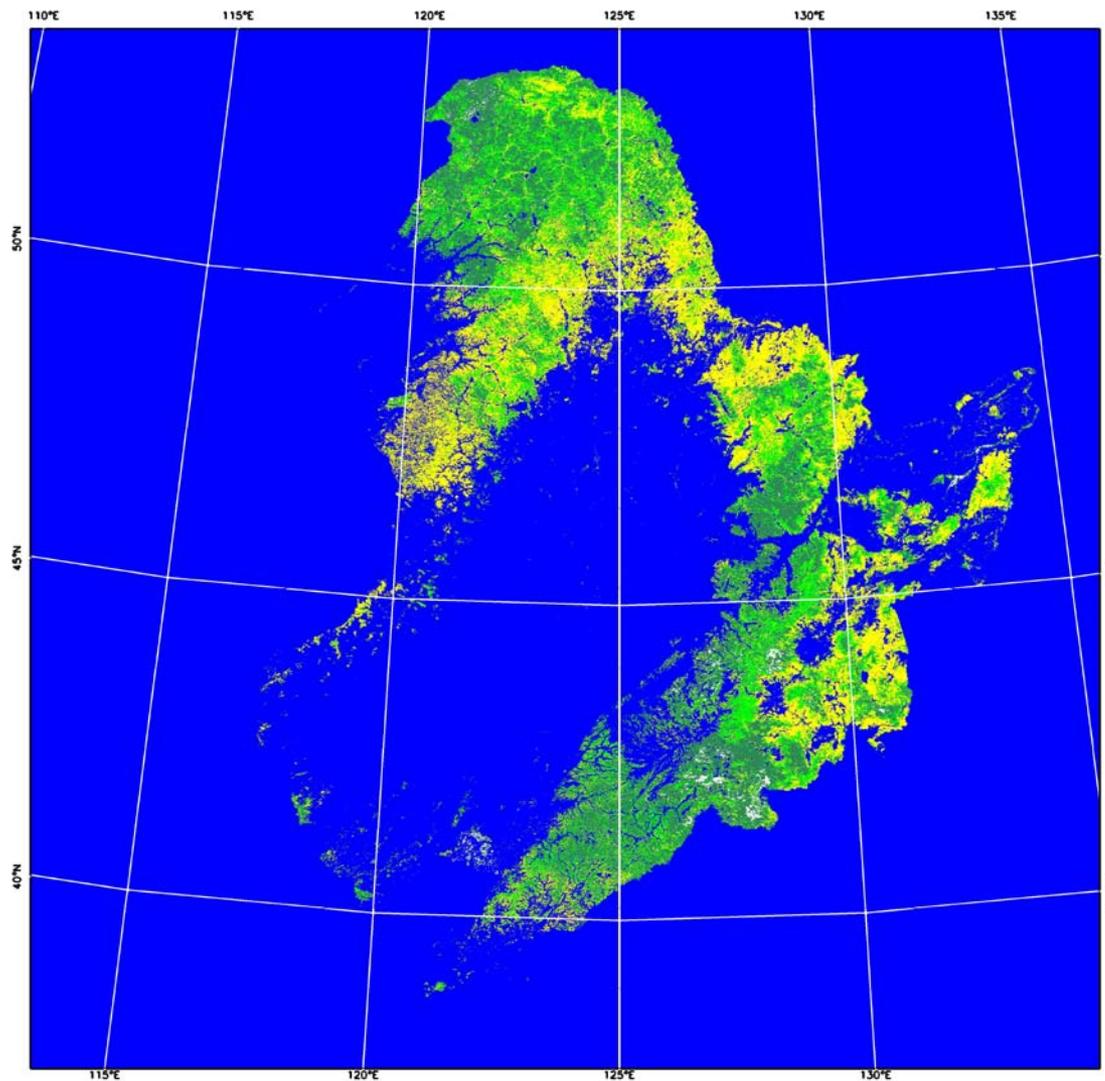
Total forest area (2001): 41.9 MHa

- 3.7% evergreen needleleaf
- 18.9% deciduous needleleaf
- 35.5% deciduous broadleaf
- 41.8% mixed dnl/dbl

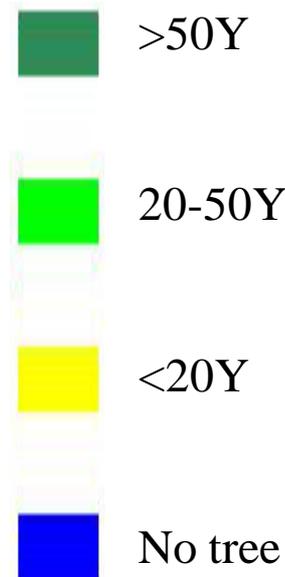
Accuracy of other classes variable (10-70% accuracy):

- confusion between grass, swamp, bare: drought in target year (2001) rendered many land-cover types non-photosynthetic
- poor accuracy for shrubs – confusion with crops and forests.

