Monitoring Landuse and Landuse Changes Using Remote Sensing

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LANDUSE/LANDUSE CHANGE & REMOTE SENSING

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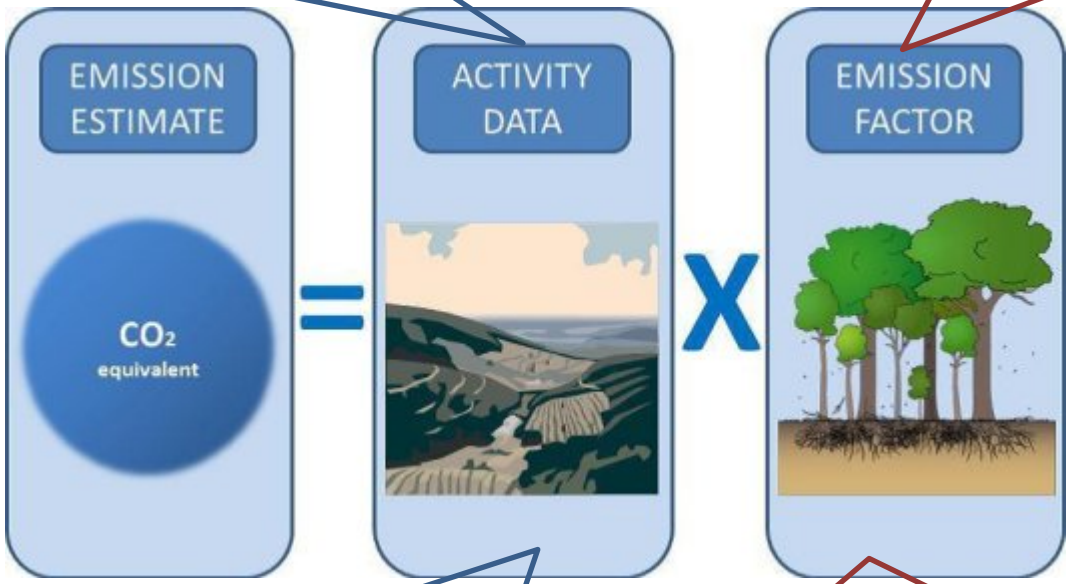
How is C emission estimated?

- Stock change method

$$\text{Emission from a LU} = \text{C stock}_{\text{beginning}} - \text{C stock}_{\text{end}}$$

$$= (\text{Area}_{\text{beginning}} - \text{Area}_{\text{end}}) \times \text{C stock per area}$$



Only ‘Remote Sensing’ can map forest

- Tree is big
- Area is wide
- Access is difficult
- Change is very slow/instant

- Only bird’s eyes can overlook

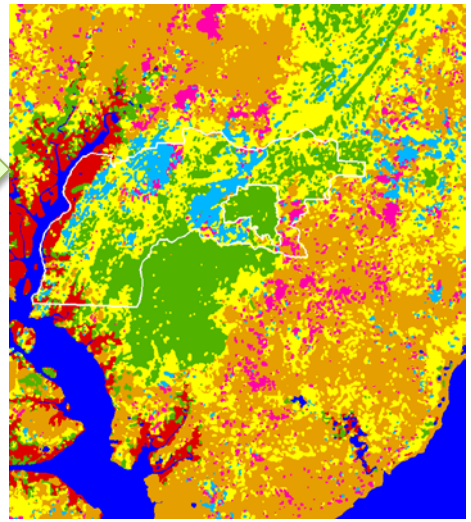
Area estimation by remote sensing present & past

New satellite image

classification

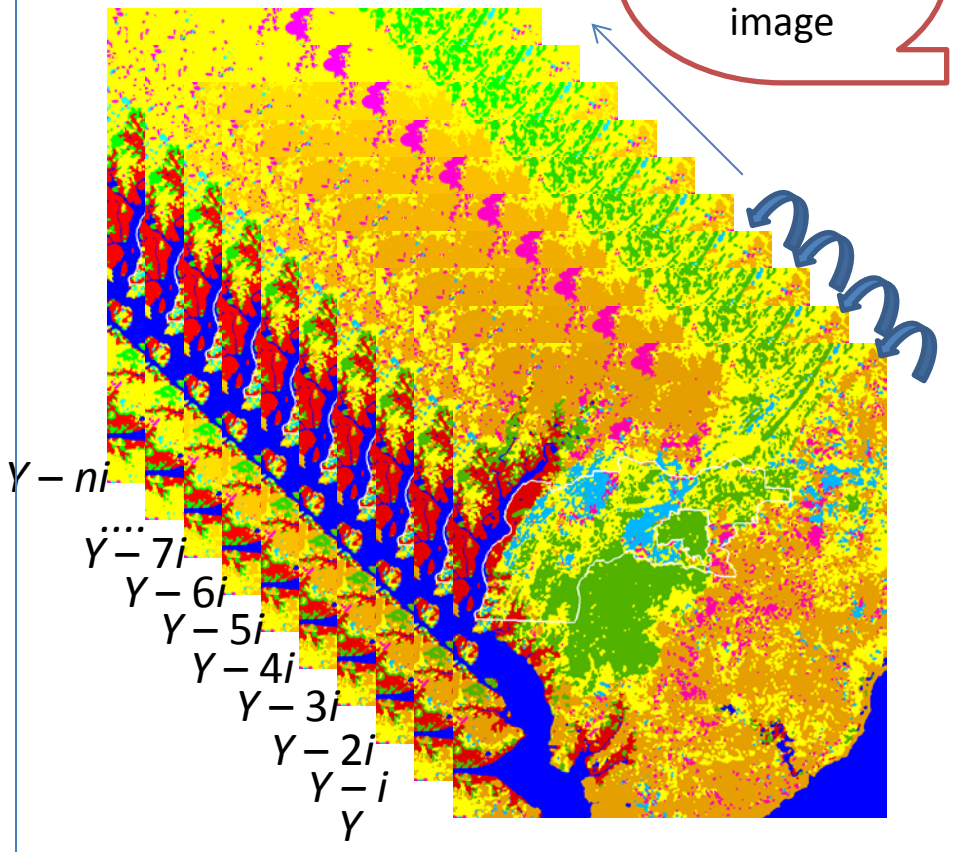
Ground checking

Y Year



Present forest classification and evaluation by ground check

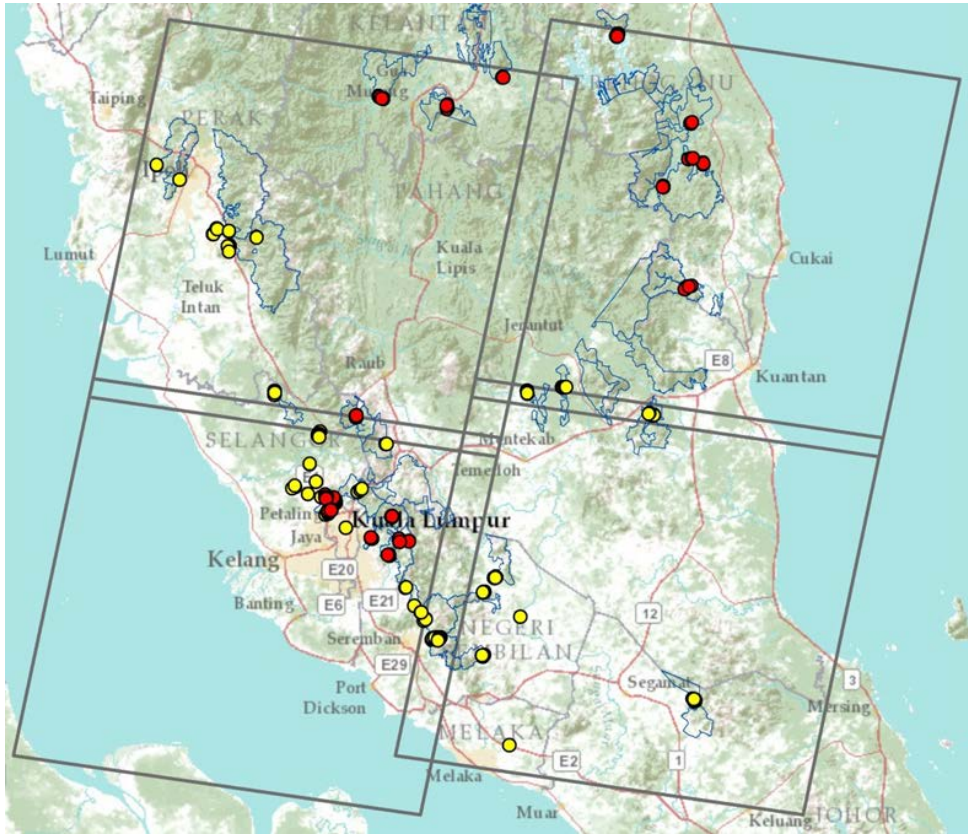
Archived satellite image



Past forest classification by retrospective extrapolation

Study site

- Part of Peninsular Malaysia
  - Path 126-127
  - Row 057-058
- Materials
  - Ca 500 USGS Landsat images
  - Ground truths from field check & high-resolution image interpretation



CLOUD –
BIG CHALLENGE IN THE TROPICS

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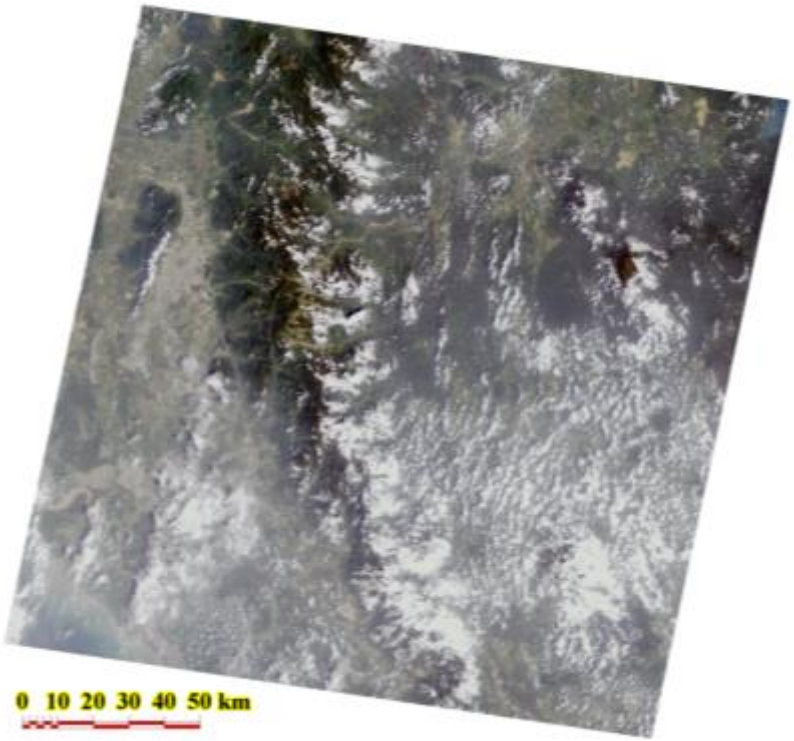
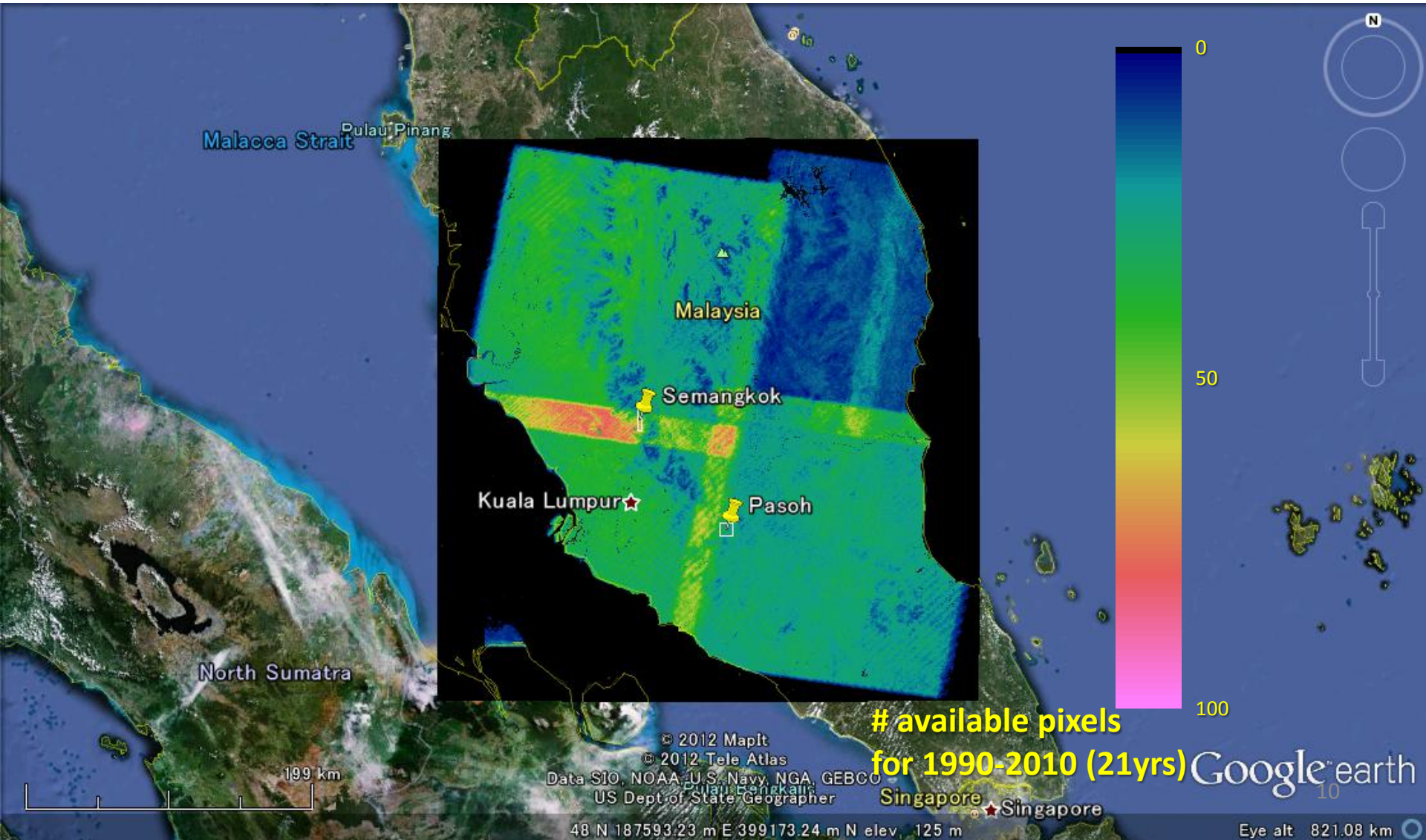
Clouds & haze everywhere

- **Clouds** cover somewhere anytime in the tropics
  - Virtually no cloud-free images
- **Haze** also hinders the reflection from ground



Frequency of cloud-free pixel; 1990 – 2010

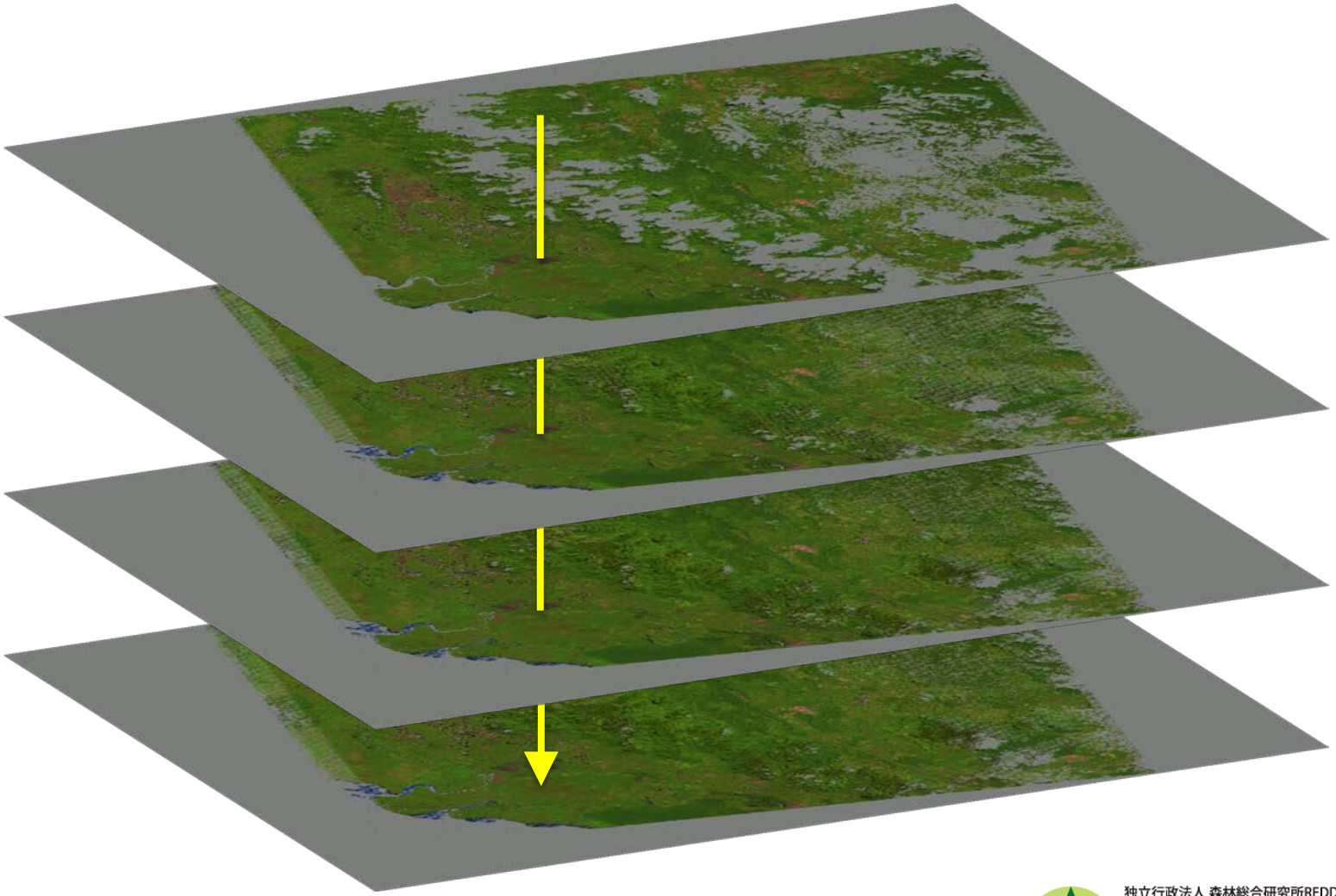
1 – 2 cloud-free pixels per year, or less … Never together



