Overview on satellite-based remote sensing methods to support REDD+

Summary of the Literature Study DLR/BMWi FK 50EE1108

REDD Workshop

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Contents

1 REDD – Requirements to Remote Sensing

- Consistency and continuity on different geometric scales:
  - national
  - sub-national/local

- Forest inventory as reference to change detection

- Robust, coherent and veryfiable methods

1 REDD – Requirements to Remote Sensing

Geometric Resolution
- Fine
  < 5 m
- Medium
  10 – 60 m
- Coarse
  250 – 1000 m

Temporal Resolution
- 1 – 2 Days
- Monthly
- Yearly

Spectral Domain
- VIS/NIR
- X/C/L/P-Band

1 REDD – Requirements to Remote Sensing

REDD-relevant Parameters:

- Special Emphasis on Geometric Resolution
  - Degradation: < 5 m
  - Deforestation/Afforestation & Biomasse: 10 – 100 m
- Temporal Resolution
  - Minimum Yearly
  - High temporal variability of degradation processes
  - Trade-off: resolution vs. coverage
  - Cloud cover influences availability

2 Applications of Remote Sensing to REDD+

- **Literature Study**
  - Analysis of scientific publications since 2000
  - Focus on publications with sufficient reference and/or inventory data
  - Special case radar applications:
    - Missing operational mapping systems
    - Publications mostly on the development of robust and automated methods (not operational applications yet)

2.1 Applications of Radar Data

- **Focus on Satellite Data**

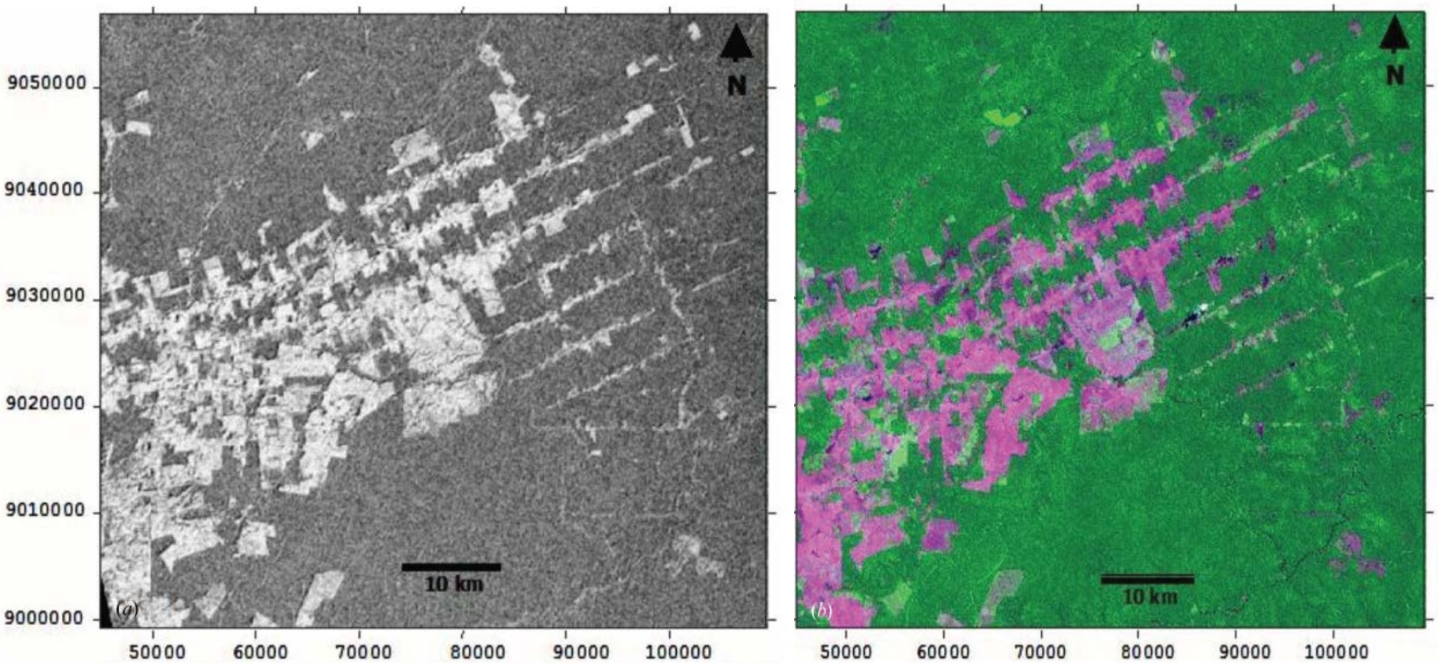
Satellite	Wavelength
ALOS PALSAR	L-Band (quad)
ERS-1/2	C-Band (VV)
JERS-1	L-Band (HH)
Envisat ASAR	C-Band (quad)
COSMO-SkyMed-4	X-Band (quad)
Radarsat 1/2	C-Band (HH)/(quad)
TerraSAR-X/Tandem-X	X-Band (quad)