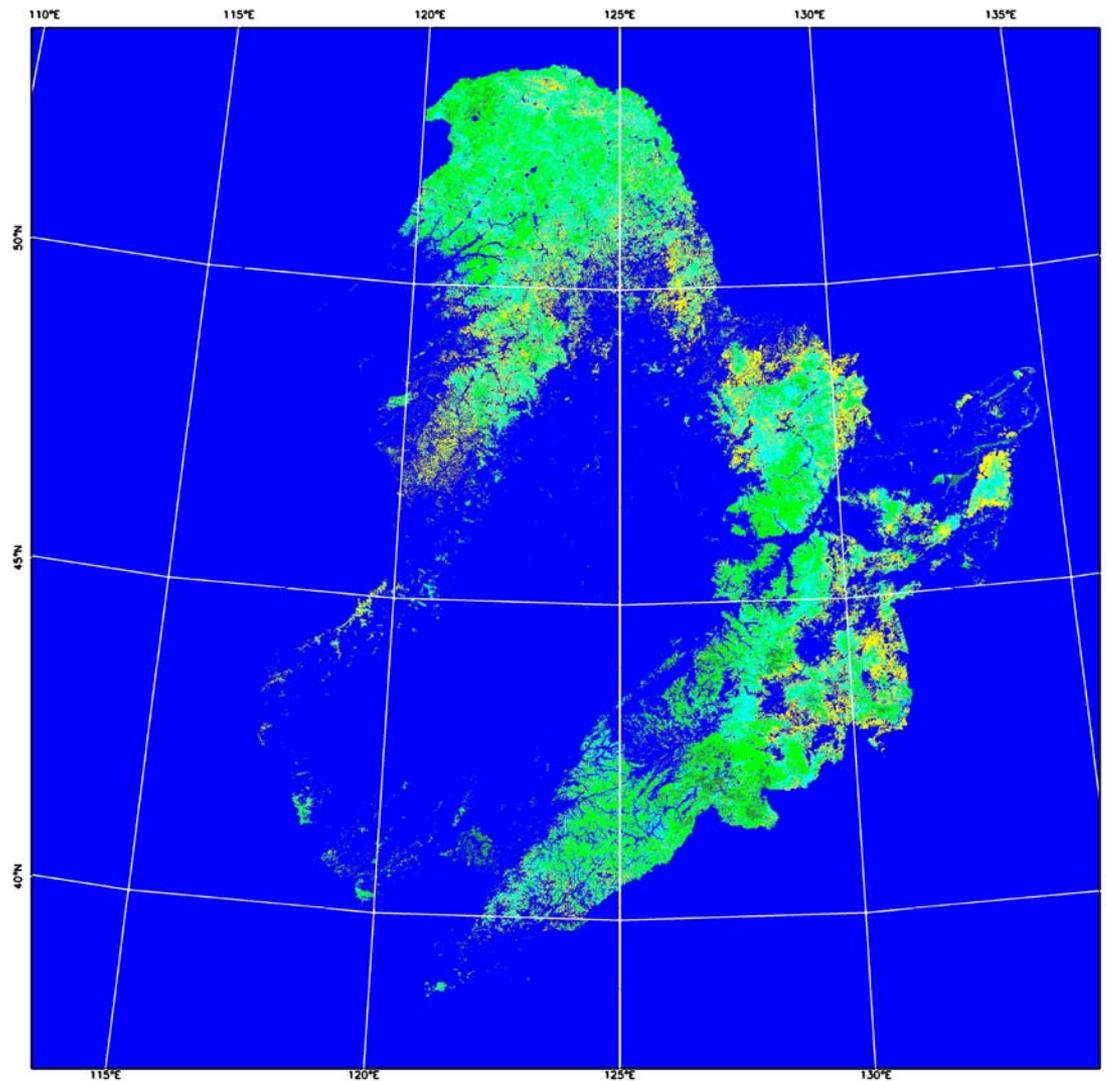
## 2. Forest Properties: Stand Age



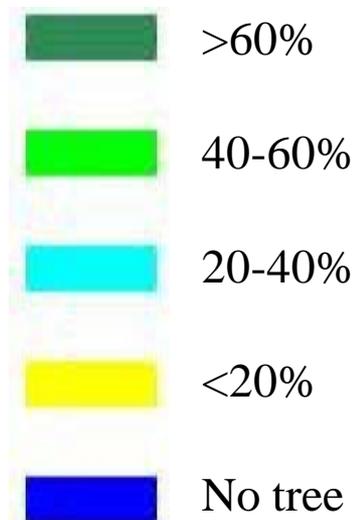
Forest age map



## 2. Forest Properties: Crown Closure



Crown Cover



### 3. Forest Cover Change

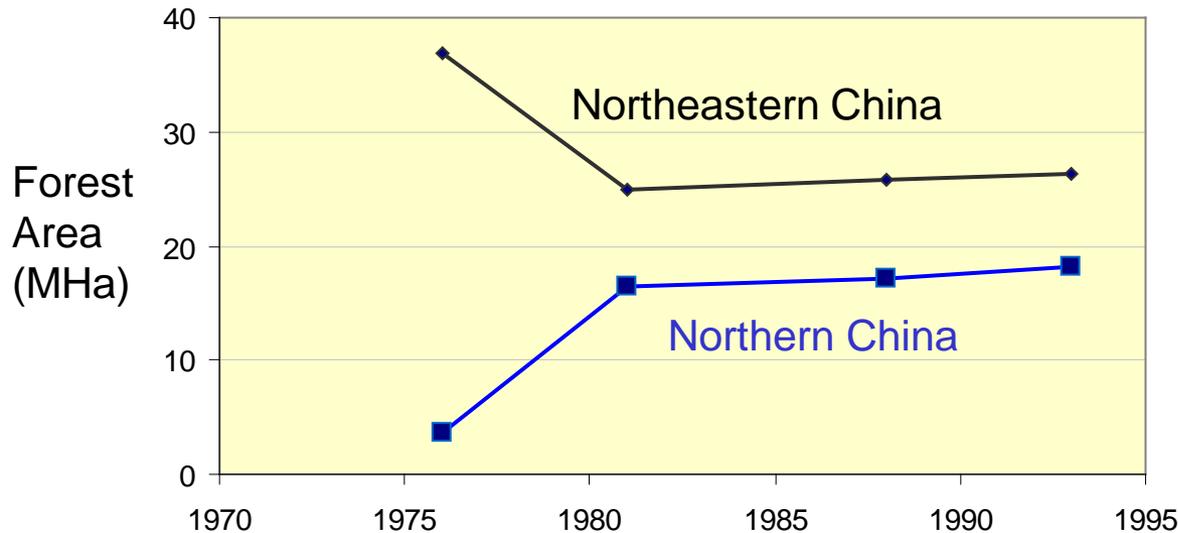


Forest inventory data suggest recent increases:

- + 0.6 %/yr 1989-1993 (NE China; Shi and Xu, 2001))
- + 1.2 %/yr 1990-2000 (all China, FAO)

Recent Landsat analyses suggest decreases:

- 0.31 %/yr 1990 – 2000 (Liu et al, 2002)
- 0.41 %/yr 1990 – 2000 (Wang et al., 2002)



*Forested area, from recent forest inventories, NE and Northern China (Shi and Xu, 2001)*

### 3. Forest Cover Change: Methods



- Assembled 52 Landsat-5 and Landsat-7 images from ~1990 and ~2000 (+/- 4 years).
- Performed scene-specific multi-temporal MLC classification:
  - forest loss
  - forest gain
  - other classes (stable forest, agriculture, etc)
- Aggregated raw results to 500m x 500m cells (=> Ha change)
- Normalized by image acquisition interval and existing (1990) forest cover within 25 x 25 km cells (=> % FC change / yr)