REMOVE CLOUDS!
VIRTUAL CLOUD-FREE IMAGES

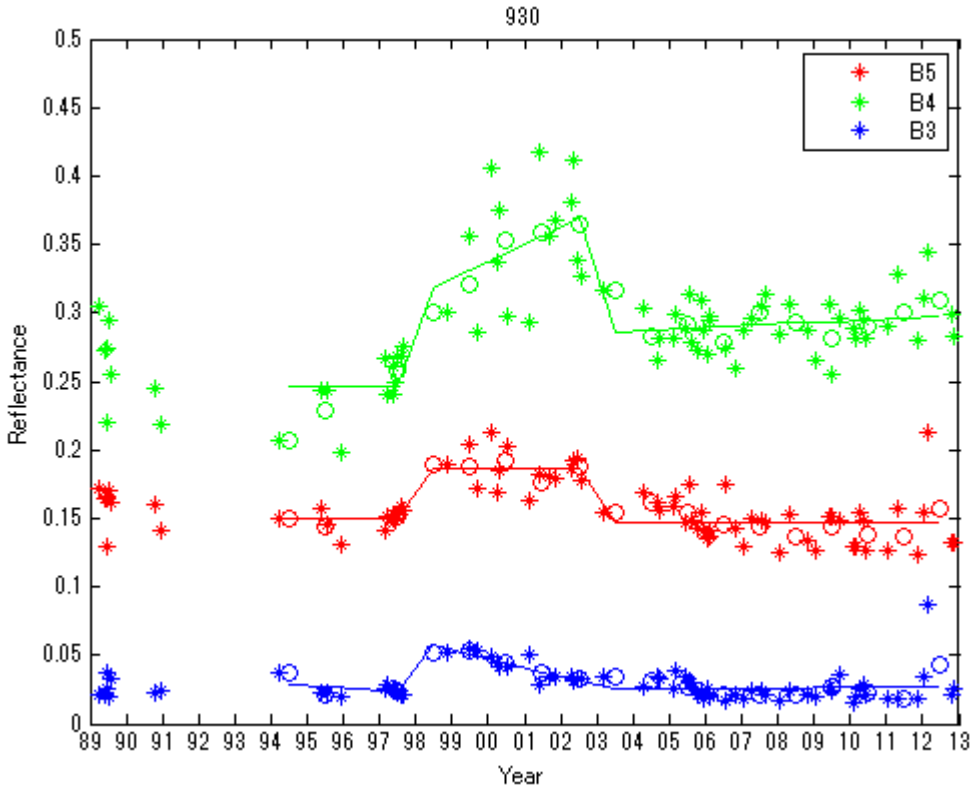
Accumulating the cloud-removed images

Skewering the images for time-series pixels

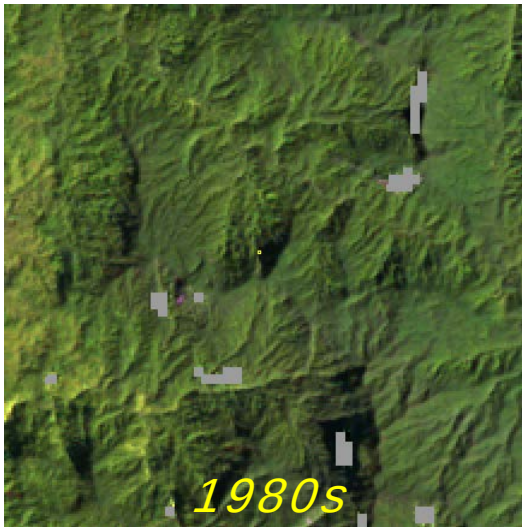


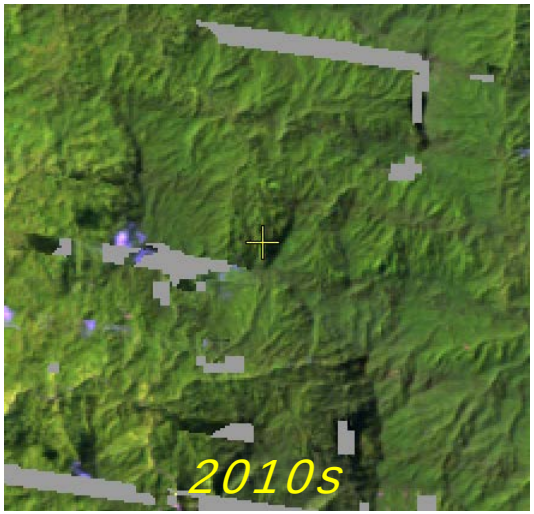
Trend analysis of the time-series pixels

- Time-series reflectance (pixel values) of a given pixel is acquired.
- Reflectance never be stable.
- However, there are certain trends through time
- By estimating trends & interpolating to any time, **virtual cloud-free time-series images** are derived.