2.1 Applications of Radar Data

- **Deforestation / Afforestation**
  - Radar-Backscatter
  - Interferometric Coherence
  - Polarimetry
  - Combination with optical, mostly Landsat-data

- Almeida-Filho et al. (2009):
  - Simple Ratio Application

$$NDI = \frac{(HH - HV)}{(HH + HV)}$$

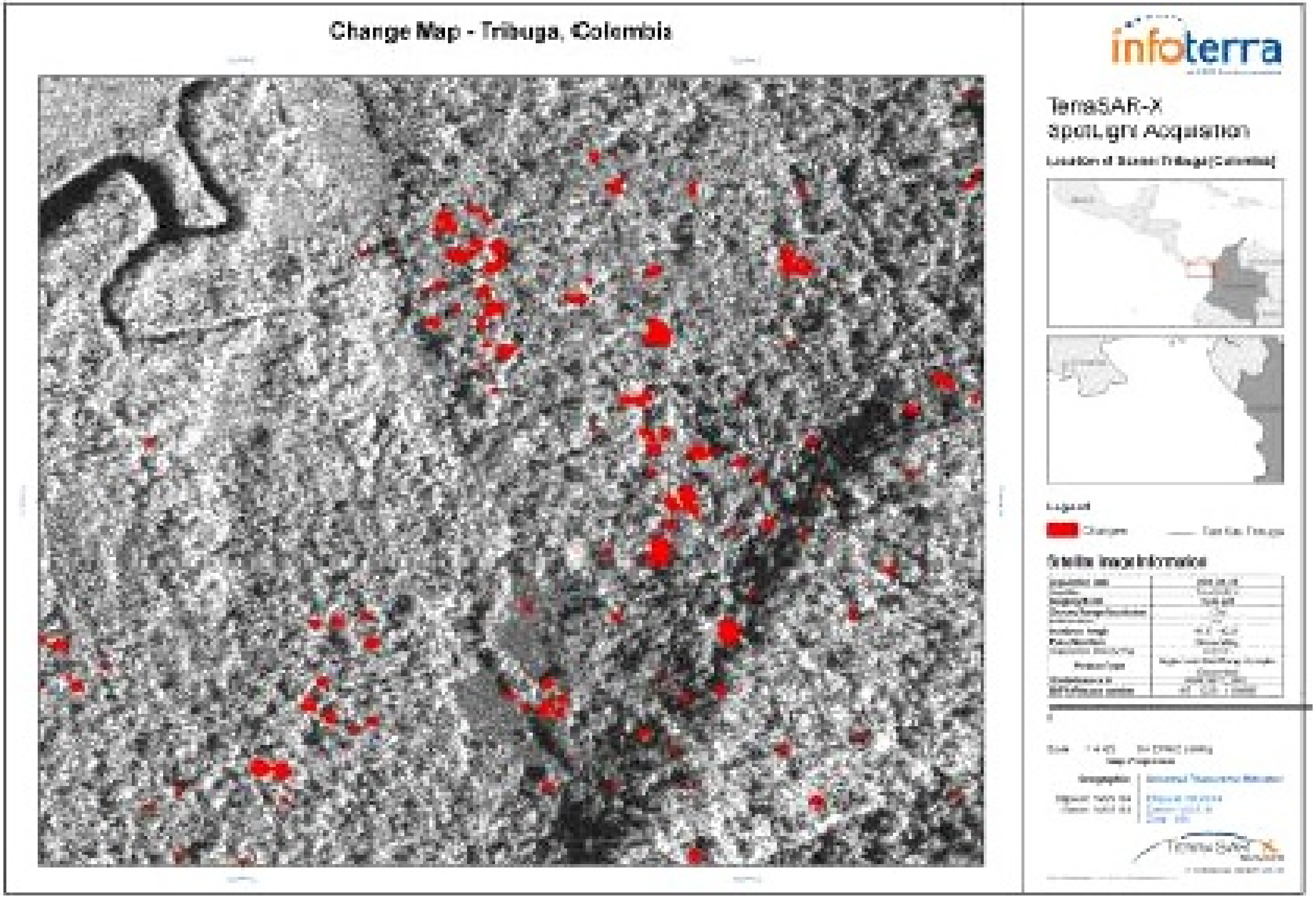


2.1 Applications of Radar Data

- **Degradation**
  - Very few publications
  - Resolution requirement < 5 m

Kuntz et al. 2011

- multitemporale analysis of TerrSAR-X spotlight data
- hypothesis: decrease of intensities with reduced tree stands
- through der Intensitäten durch Abholzung

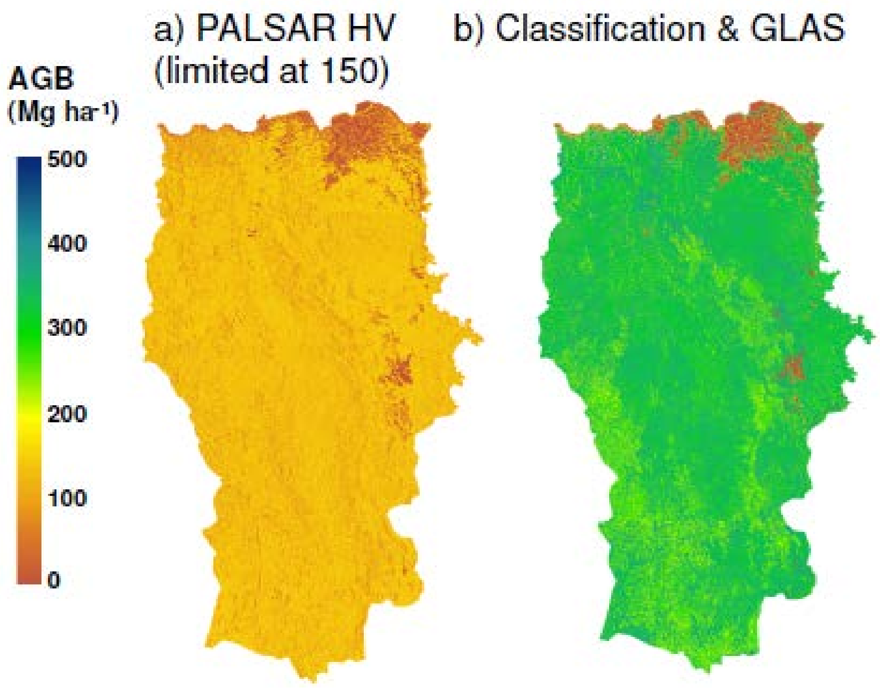

Change Map - Tribuga, Colombia
infoterra
TerraSAR-X
SpotLight Acquisition

2.1 Applications of Radar Data

- **Biomasse**
  - Regression analysis using
    - intensity,
    - InSAR and
    - PolSAR-Data

  - Additional synergetic use of
    - inventory data,
    - optical data and
    - lidar

- Mitchard et al. (2011):
  - Synergy ALOS PALSAR and GLAS IceSAT
  - Classification of Tree Structure and Retrieval of AGB from Lidar-Data



2.2 Applications of optical & Lidar-Data

- **Airborne Systems** (!)
  - Aerial Photographs
  - LIDAR

- **Satelliteborne Systems**
  - Optical Sensors (e.g. Landsat, SPOT, IKONOS, QuickBird, ..)
  - LIDAR: IceSat/GLAS