### 3. Forest Cover Change: 1990-2000

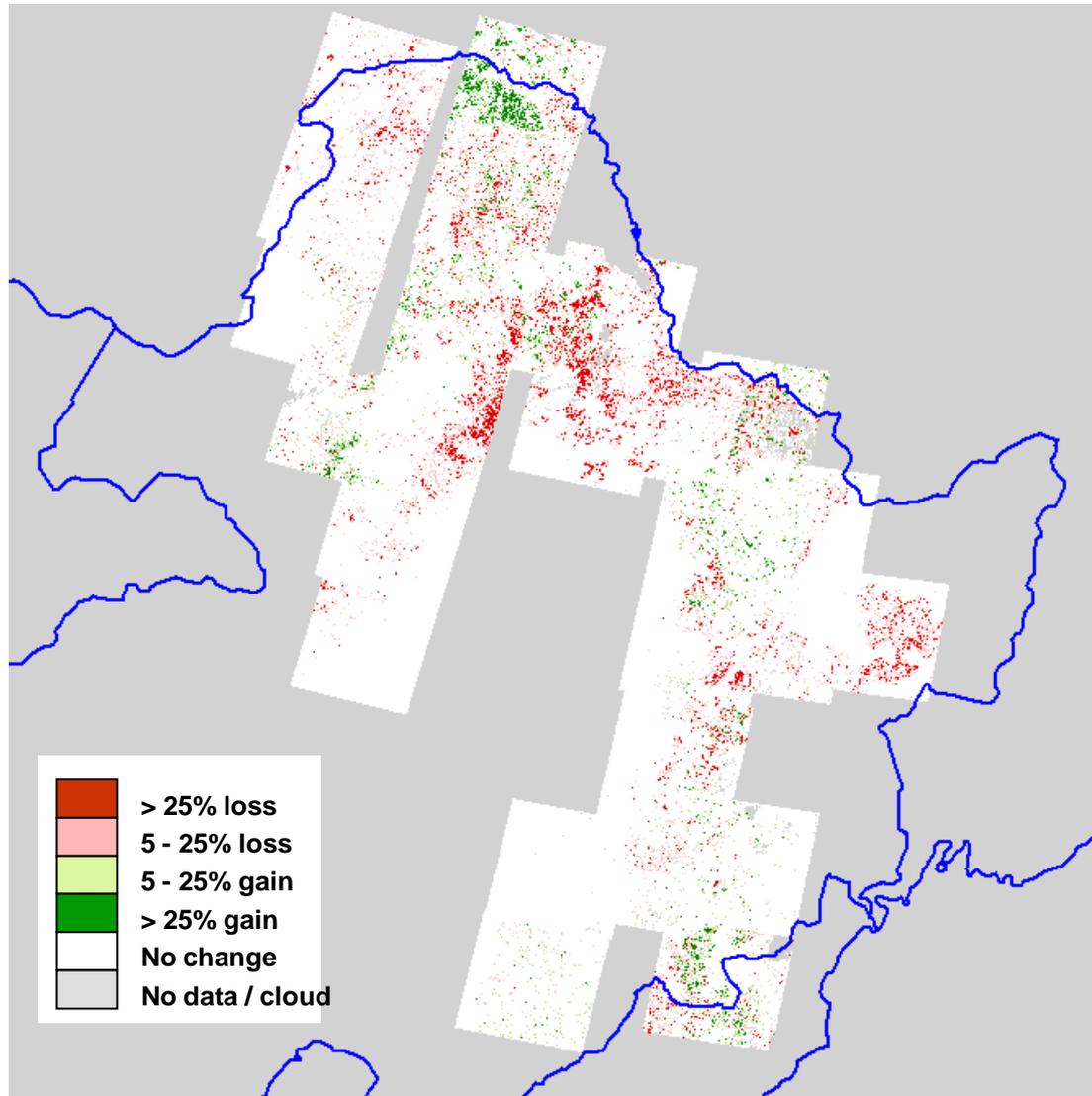
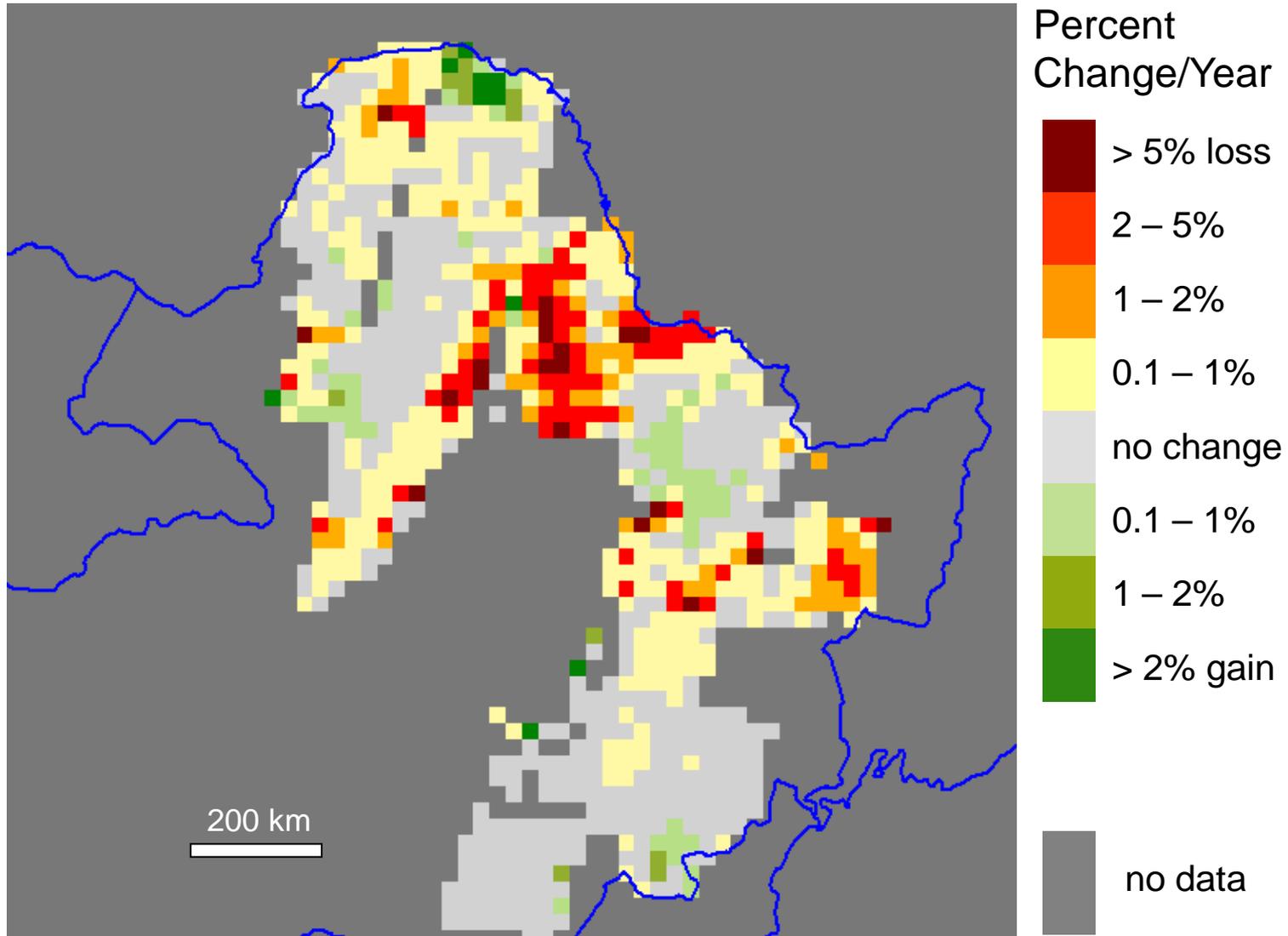