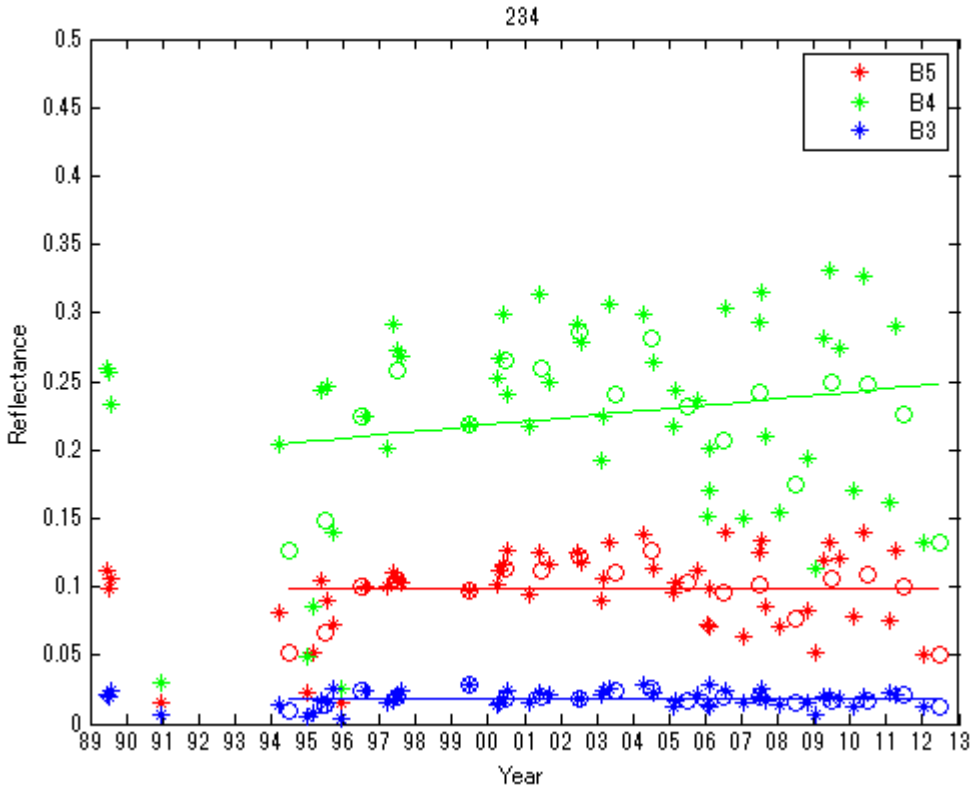


Changes through time – No breakpoints

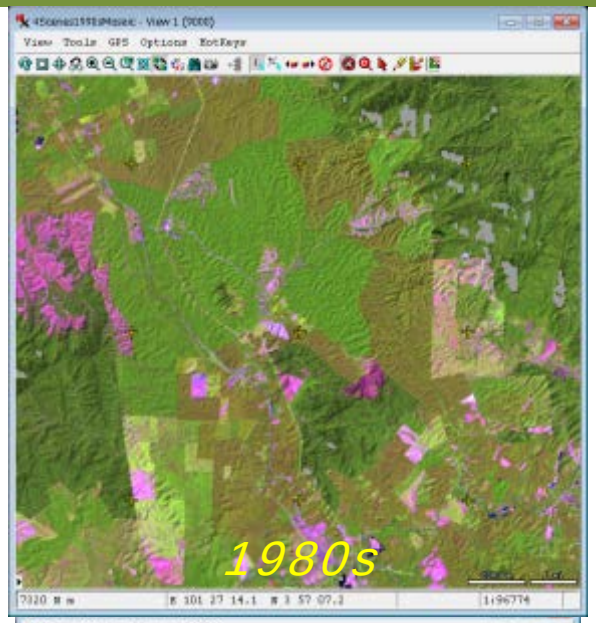




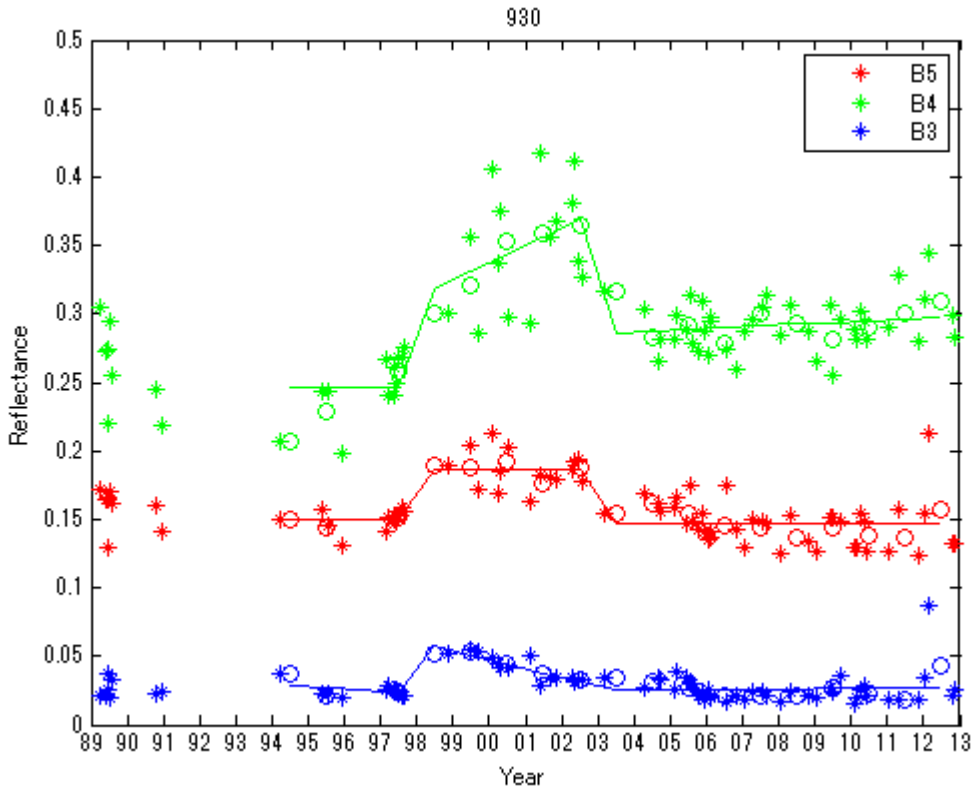
Supposedly undisturbed forest



Changes through time – A few breakpoints

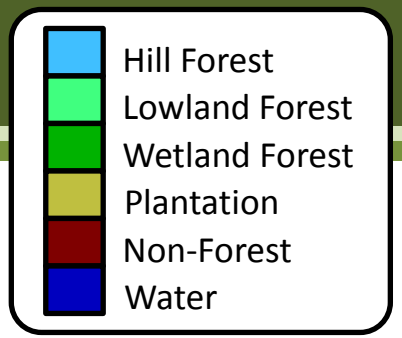


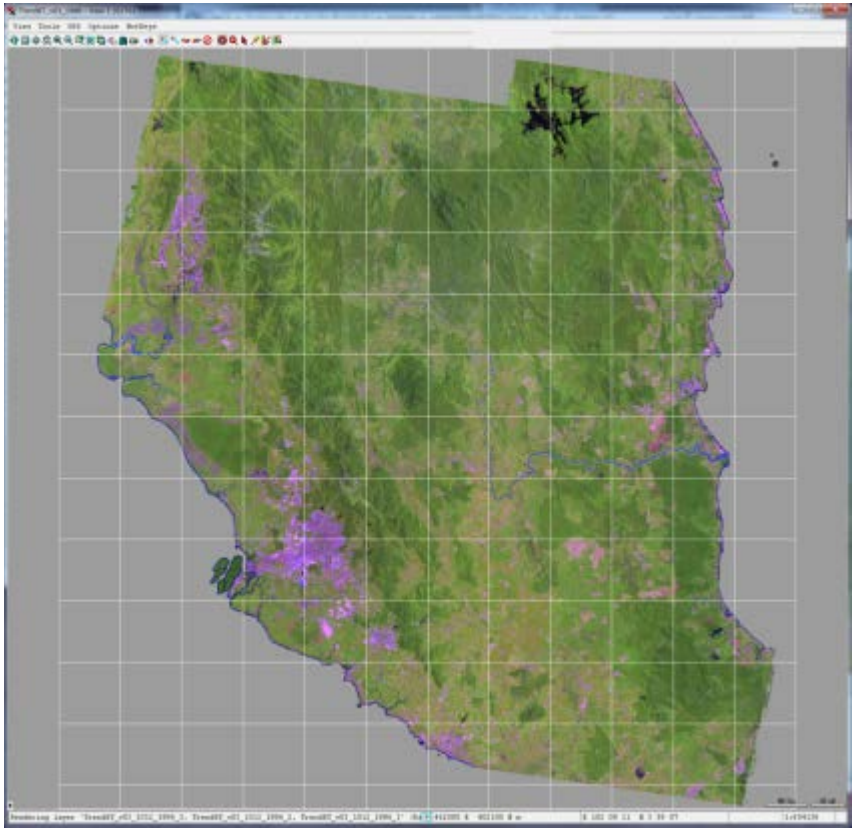
Supposedly rubber re-planting

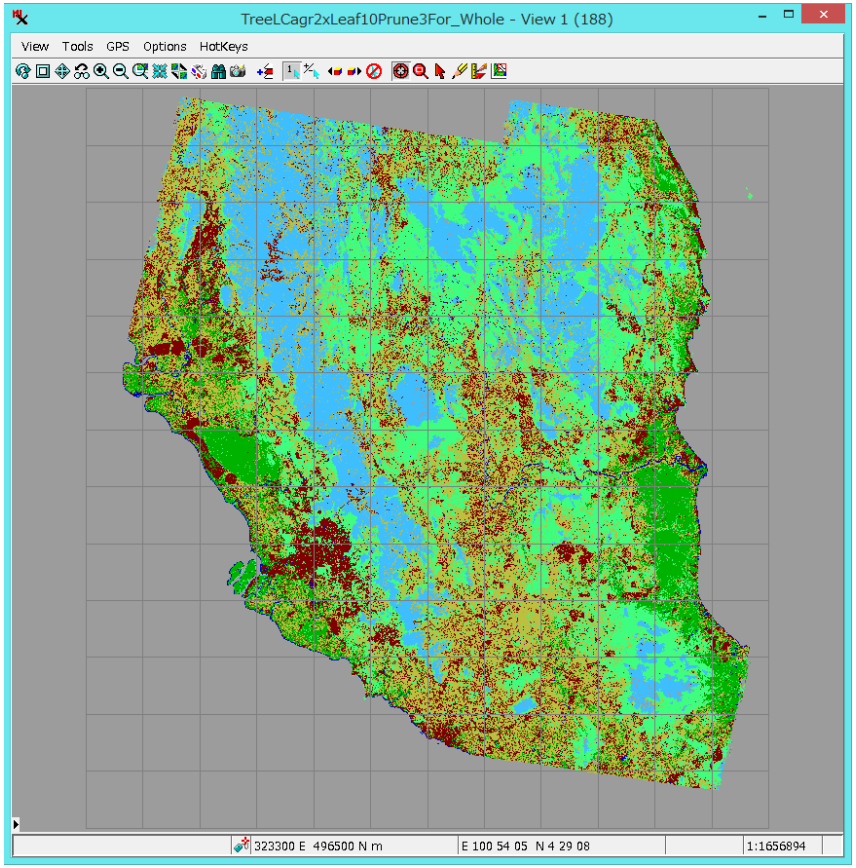


ESTIMATED LANDUSE/ LANDUSE CHANGES

Virtual Cloud-free Image & LU 1996







格子は30km、約360km四方の範囲

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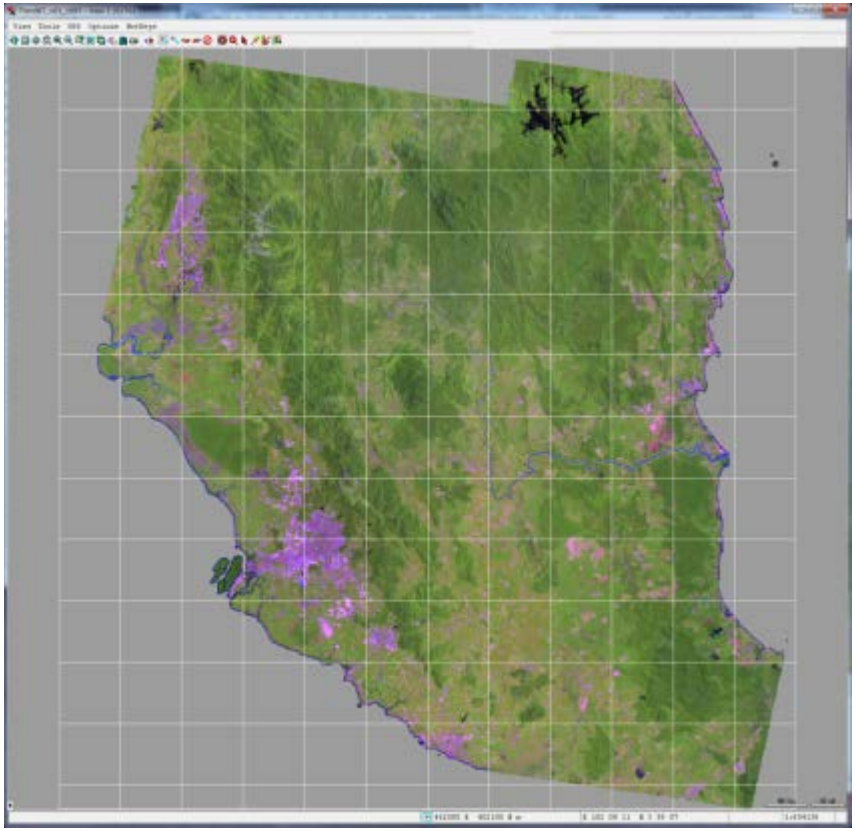
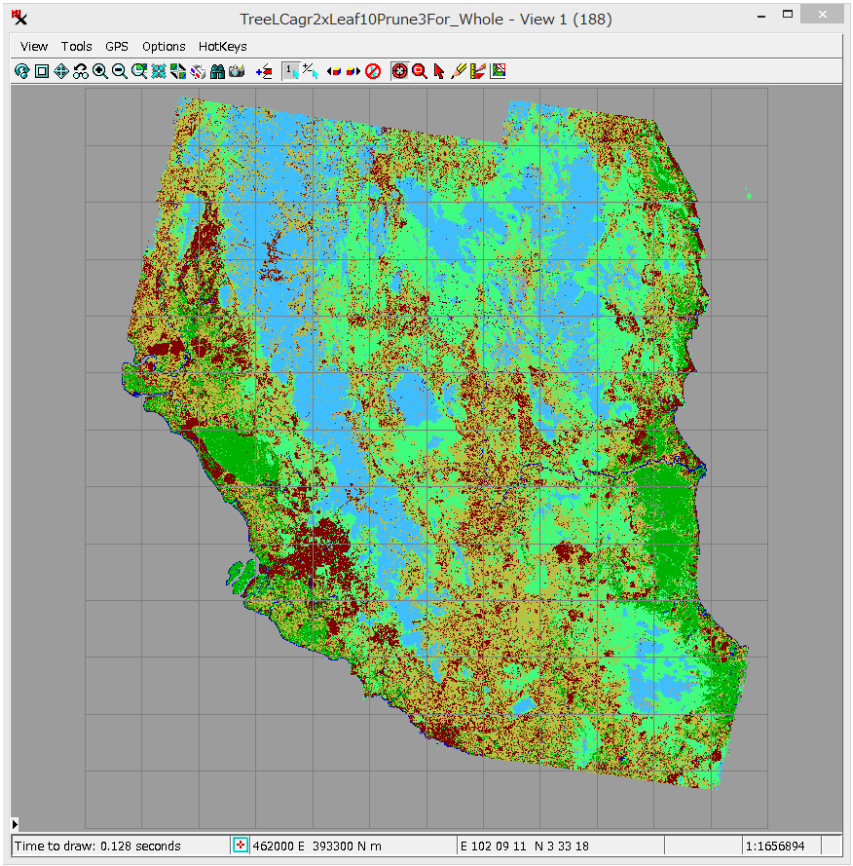
Virtual Cloud-free Image & LU 1997

- Hill Forest
- Lowland Forest
- Wetland Forest
- Plantation
- Non-Forest
- Water





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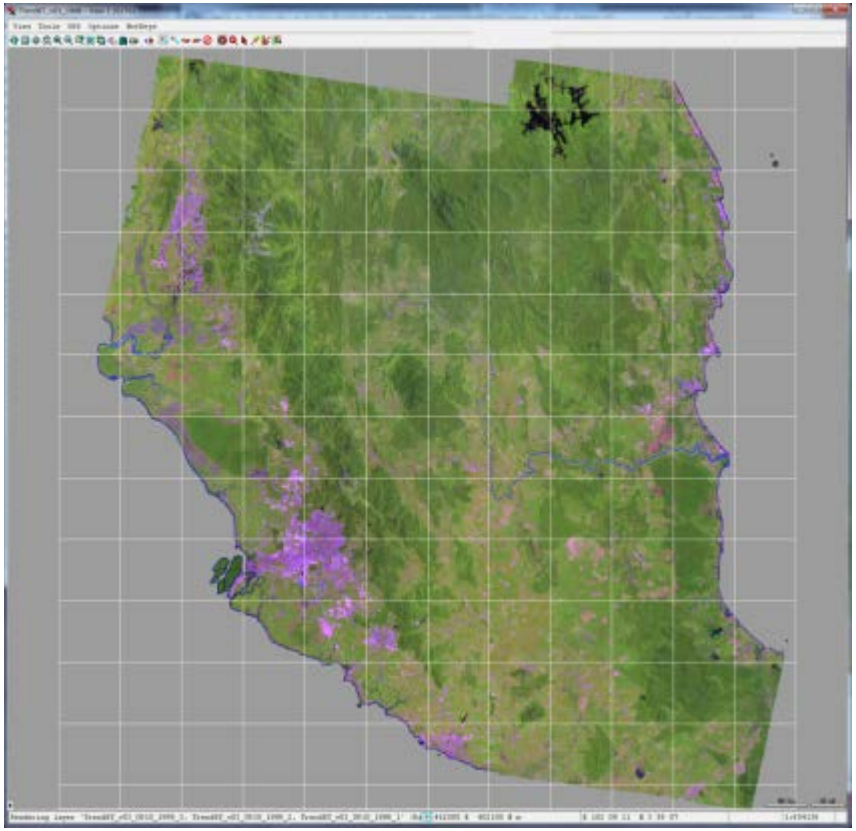

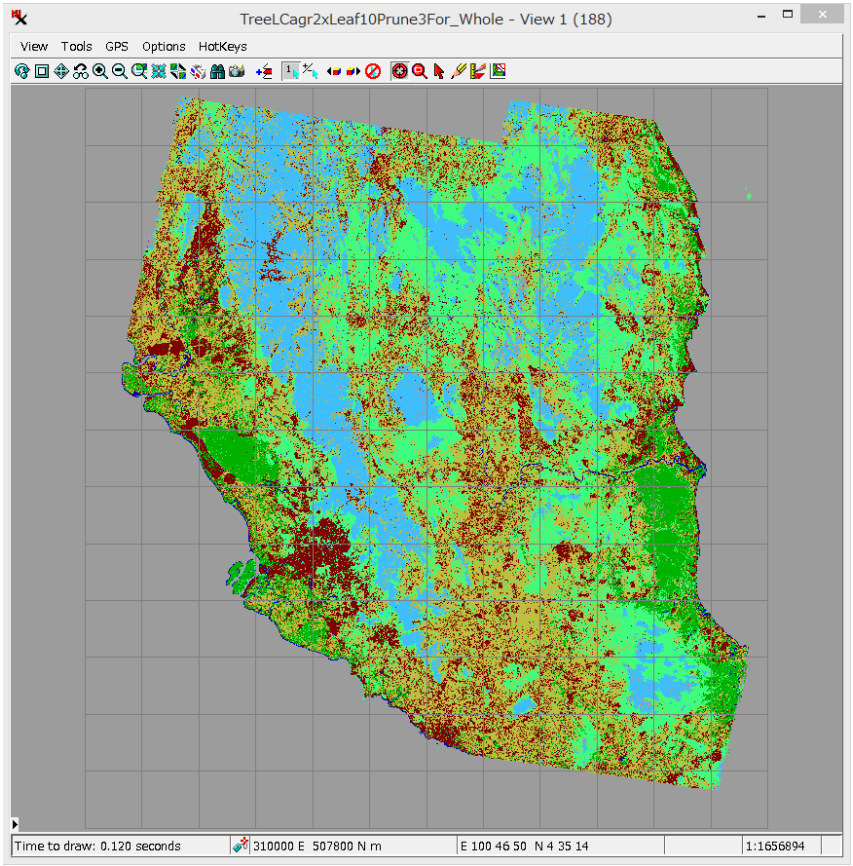

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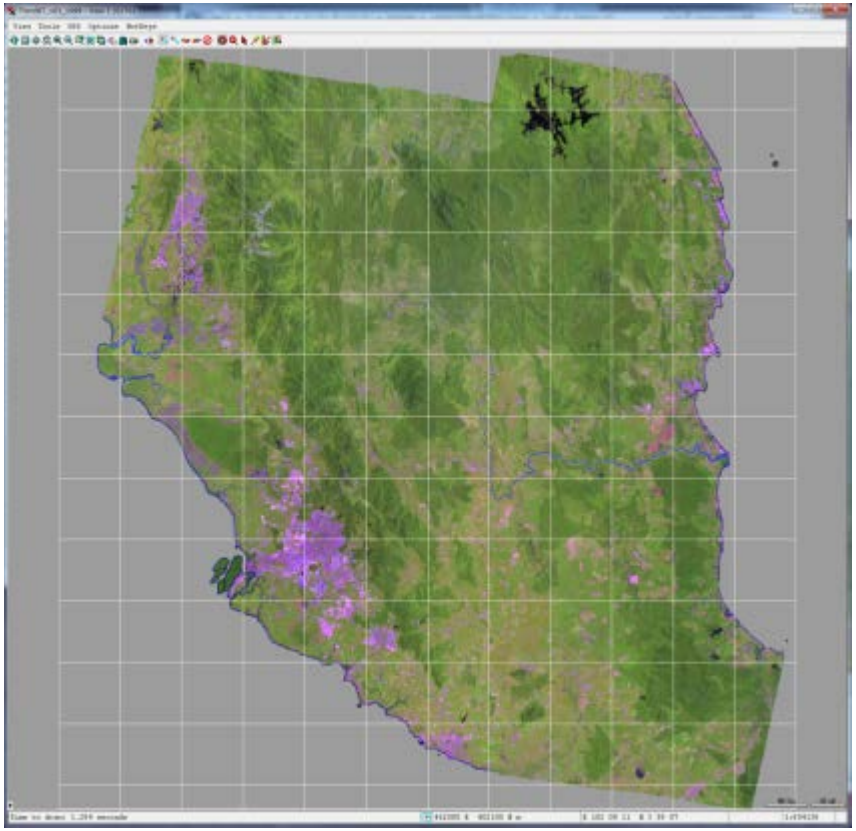

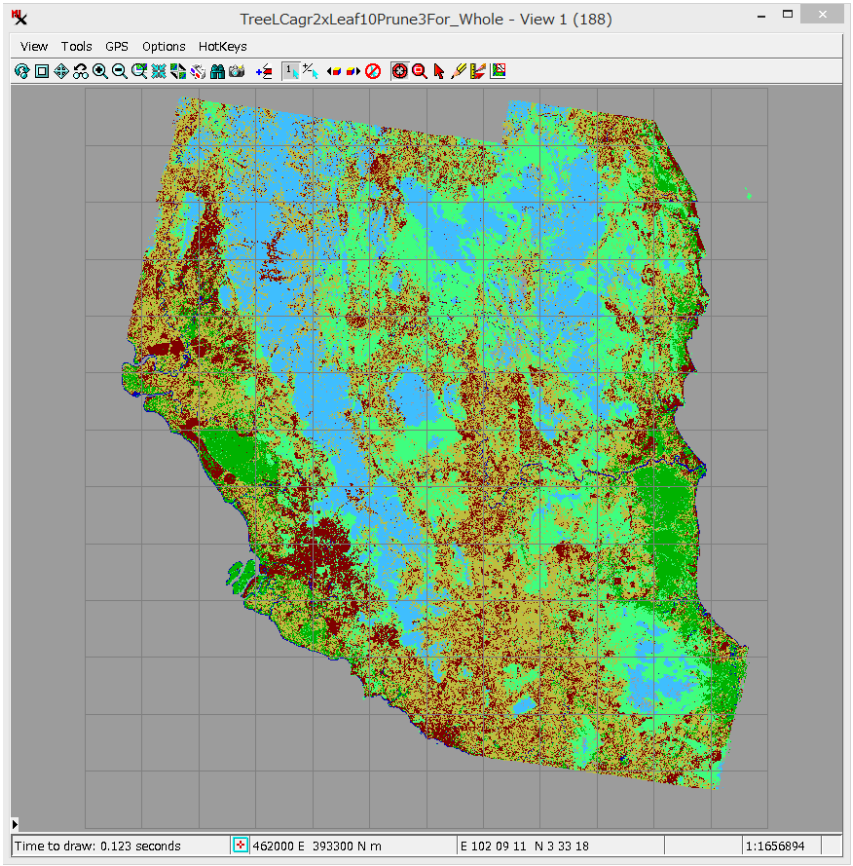

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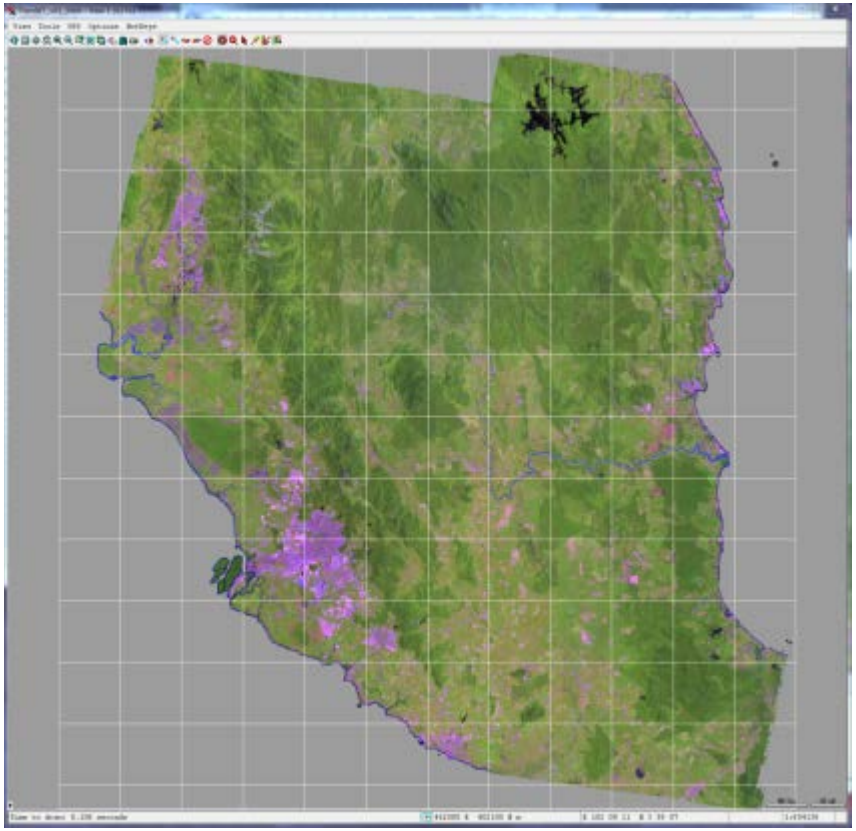

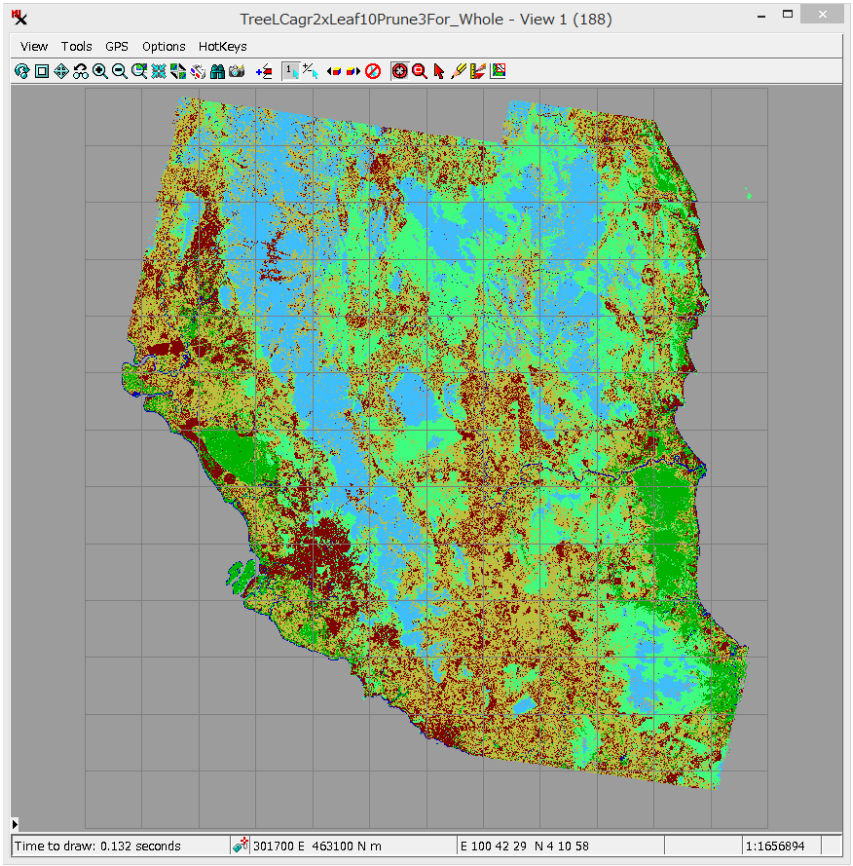

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Virtual Cloud-free Image & LU 2001