2.2 Applications of optical & Lidar-Data

Sensor & resolution	Examples of current sensors	Minimum mapping unit (change)	Cost for data acquisition[8]	Utility for forest cover monitoring
Coarse (250-1000 m)	SPOT-VGT (1998-) Terra-MODIS (2000-) Envisat-MERIS (2004-)	~ 100 ha ~ 10-20 ha	Low or free	Consistent pan-tropical annual monitoring to identify large clearings and locate "hotspots" for further analysis with mid resolution
Medium (10-60 m)	Landsat TM or ETM+, SPOT HRV IRS AWiFs or LISS CBERS HRCCD	0.5 - 5 ha	<$0.001/km² for historical data $0.02/km² to $0.5/km2 for recent data	Primary tool to map deforestation and estimate area change
Fine (<5 m)	IKONOS QuickBird Aerial photos	< 0.1 ha	High to very high $2 -30 /km²	Validation of results from coarser resolution analysis, and training of algorithms

GOFC-GOLD REDD SOURCE BOOK 2011: 2-18

2.2 Applications of optical & Lidar-Data

- **Deforestation / Afforestation**
  - Synergistic exploitation of airborne and satellite-borne data sets
  - Methods are widely being applied
  - VHR and airphotos are being used for validation
  - Automated methods are being developed for use by non-experts

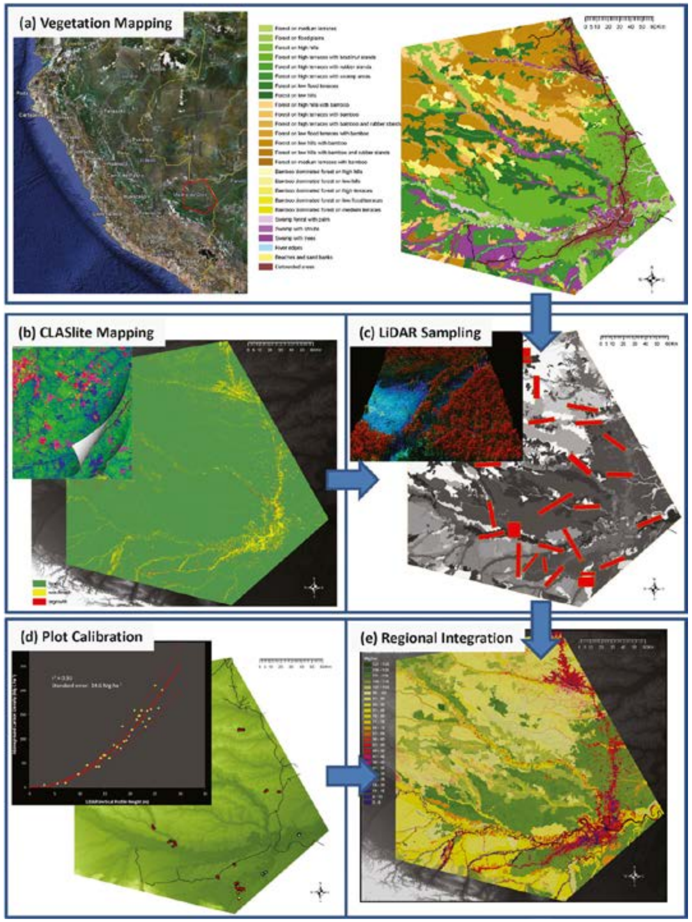
2.2 Applications of optical & Lidar-Data