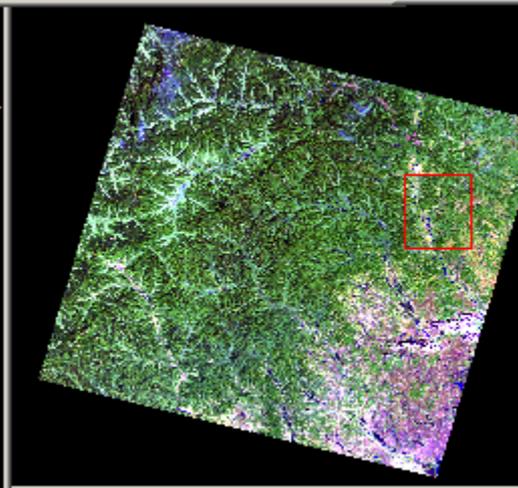
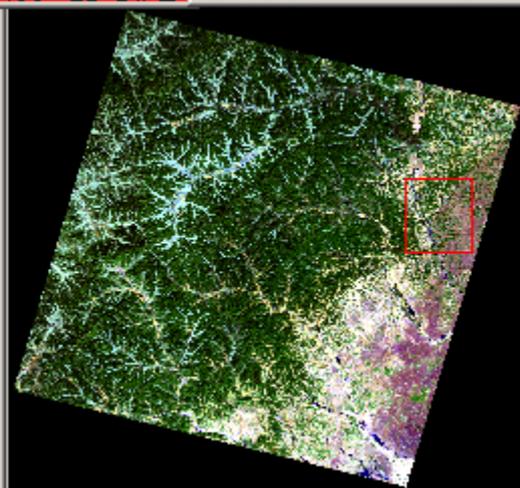