- Hill Forest
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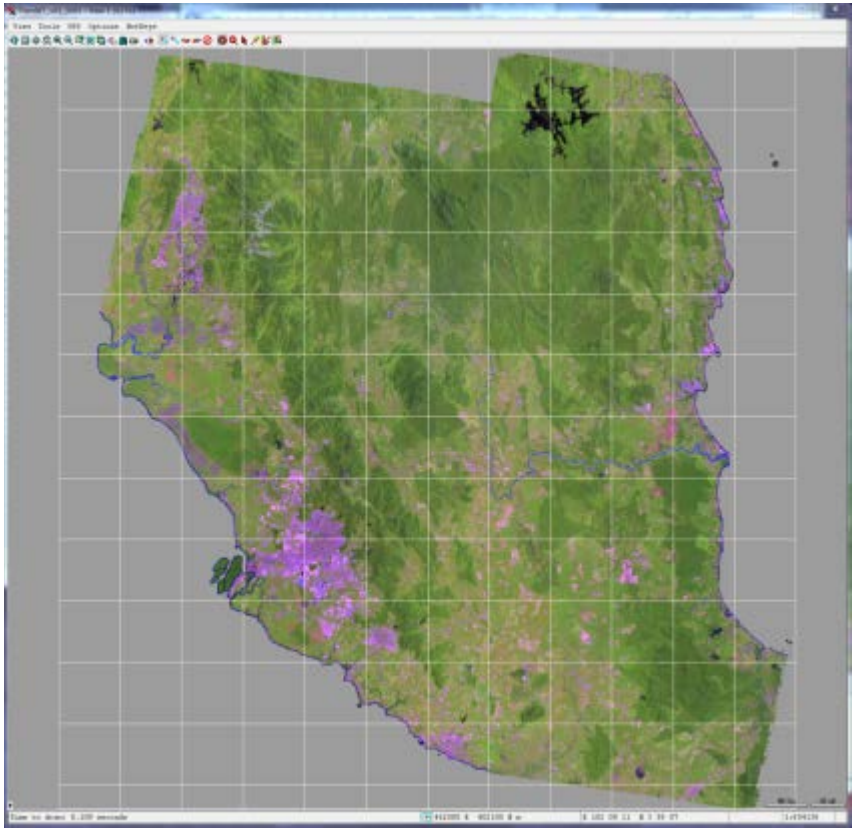
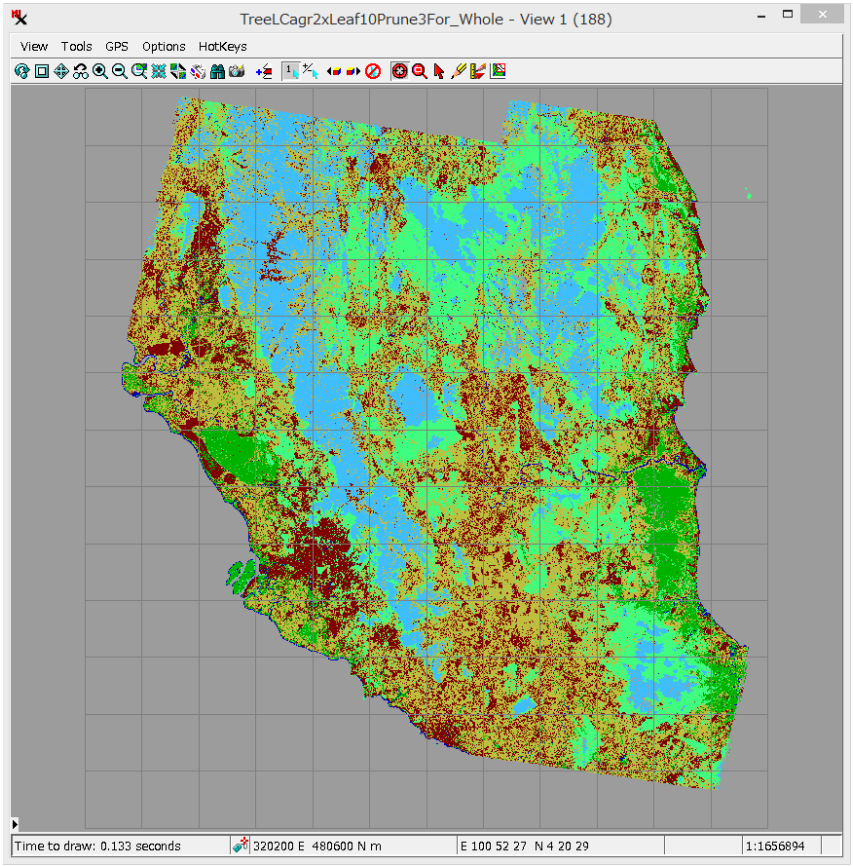
- Water





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Virtual Cloud-free Image & LU 2002

- Hill Forest
- Lowland Forest
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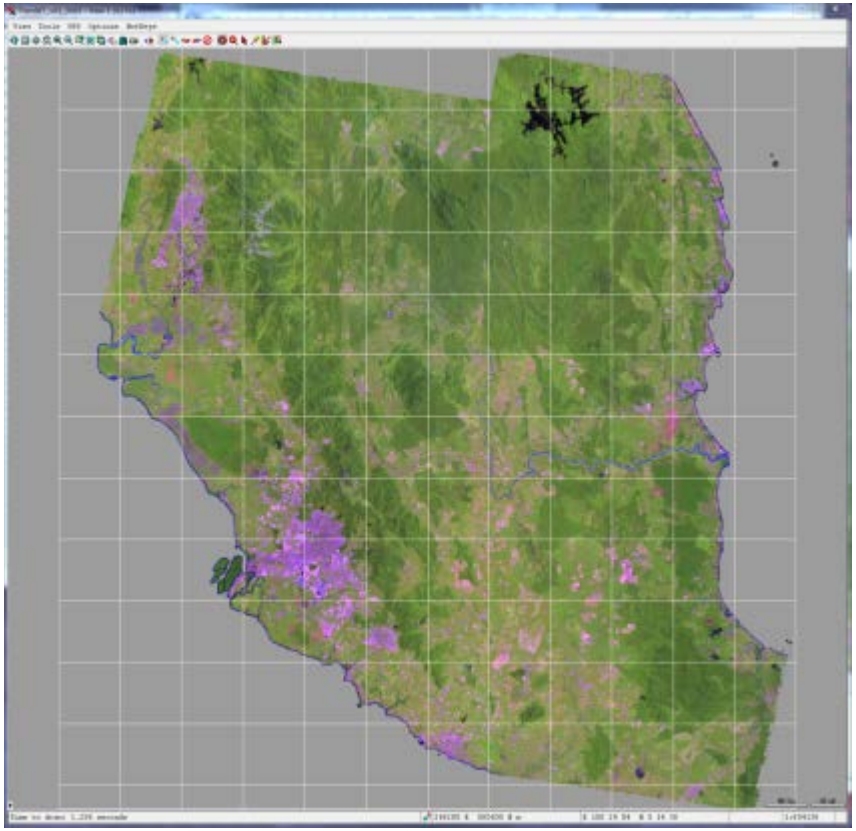
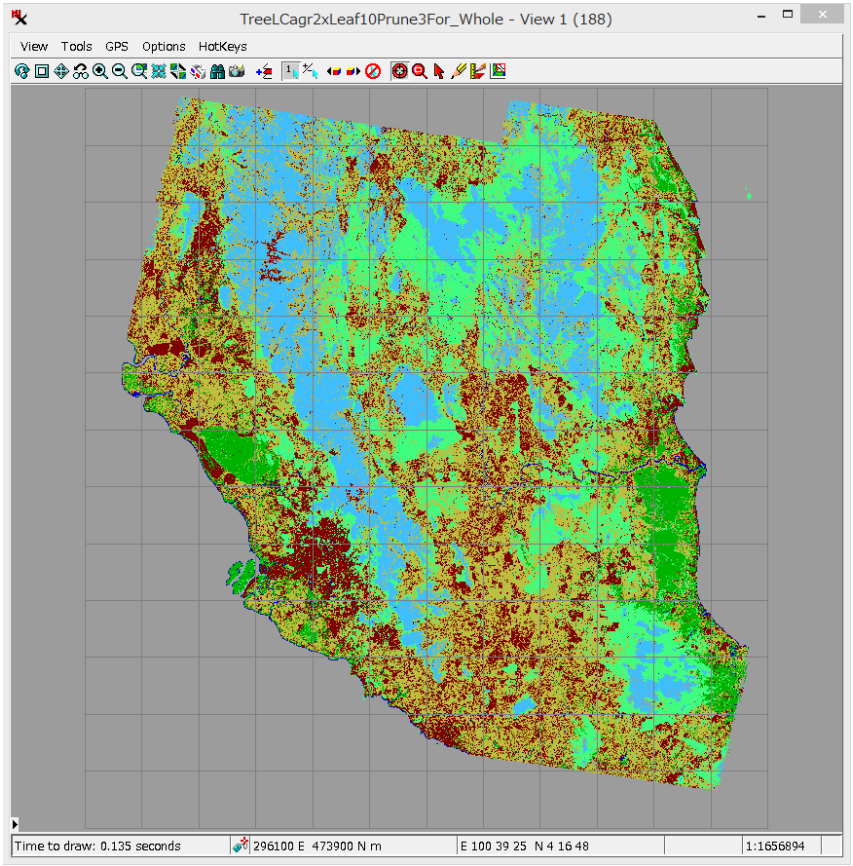
- Plantation
- Non-Forest
- Water





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Virtual Cloud-free Image & LU 2003

Hill Forest
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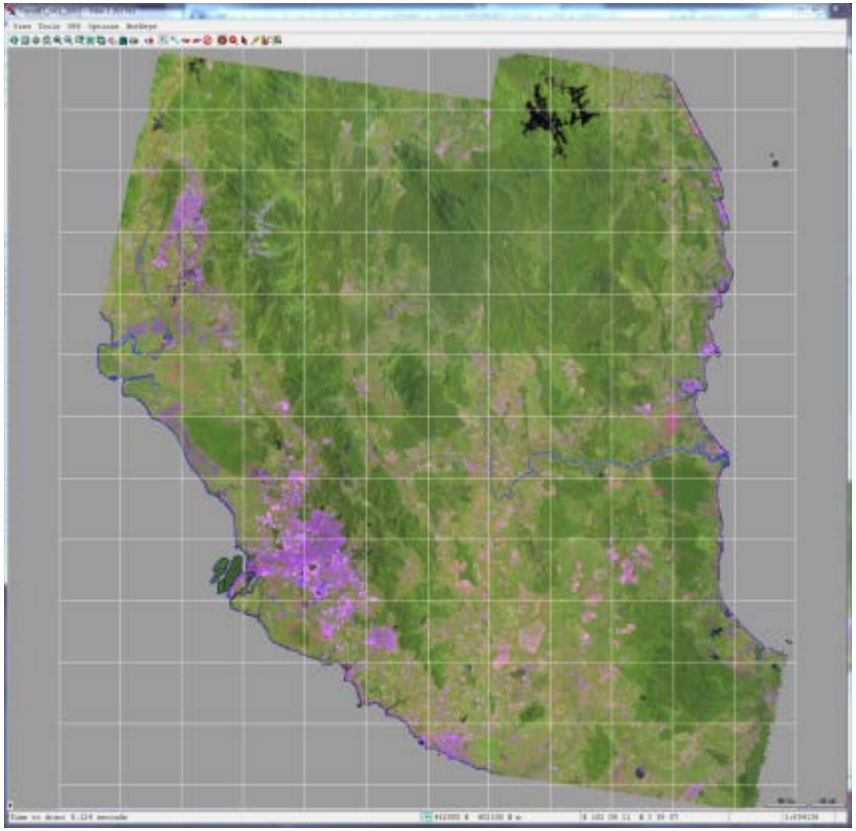

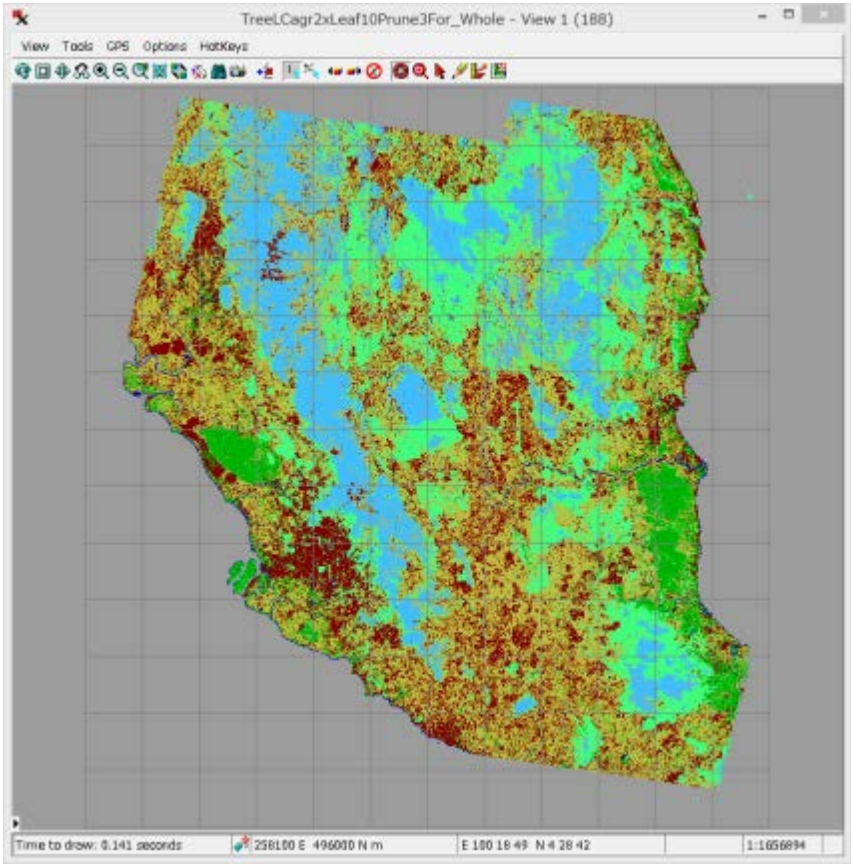

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Virtual Cloud-free Image & LU 2004

Hill Forest
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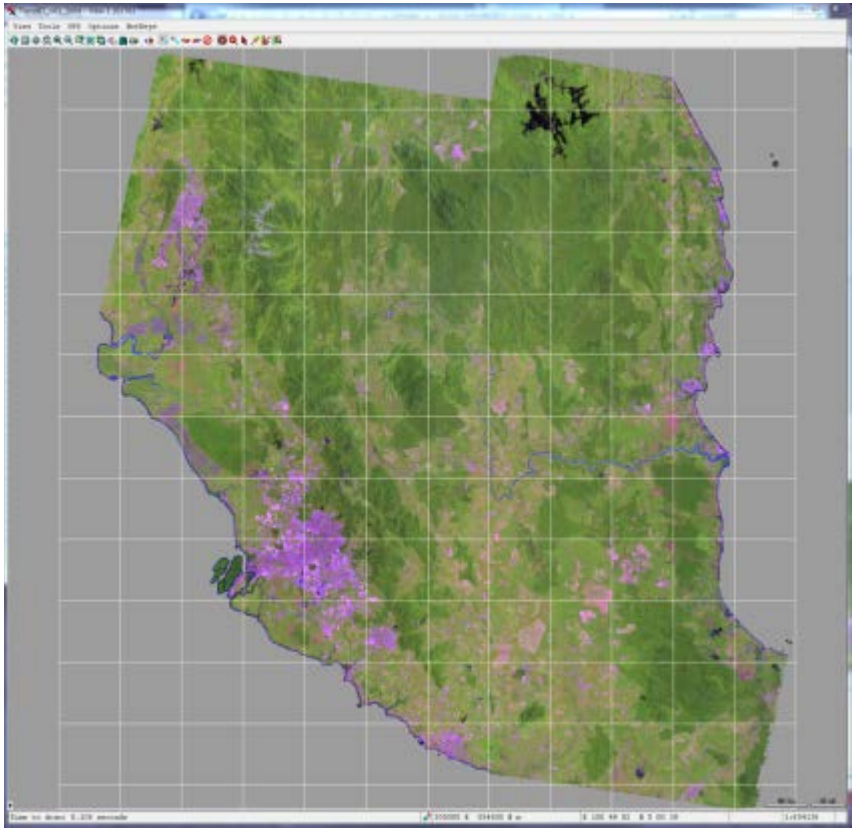