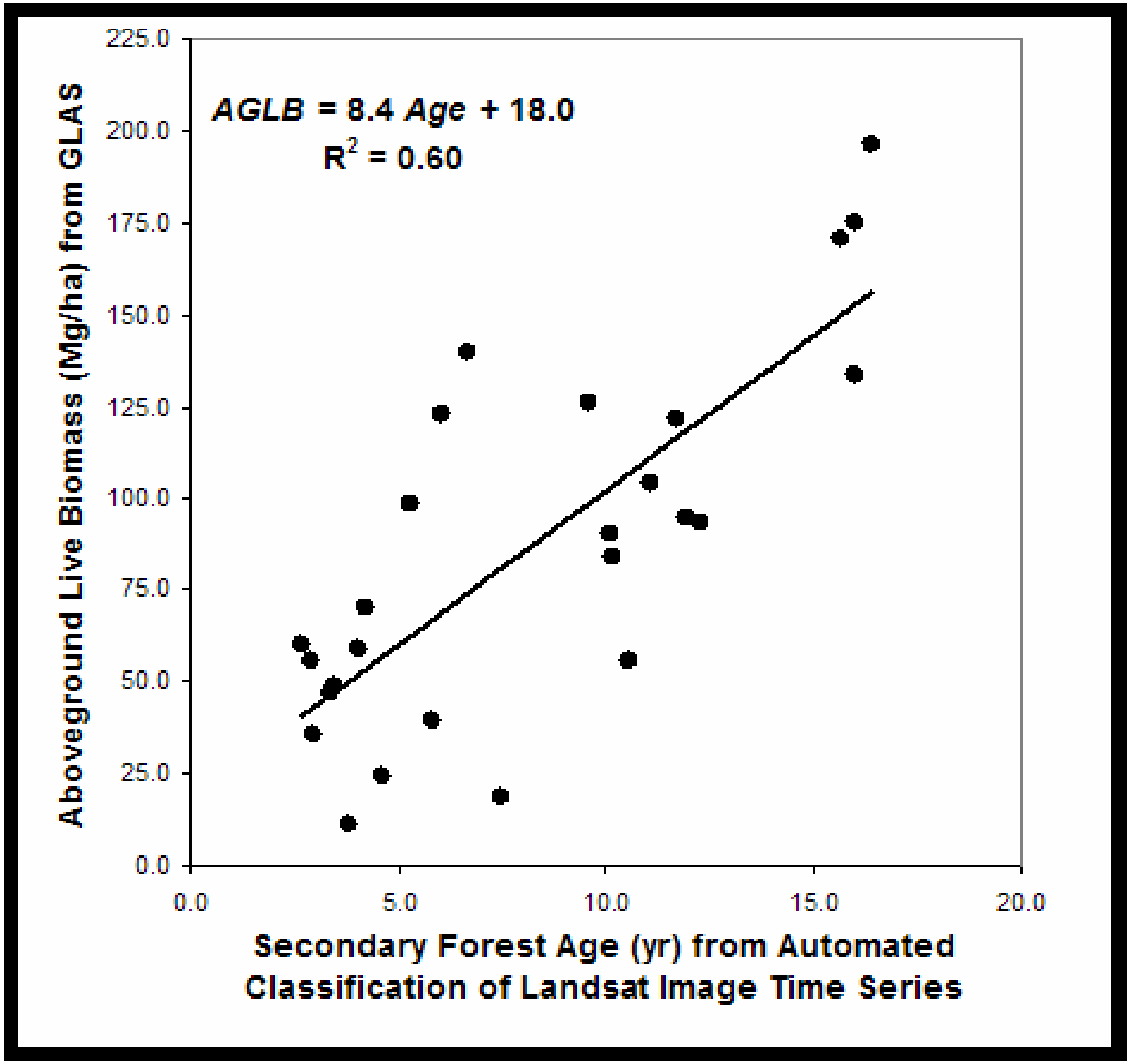
- **Degradation**
  - Similar methods as for de-/afforestation
  - Great difficulties where degradation is not changing the top canopy structure
  - Temporal resolution not sufficient
  - Very small scale changes by medium resolution not detectable
  - Combination with LIDAR promising
  - Better spatio-temporal and radiometric resolution needed

2.2 Applications of optical & Lidar-Data

- **Biomasse**
  - Correlation of satellite classifications with inventories
  - Correlation of satellite classifications with airborne LIDAR-Data and inventories
  - Correlation of satellite classifications with (ICESat/GLAS) and inventories
  - Correlation airphotos with satellite data, airborne LIDAR and inventories

- CLASSlite and airborne LIDAR-Data (ALS) - ASNER (2009a), ASNER et al. (2010)
  - Befliegung von min. 1% der Fläche mit ALS
  - Kalibrierung der 3D-Strukturdaten des ALS durch eine eingeschränkte Anzahl von Felderhebungsdaten
  - Erstellung von Biomassekarten mit 0,1 ha Auflösung