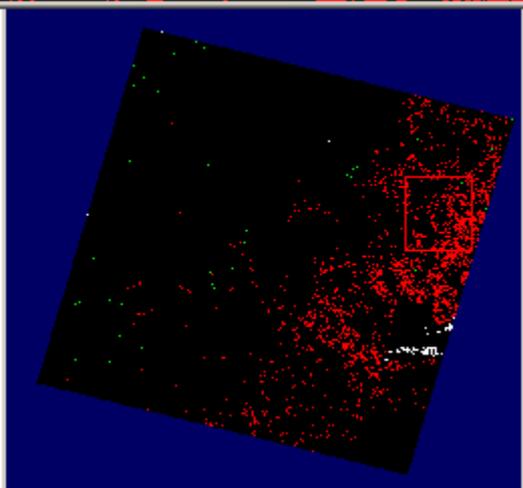
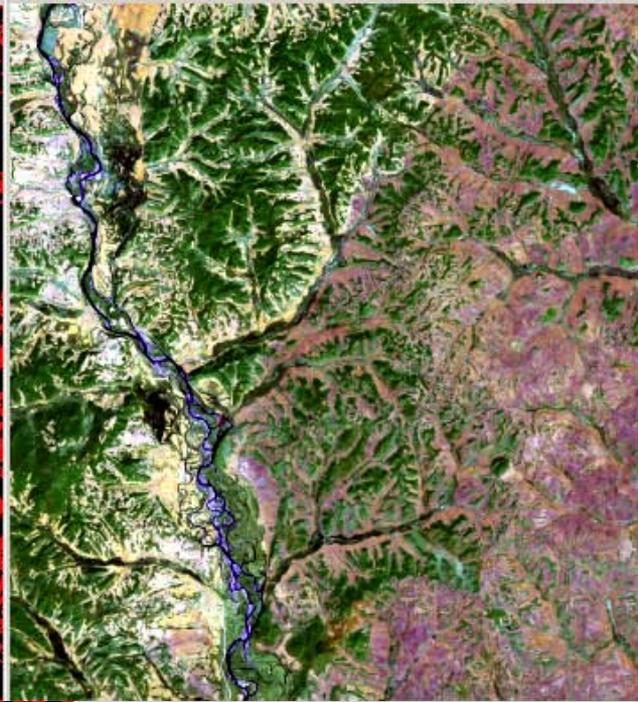
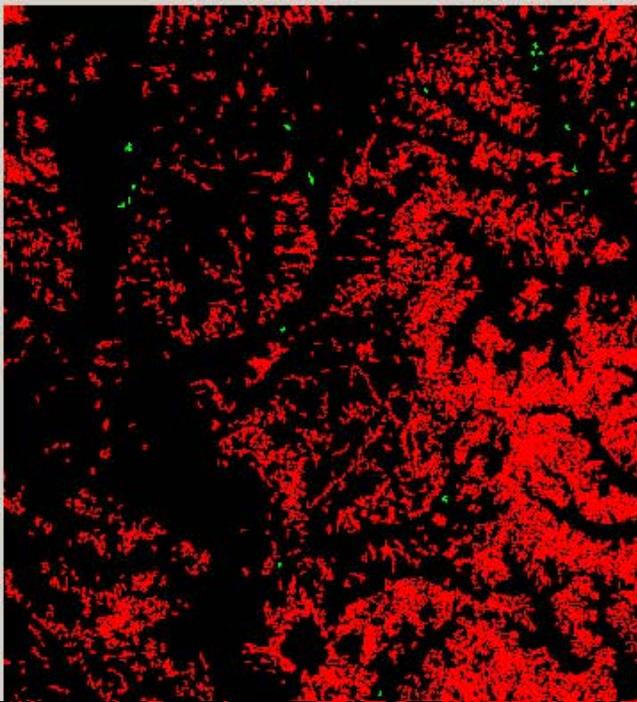


