Mapping deforestation and post-deforestation dynamics in the tropics with Landsat time series

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One of today’s most active deforestation frontiers runs along the BR-163 from Mato Grosso to the Amazon.

PRODES digital: yearly deforestation maps since 2002, 6.25 ha MMU, visual interpretation of spectrally unmixed Landsat mosaics.
Uncertain carbon stock estimates for the Amazon...

Mitchard et al., 2014 (referring to Saatchi et al. 2011 and Baccini et al. 2012)
Southern Pará

Land use system dominated by extensive pastoralism
Fast regrowth of invasive species

Mato Grosso

Land use system dominated by intensive crop cultivation
Large-scale soy monocultures
Post-deforestation analysis

- Post-deforestation vegetation dynamics are complex and depend on growth rates and land management.

- Most tropical countries have larger areas of secondary forests than primary forests.

- We need to better understand regrowth dynamics: carbon stocks, habitat analyses, land management optimization, ...

Ramankutty et al. (2007)
## Processing workflow

- **Data import**
  - → 15,000 L1T Landsat scenes since 1984 (<80% CC)

- **Preprocessing (1)**
  - → Ledaps and Fmask

- **Preprocessing (2)**
  - → Reprojection, combine masks, cloud dist. images, extract reflectance & tIR

- **Compositing**
  - → Read 4D cubes to main memory
  - → Best observation compositing (DOY, cloud distance, ...)
  - → Summary statistics (Metrics)
  - → QA Layer (MetaFlags)

- **Mapping**
  - → Random forest using yearly metrics

Griffiths, P. et al., 2013
Yearly compositing - DOY

- Target DOY 213 (light green)
- Few no-data values
- Max. clear observation count for 2000: 31

Observations from DOY 150 (dark blue) to DOY 240 (dark green) in best observation composite for year 2000
Yearly compositing (year 2000)

- Number of cloud free observations per year strongly decreases from S to N
- Data scarcity in the 1980s and 1990s (specifically close to the Amazon)
Griffiths, P. et al. (in prep.)
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From multitemporal land cover to land use change

- Pixel based $TCW_{\text{min}}$ as surrogate for vegetation density/coverage

![Graph showing deforestation event, regrowth, and recultivation phases over years 1985 to 2010. The graph plots TCWmin against years with annotations for deforestation event, regrowth, and recultivation phases.]
From multitemporal land cover to land use change

- $\text{TCW}_{\text{min}}$ thresholding allows to include/exclude early stages of regrowth

- Needs to be fine-tuned based on field evidence
Ca. 20% of the deforested area is covered by secondary vegetation after 2-3 years.
Secondary vegetation mapping

- Regrowth dynamics are an indicator of land use management intensity
- Relative regrowth rates e.g. decreased with soy boom in early 2000

Müller et al. (in prep)
Identification of deforestation and regrowth increases towards the end of the dry season (Day Of Year 231)

End of dry season is critical for detecting deforestation and regrowth.
Distribution of annual Landsat TM/ETM+ observations (227/65). Size of dots represents cloud cover. Red lines mark beginning and end of the dry season.
Data density, specifically at the end of the dry season is critical for detecting deforestation and analyzing regrowth.
Summary and outlook

- Compositing approach suited for annual deforestation analysis in Brazil since the 1980s
- Long time series allow inferring regrowth and secondary vegetation dynamics
- Regionalized biomass data needed (Mitchard et al. 2014)
- Higher acquisition frequency will further improve results -> Sentinel-2

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References


Griffiths, P., Müller, H., Jakiomow, B., Hostert, P. (in prep.). Mapping 30 years of deforestation and post-deforestation dynamics in Mato Grosso and Pará, Brazil.