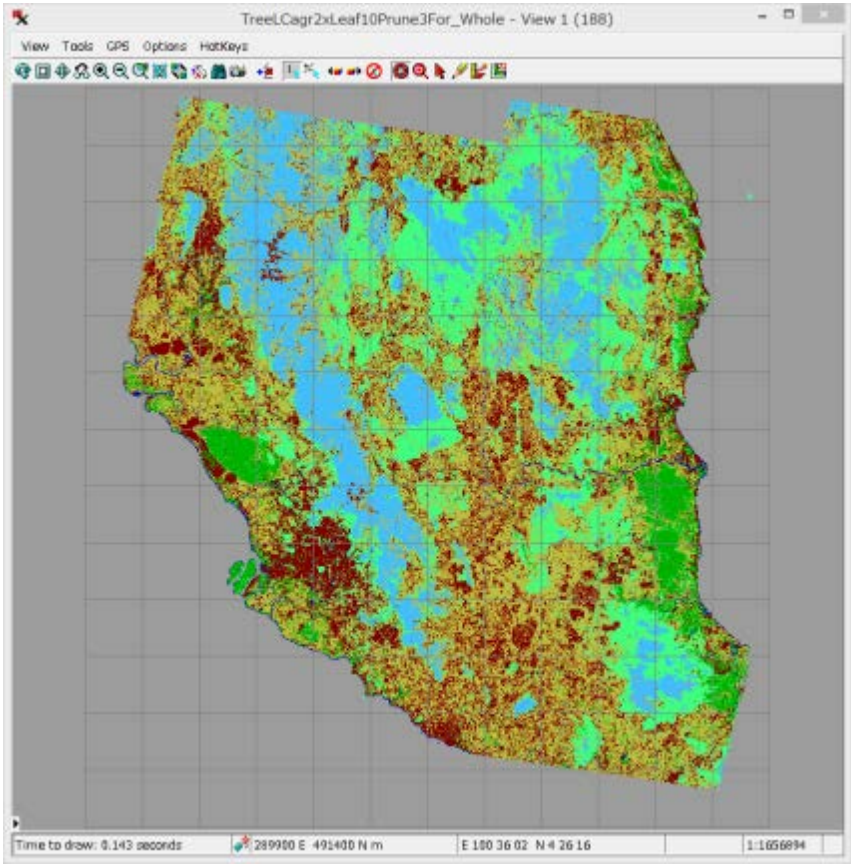

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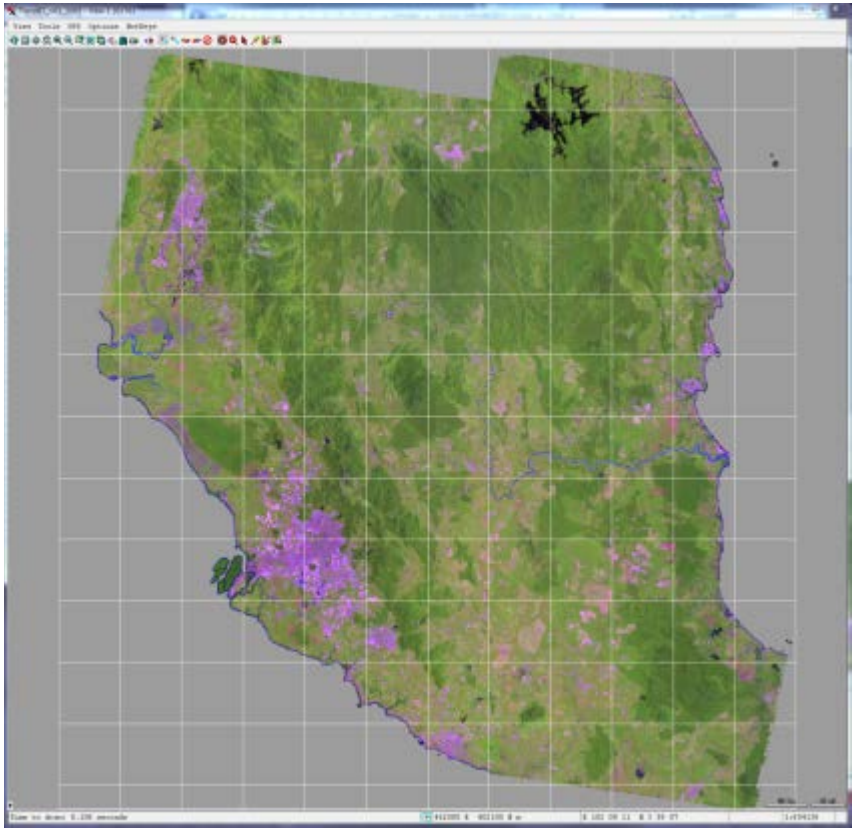
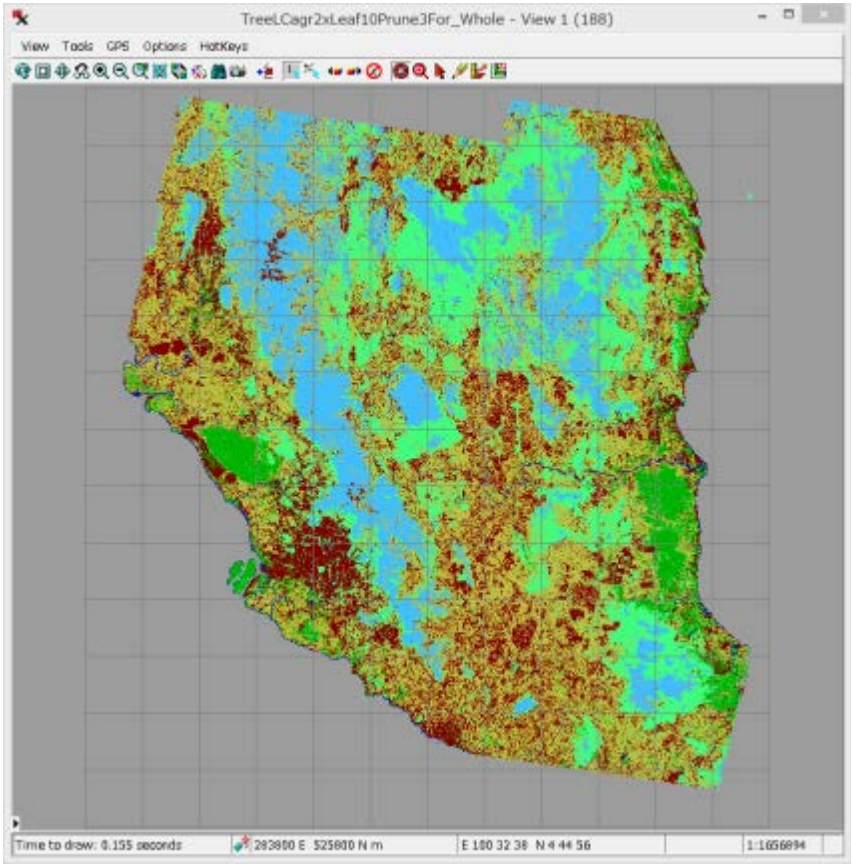
Virtual Cloud-free Image & LU 2005





Hill Forest
Lowland Forest
Wetland Forest
Plantation
Non-Forest
Water

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Virtual Cloud-free Image & LU 2006

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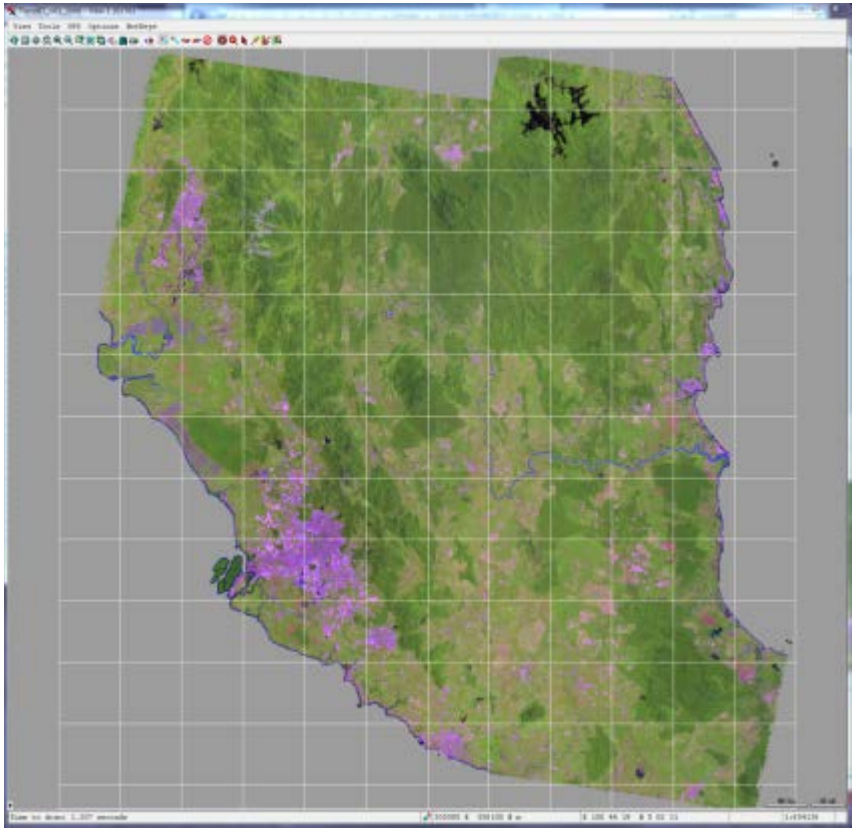

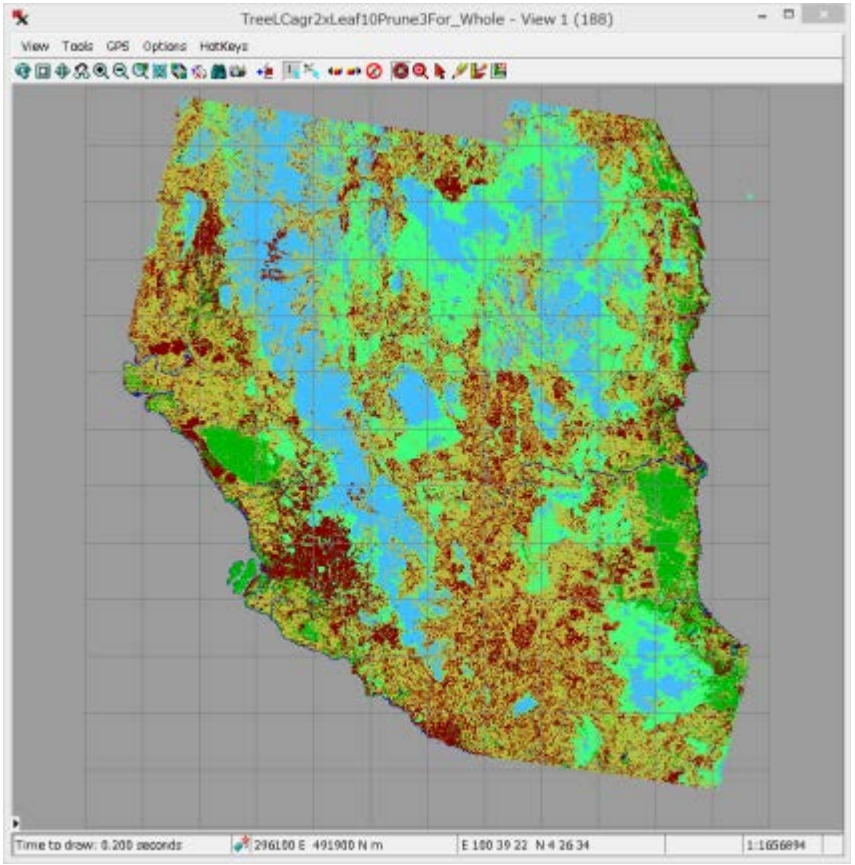

格子は30km、約360km四方の範囲

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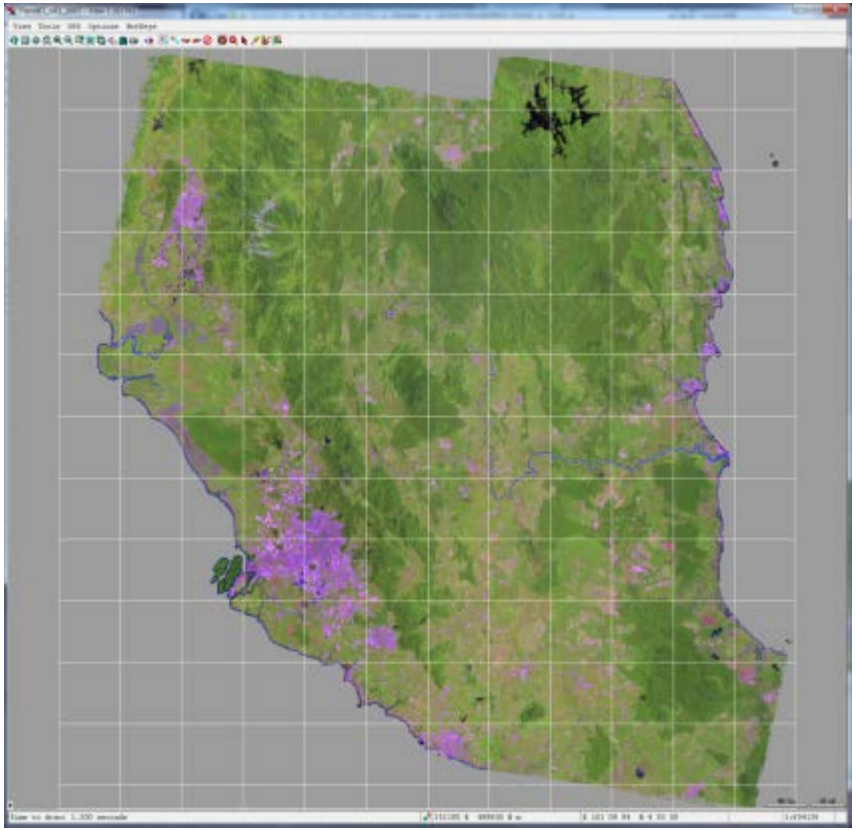
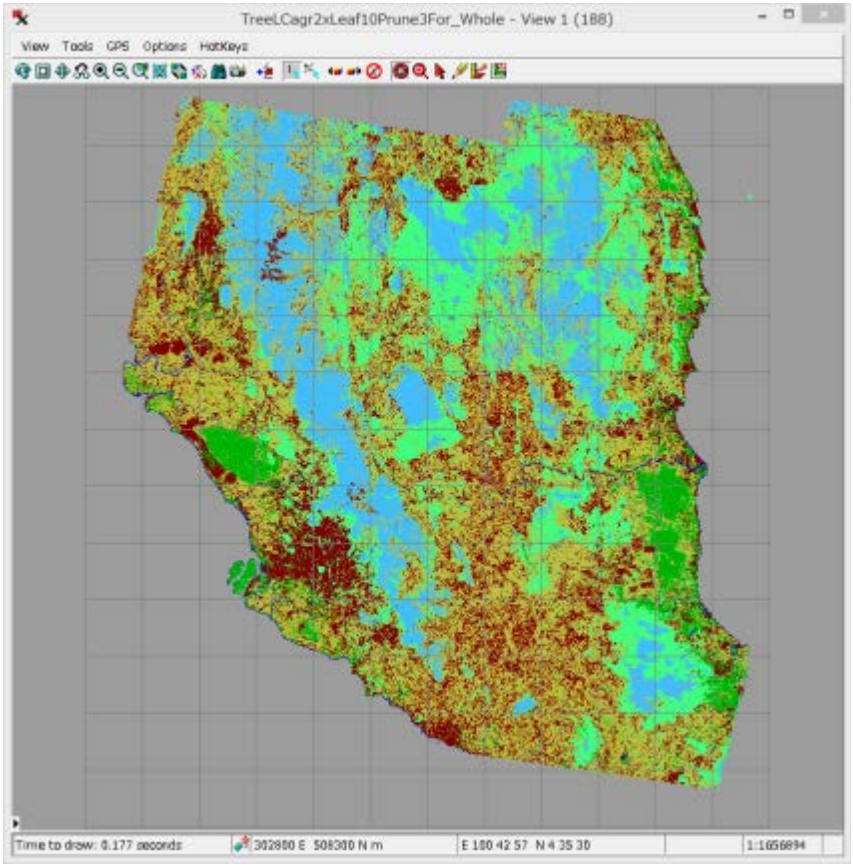
Virtual Cloud-free Image & LU 2007





Hill Forest
Lowland Forest
Wetland Forest
Plantation
Non-Forest
Water

格子は30km、約360km四方の範囲

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Virtual Cloud-free Image & LU 2008

Hill Forest
Lowland Forest
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Non-Forest
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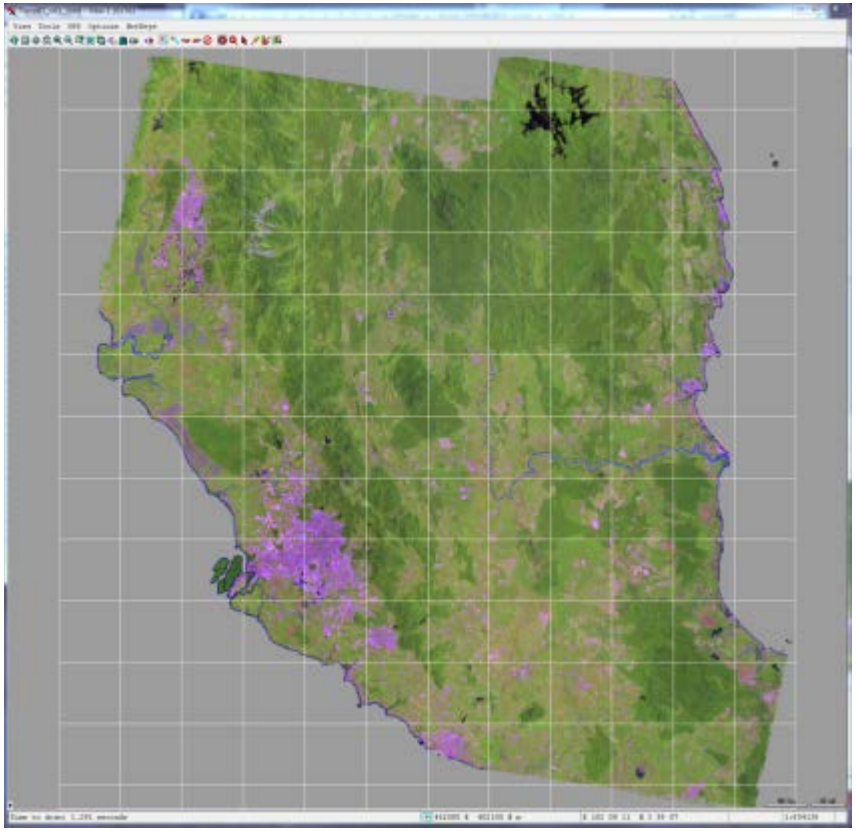