Fig 4: Net change in forest cover, NE China. The values represent the percent of each 25 Ha cell (500m x 500m) that experienced either forest loss or gain. Grey areas indicate regions not analyzed or cells with >70% cloud cover.

### 3. Forest Cover Change: 1990-2000





Forest Clearing for Agriculture,  
Da Xingan Ling, 1987-2000

### 3. Forest Cover Change



Managed Forestry, Chang Bai mountains:

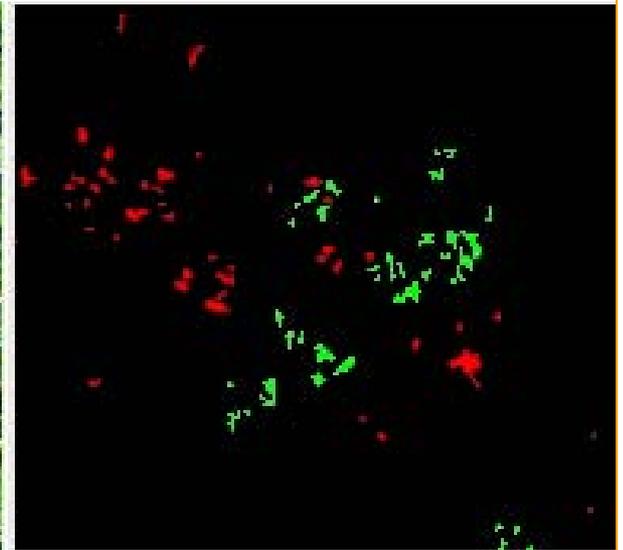
5 km



1991



1999



Change

### 3. Forest Cover Change: Results



This study records a net forest-cover loss of 164,000 Ha/yr (-0.36 %/yr) across NE China

- *losses concentrated northwest study area*
- *reflects agricultural clearing by migrants from central China*
- *< 25% related to obvious natural disturbance*

Agrees well with other Landsat-based studies, appears inconsistent with recent forest inventory data

- *different methodologies, definitions of 'forest'?*
- *inventories are aggregations of self-reported statistics*

# Project Conclusions



Northeast China forest cover extent and condition well documented for Year 2001:

- 41.9 MHa forest cover
- above-ground biomass needs to be better characterized for carbon assessments

Remote sensing analyses agree: NE China forest cover is declining at 0.3-0.4 %/yr:

- Net loss of 164,000 Ha/yr across NE China (1990-2000)
- Rapid deforestation in Da Xingan Ling region
- Remote sensing results do not agree with forest inventories

# Future Directions



## What will be the effect of ...

- **Natural Forest Conservation Policy (“Logging Ban”) ?**
- **Fire Supression Policies?**
- **Continued economic growth and urbanization?**

# Publications



## PROCEEDINGS

Sun, G., L. Rocchio, J. Masek, D. Williams, and K. J. Ranson, Characterization of Forest recovery from fire using Landsat and SAR data, Proceedings of IGARSS'02, June 24-28, 2002, Toronto, Ontario, Canada.

Sun, G., J. Masek, D. Williams, L. Rocchio, and K. J. Ranson, Forest and land-use mapping from temporal MODIS Data, Proceedings of IGARSS'02, June 24-28, 2002, Toronto, Ontario, Canada.

Sun, G., D. Williams, X. Zhan, Z. Li, J. Masek, K. J. Ranson, and L. Rocchio, Monitoring forest Dynamics using multi-sensor data in Northeastern China, IGARSS'01, 9-13 July 2001, university of New South Wales, Sydney, Australia.

## BOOK CHAPTERS

Krankina, O., K. M. Bergen, G. Sun, H. H. Shugart, V. I. Kharuk, J. G. Masek, W. B. Cohen, M. Duane and E. Kasiischke. 2003 in press. Northern Eurasia. Chapter 5 in *Land Change Science: Observing, Monitoring, and Understanding Trajectories of Change on the Earth's Surface*. Dordrecht, Netherlands, Kluwer.

## JOURNAL ARTICLES

Masek, J.G., and G. Sun, A spectral-angle methodology for mapping net forest cover change in Northeastern China, *Int. Jour. Remote Sensing*, in press, 2004

Masek, J.G., G. Sun, and D. Williams, Forest Cover Change in Northeast China Mapped from Satellite Data, in prep, 2004.



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