(HELMER et al. (2009)

www.redd.uni-jena.de

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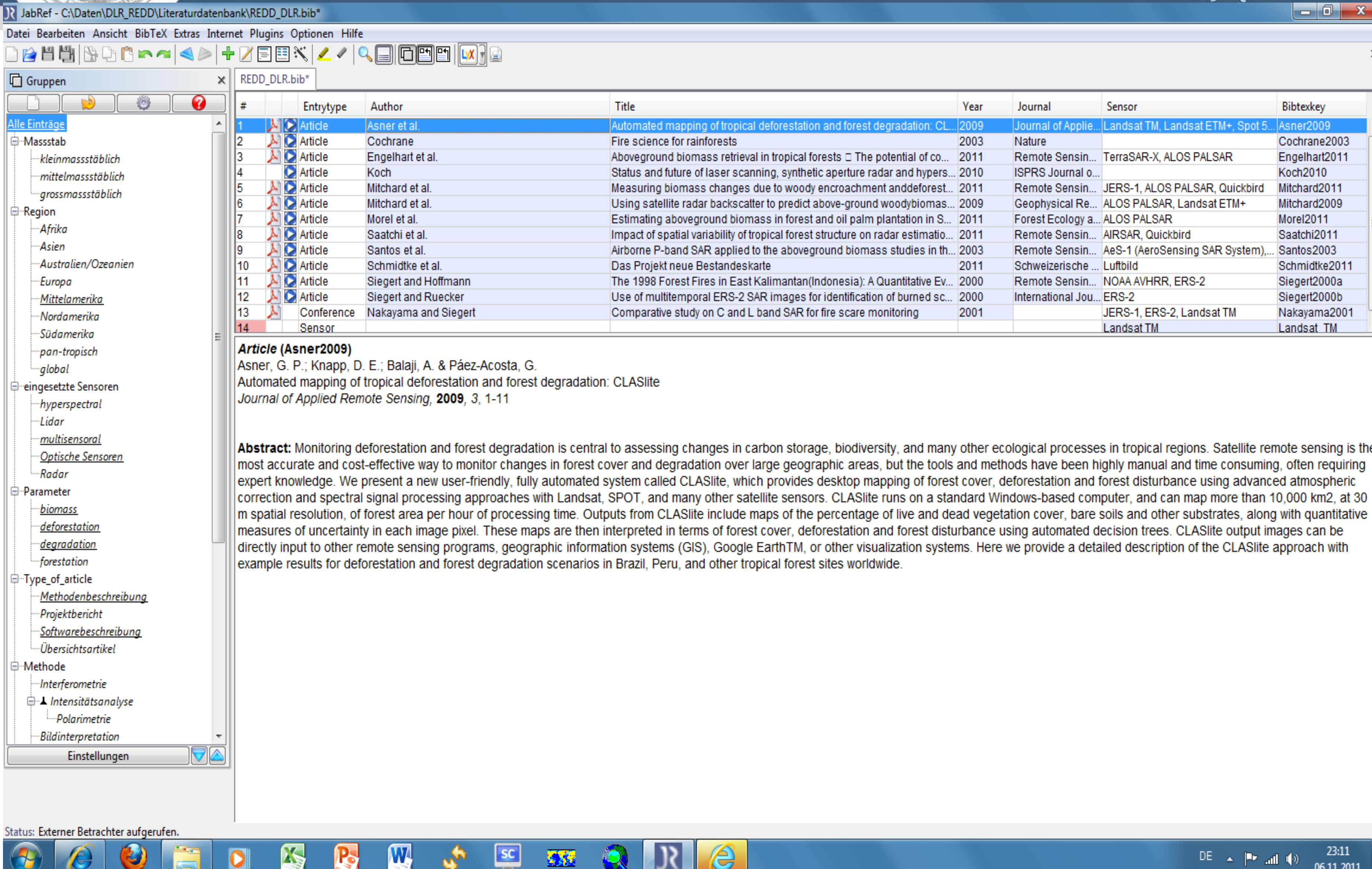

4 Summary

- Very dynamic application field due to upcoming sensors
- Increasing development of expert systems for non remote sensing users
- Explosion of applications in the field of airborne LIDAR-Systems
- Decreasing costs for (some) data sets

- NEEDS:
  - Methods in heavily reliefed terrain
  - Methods for degradation monitoring
  - More synergetic applications including radar

...and a personal wish: Spaceborne LiDAR and PolInSAR L-band