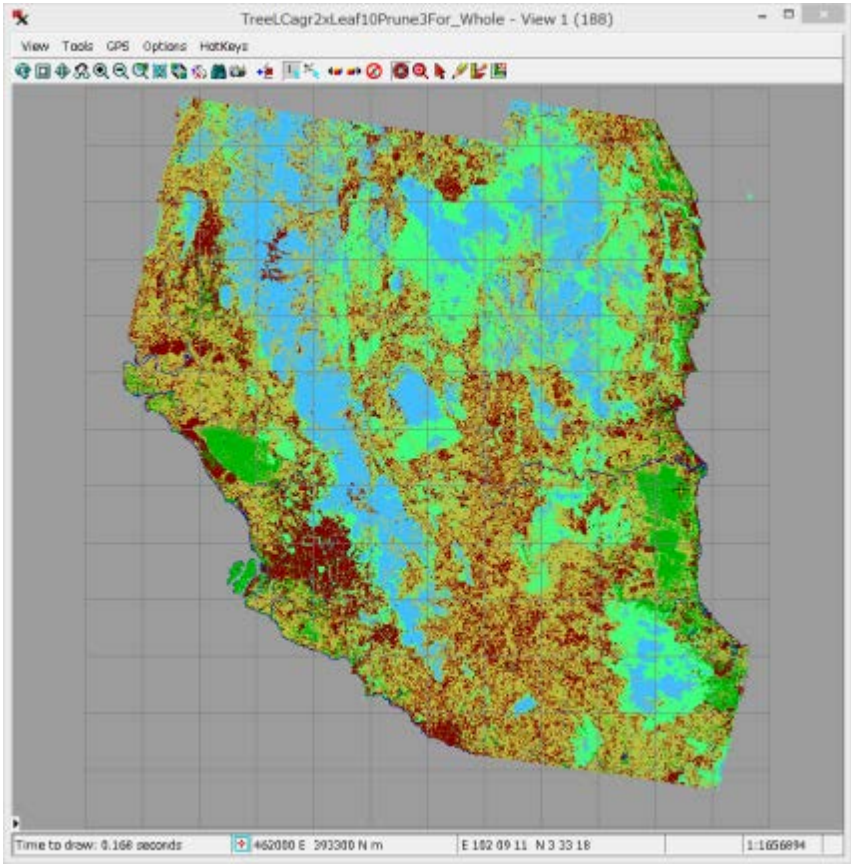

格子は30km、約360km四方の範囲

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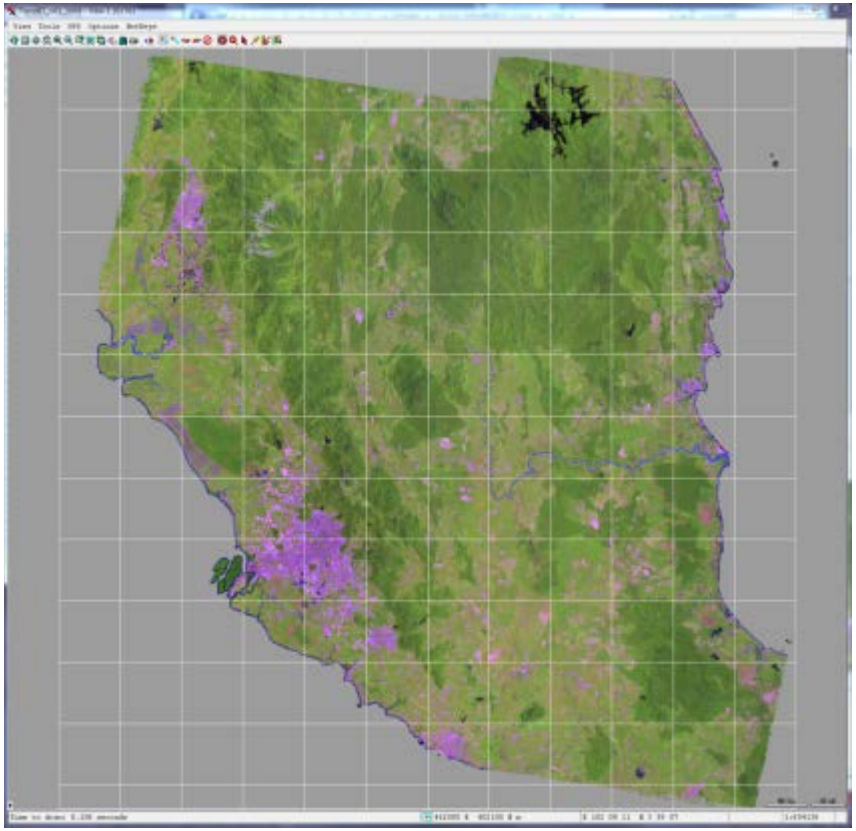
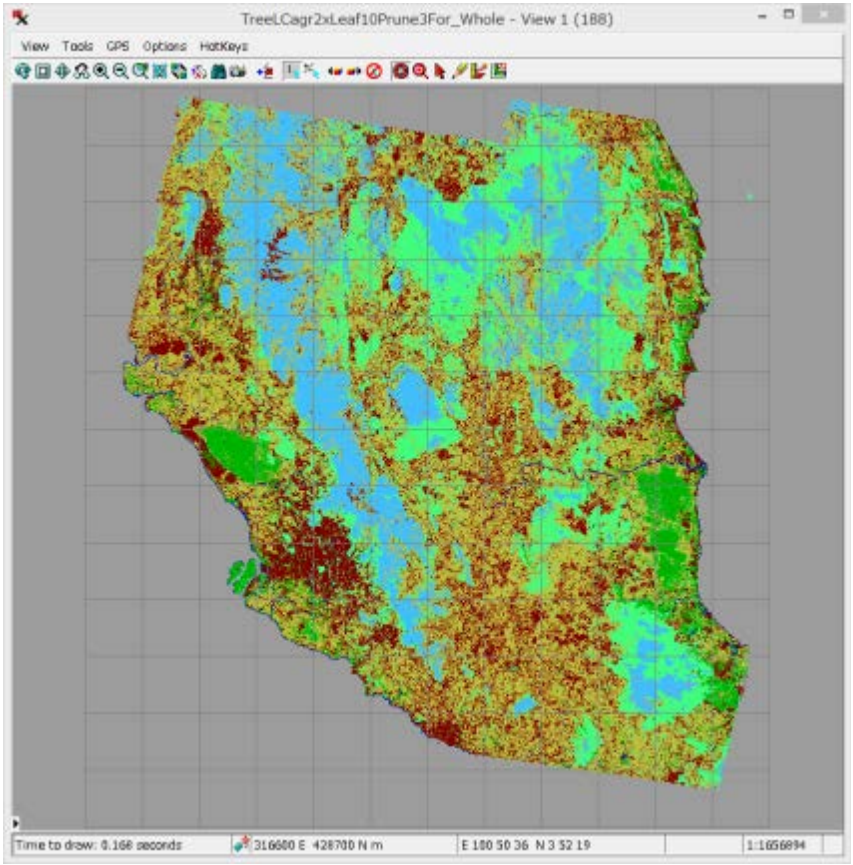
Virtual Cloud-free Image & LU 2009





Hill Forest
Lowland Forest
Wetland Forest
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格子は30km、約360km四方の範囲

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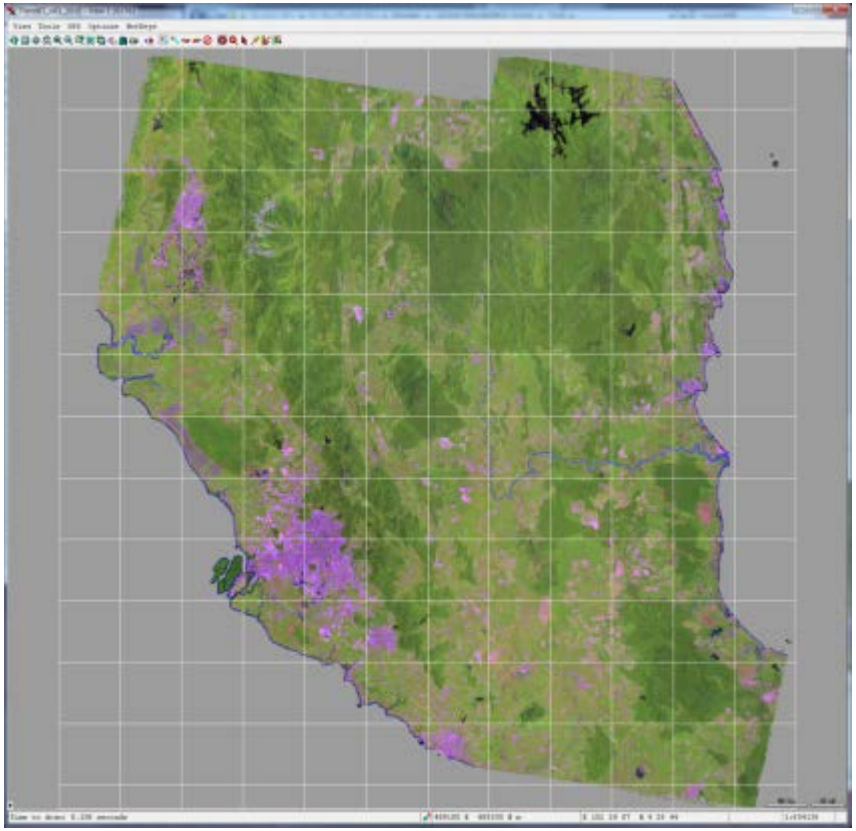
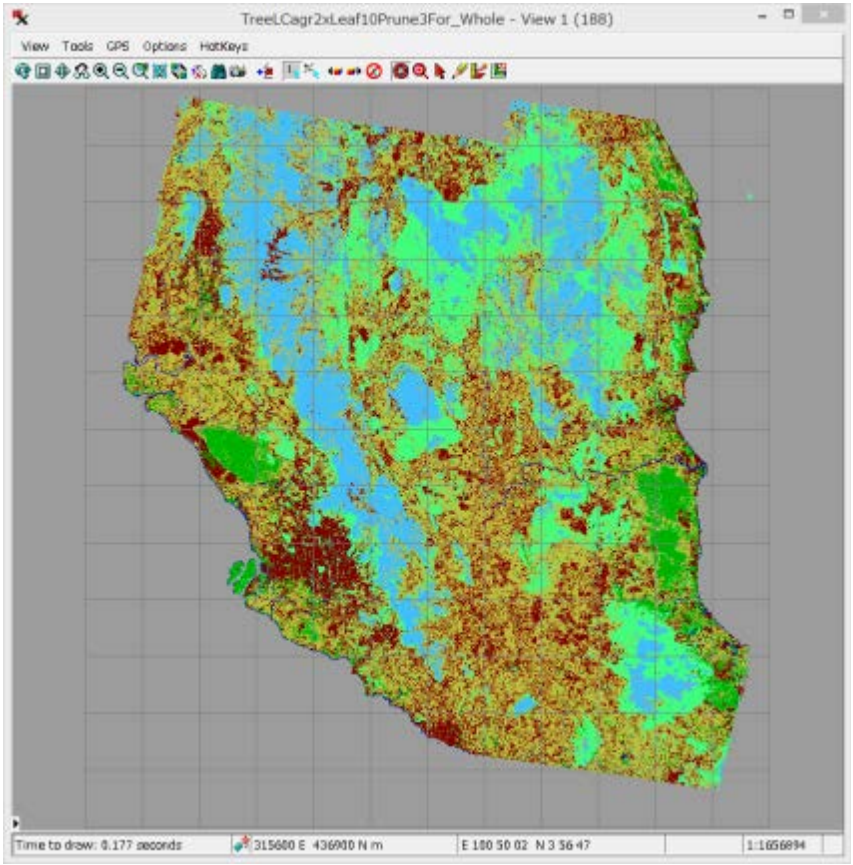
Virtual Cloud-free Image & LU 2010





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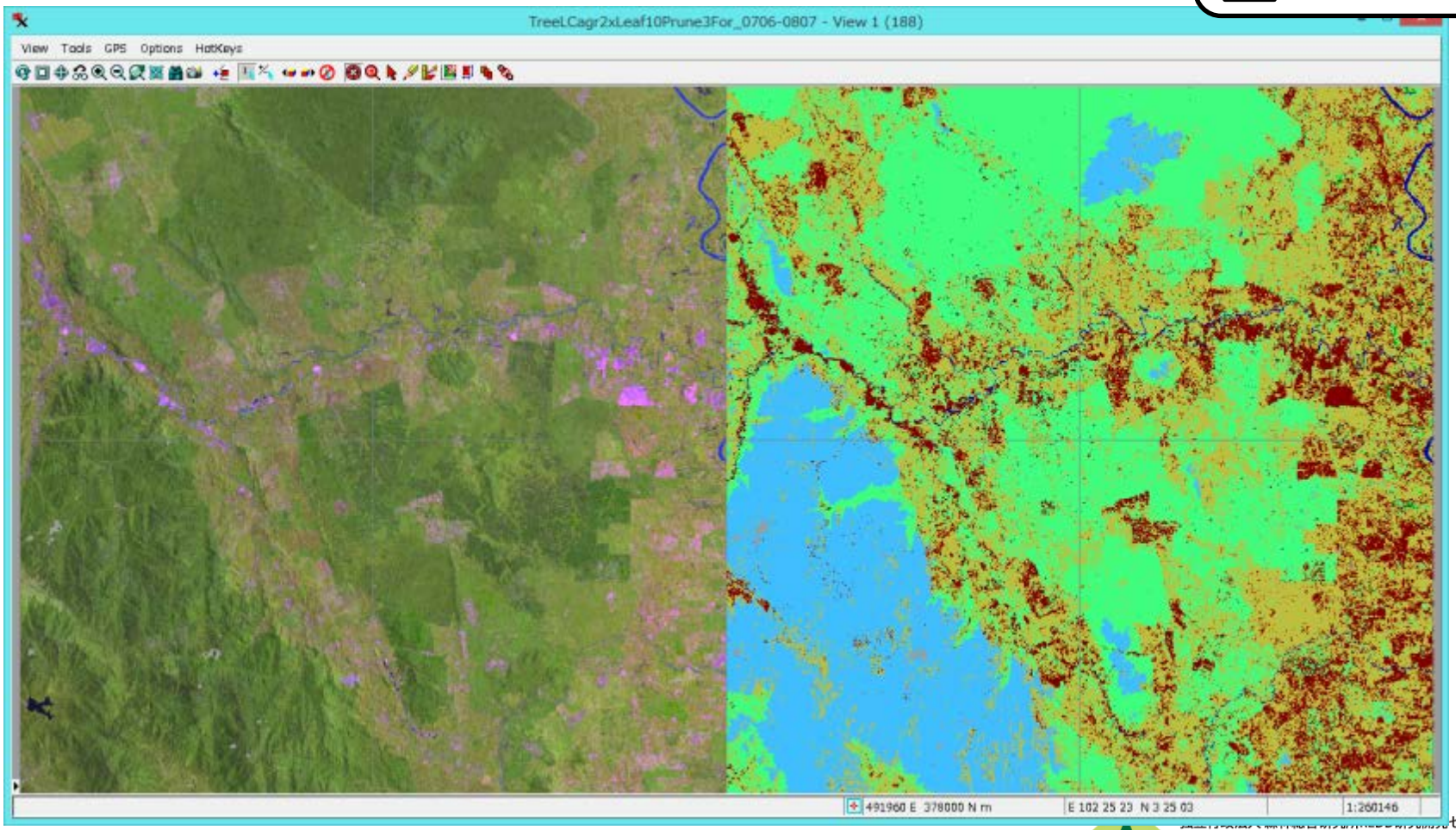
Lowland & Hill Forests 1996



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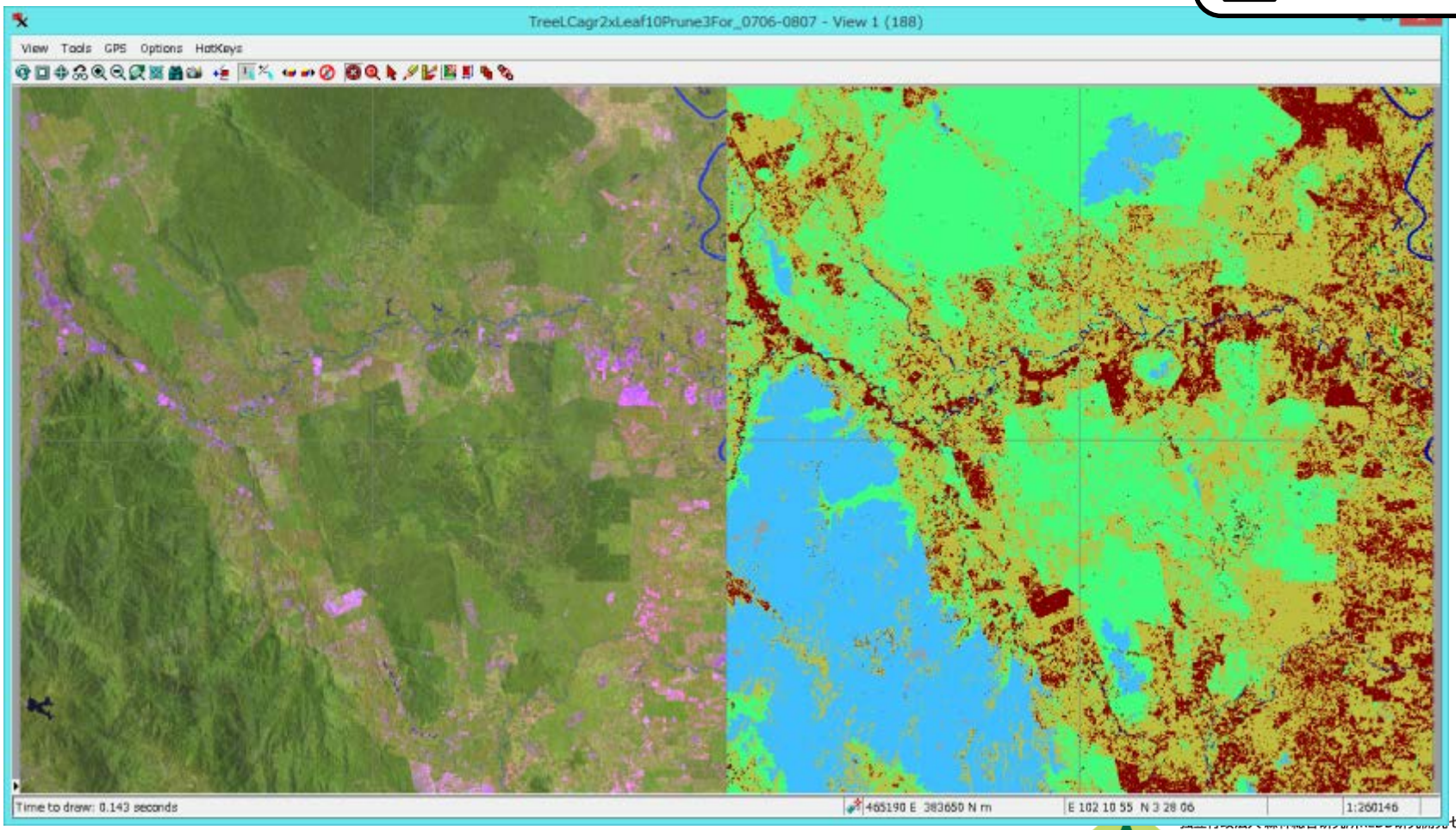
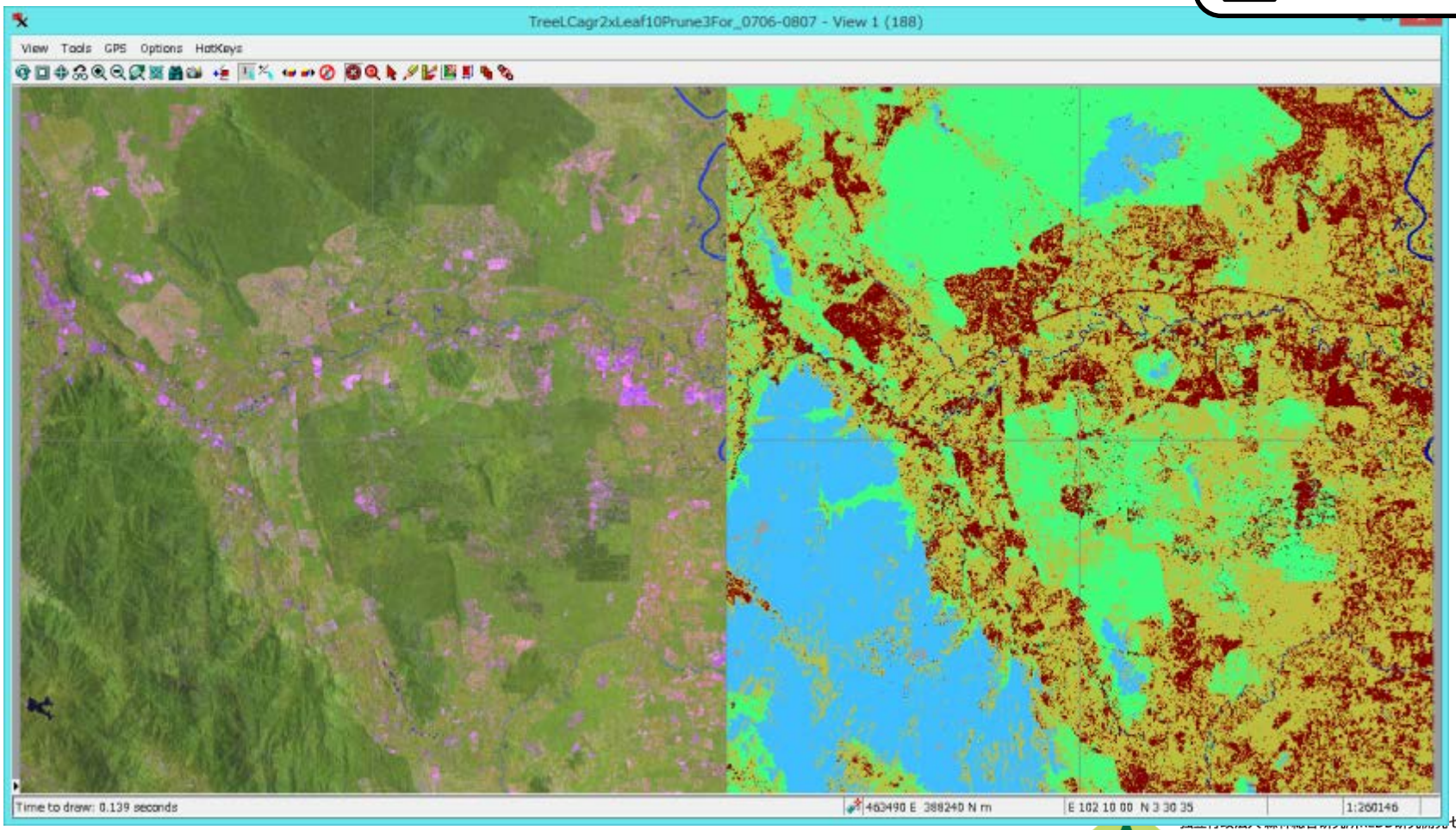
Lowland & Hill Forests 2000



格子は30km、60km四方の範囲

FFPRI REDD Research and Development Center Japan

Lowland & Hill Forests 2005



格子は30km、60km四方の範囲

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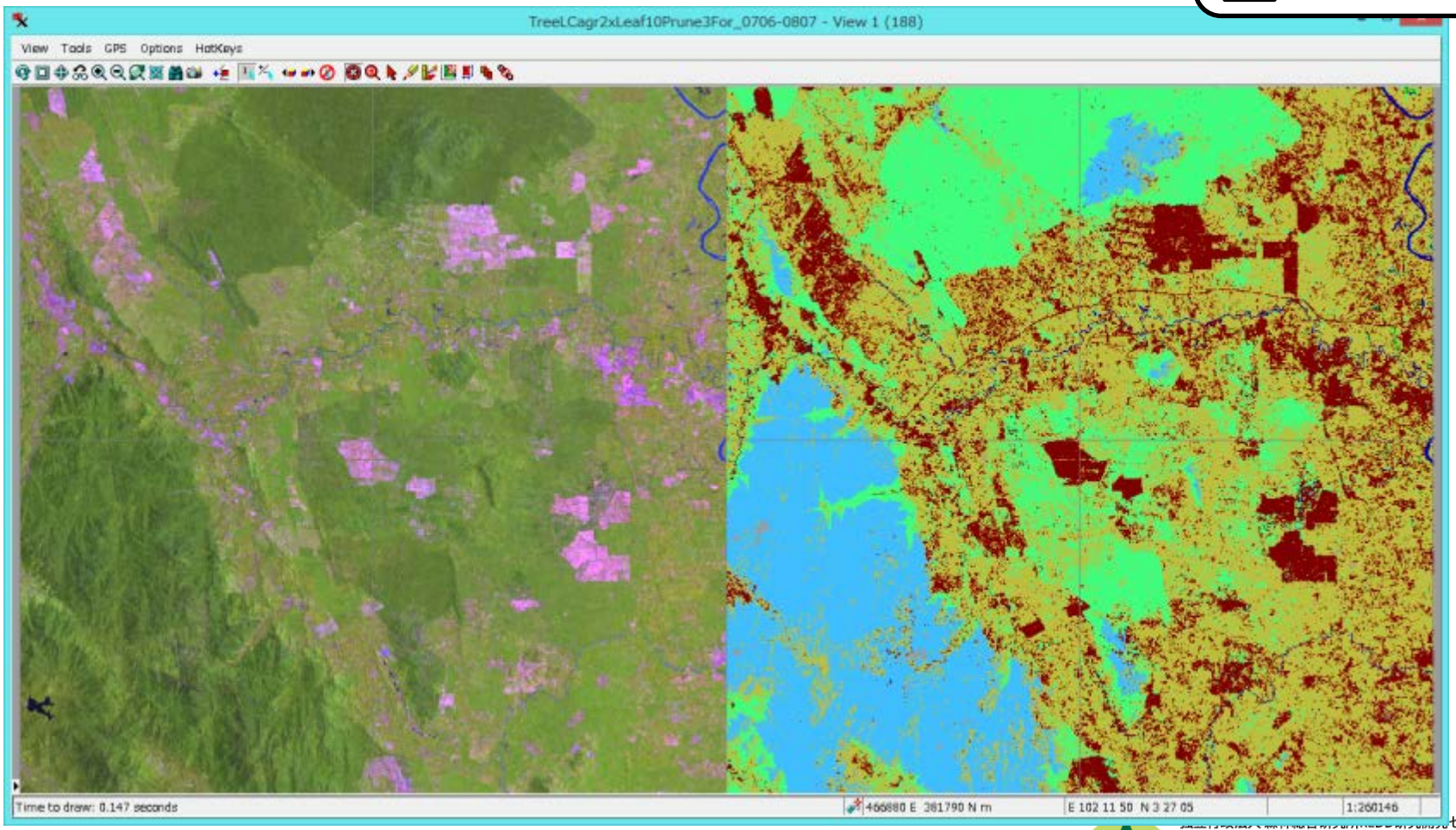
Lowland & Hill Forests 2010



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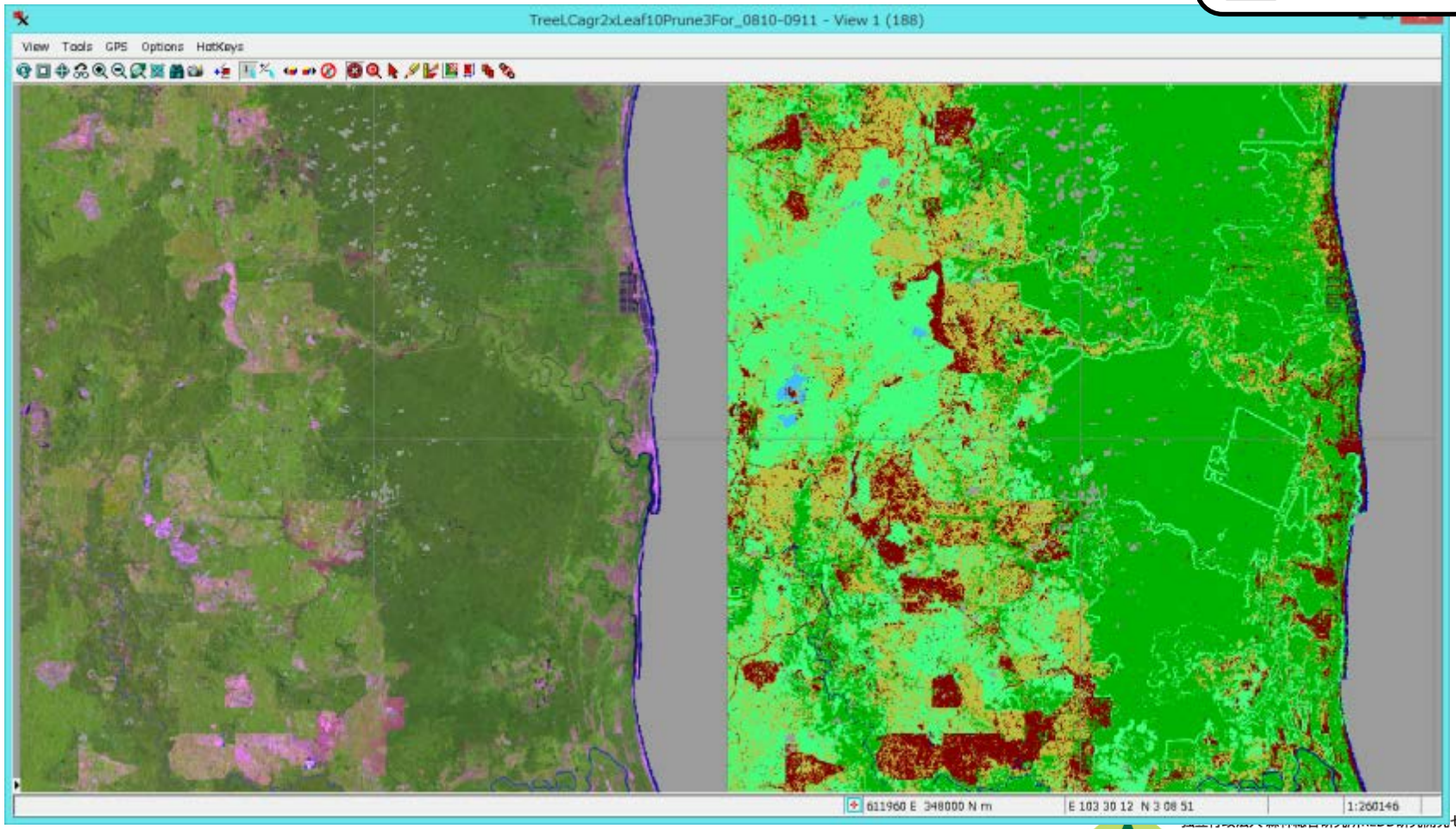
Swamp Forest 1996



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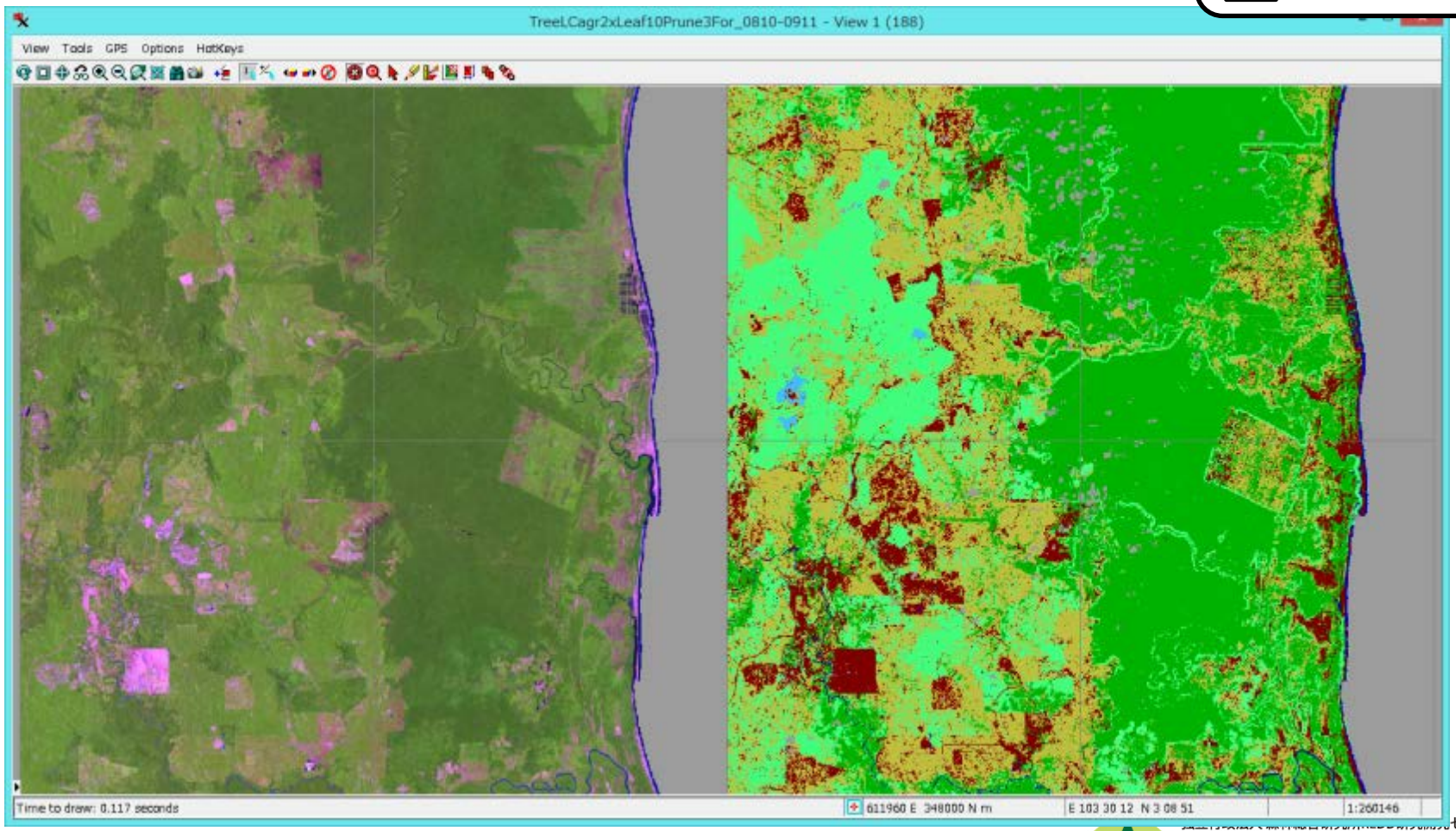
Swamp Forest 2000



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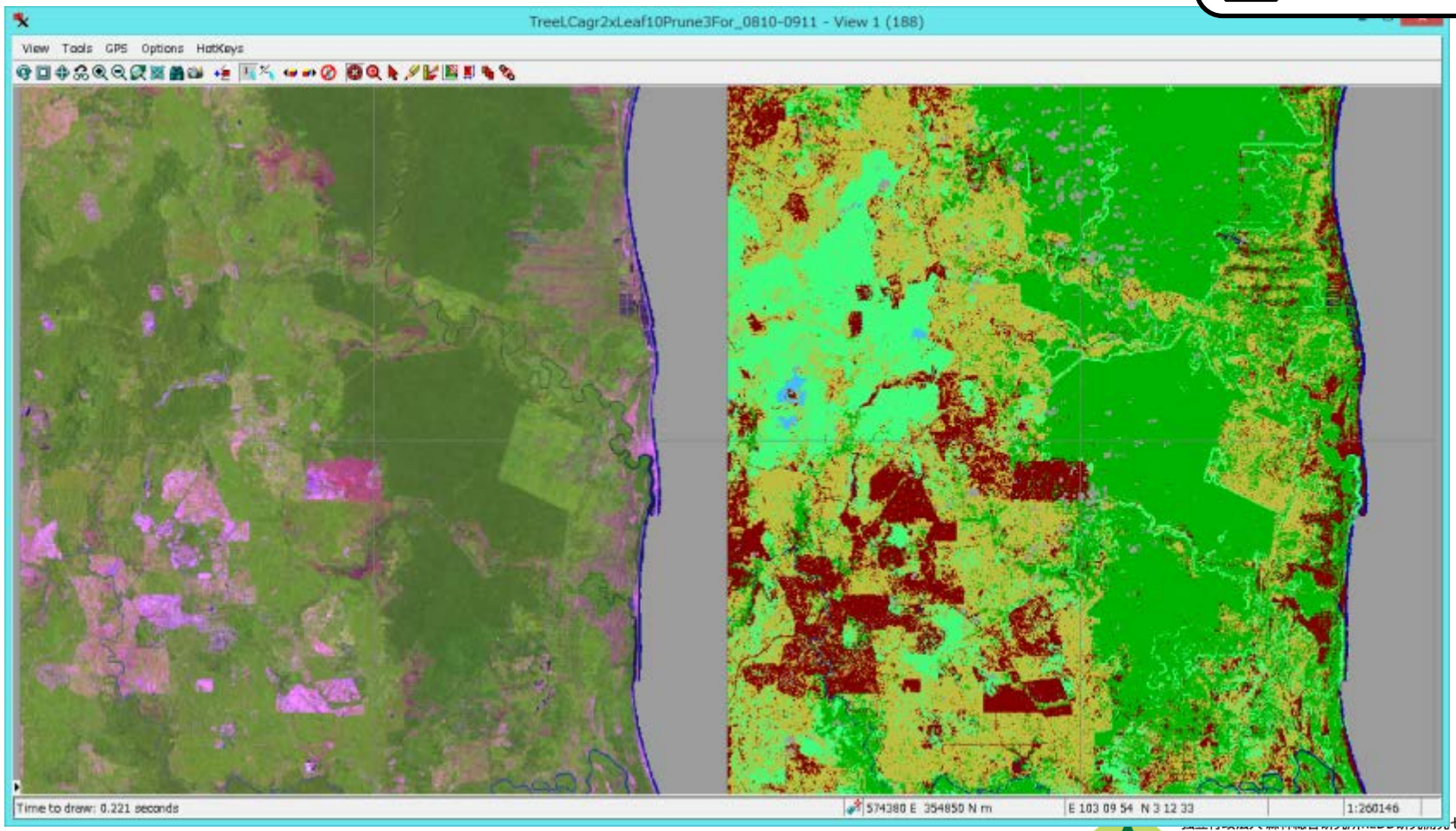
Swamp Forest 2005



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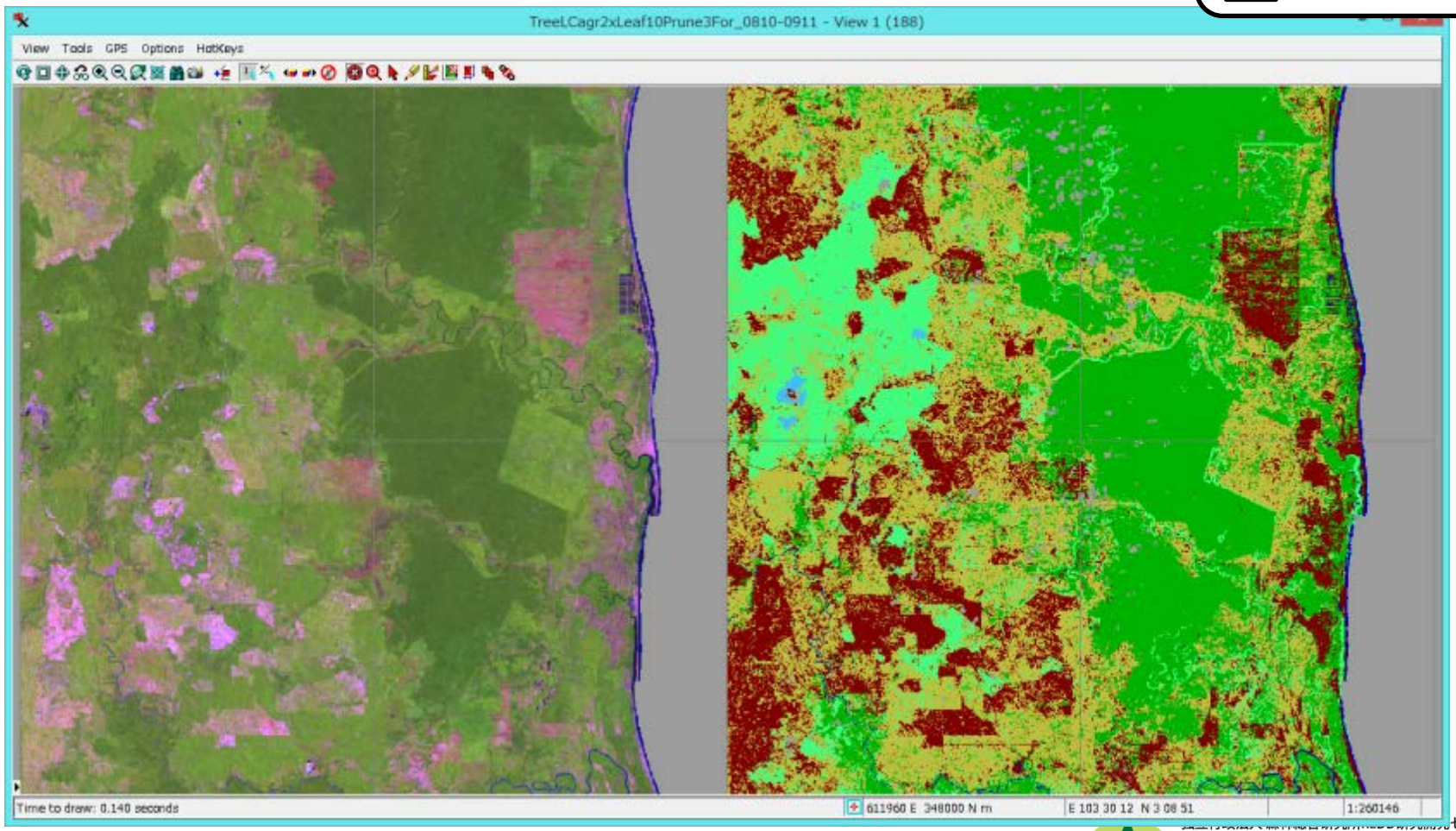
Swamp Forest 2010



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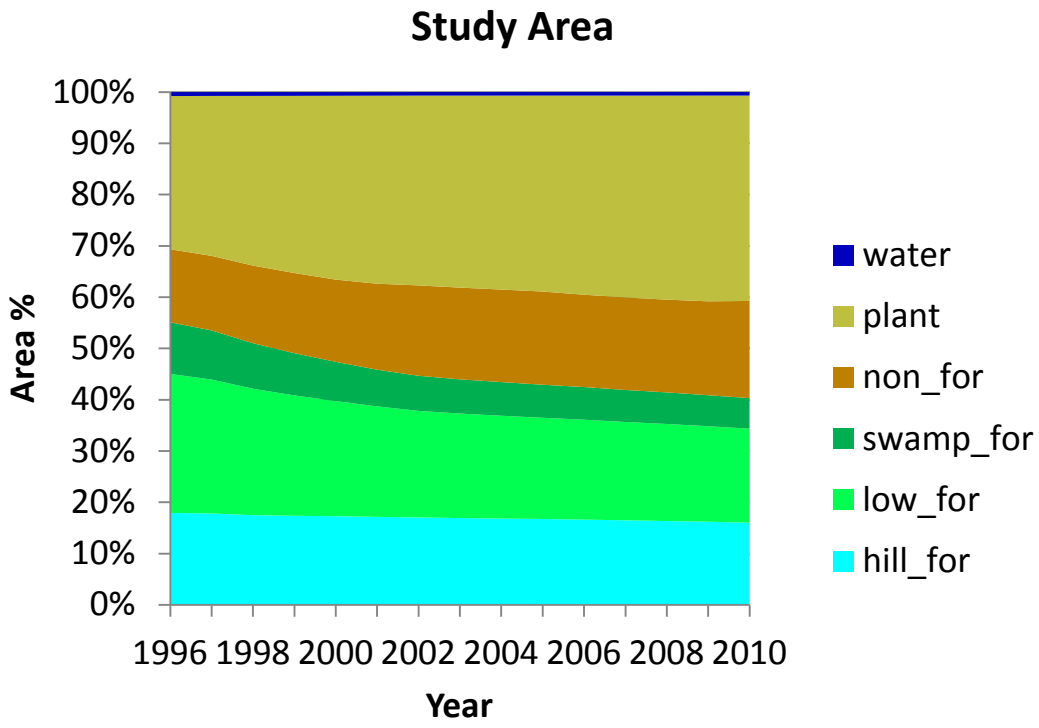
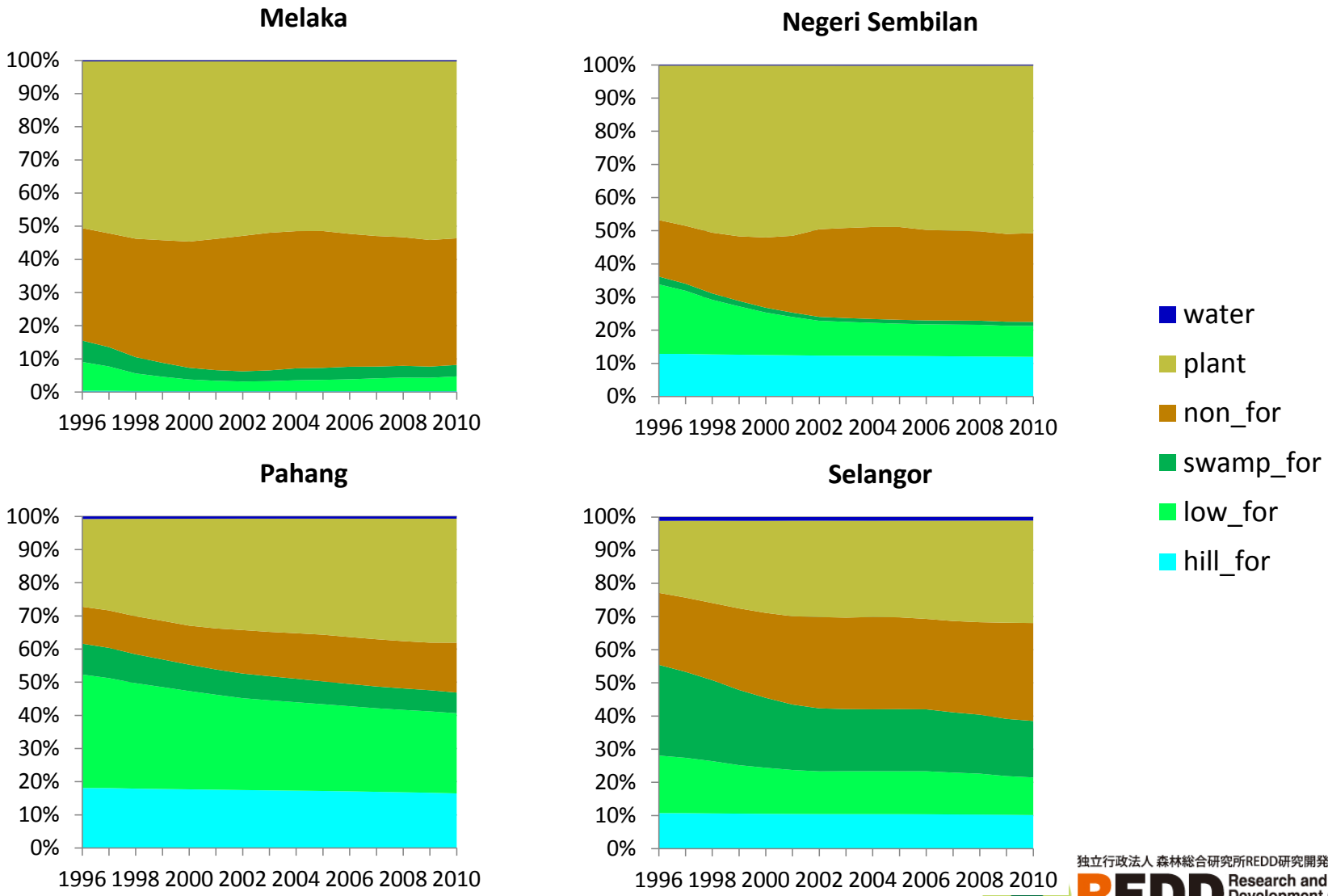
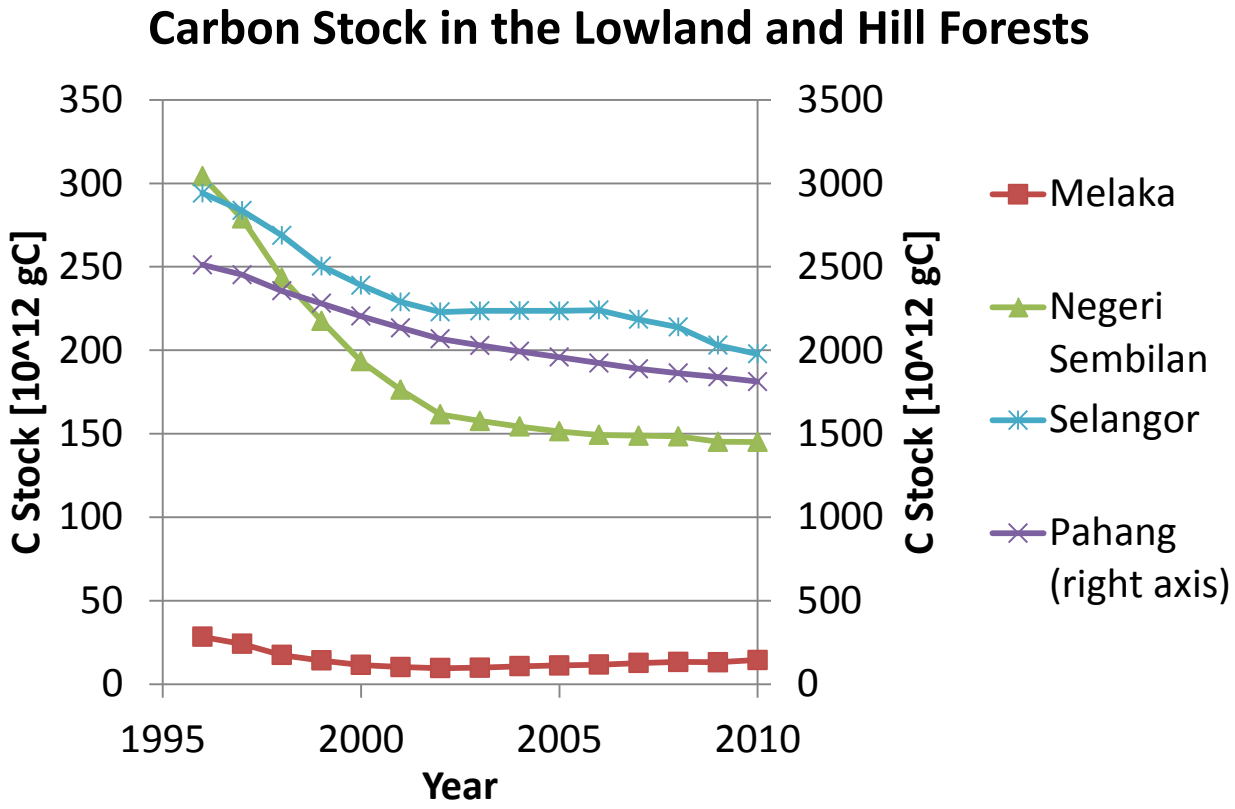
Areal changes through years



Areal changes through years, by state



C Stock Trend by State



CONCLUSION

Conclusion

- We've developed **time-series virtual cloud-free images** from the Landsat's historical
  - Landcover/landuse at any location at any time can be estimated
  - In situ information can be extrapolated over time and space
- This technique can be applied to any humid tropical and temperate countries
  - It would help REDD countries develop detailed baselines

Acknowledgement

- We are grateful to
  - FDPM for their kind supports and guidance throughout our study
  - FRIM's scientists & staffs for their great cooperation, indispensable supports, and friendship

Thank you very much for your attention!

RESERVE

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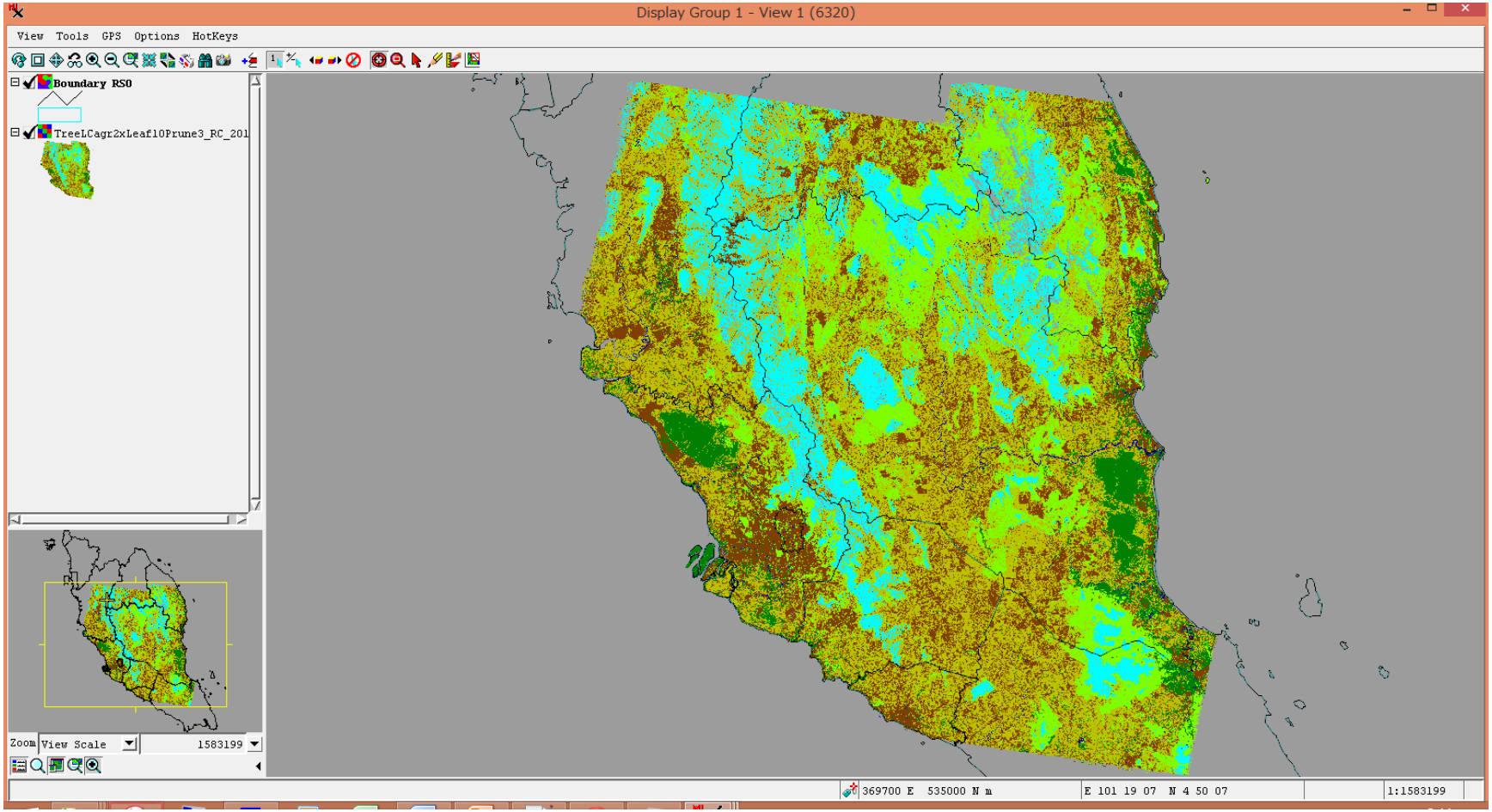

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