Global Biomass Monitoring

DLR contribution and perspectives

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DLR Space Administration, Earth Observations
Three Pillars of German Earth Observation

International Cooperation
- bi-/multilateral
- CEOS
- GEO
- Int. Charter „Space and Major Disasters“

National Programme

European Programmes
Roadmap of national Missions

National Missions

- TerraSAR-X
- RapidEye
- TanDEM-X
- TET
- BIROS
- TSX-nG
- EnMAP MERLIN
- HRW-S
- METimage
- EnMAP-2

07 08 09 10 11 12 13 14 15 16 17 18 19 20
TerraSAR-X and TanDEM-X (1)

- **TerraSAR-X**
  - Launch: June 2007
  - National x-band radar mission
  - High-resolution radar data for scientific and commercial use
  - Public Private Partnership between DLR and EADS Astrium
<table>
<thead>
<tr>
<th>Mode</th>
<th>Swath Width</th>
<th>Resolution</th>
<th>Multi-Polarimetric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stripmap Mode</td>
<td>30 km</td>
<td>3 m</td>
<td>Yes</td>
</tr>
<tr>
<td>ScanSAR Mode</td>
<td>100 km</td>
<td>16 m</td>
<td>Yes</td>
</tr>
<tr>
<td>HR Spotlight Mode</td>
<td>5 km x 10 km</td>
<td>1 m</td>
<td></td>
</tr>
</tbody>
</table>

**Dual Receive Antenna Mode**
- Along-Track Interferometry, Moving Target Identification

**Images**
- Stripmap: Moderate resolution and swath width
- ScanSAR: Small, discontinuous scenes
- Spotlight: Low resolution
TerraSAR-X and TanDEM-X (3)

TanDEM-X – a second TerraSAR-X

- Launch: June 2010
- National SAR Interferometry Mission
- Extension of Public Private Partnership between DLR and EADS Astrium
- Primary mission goal: global high-resolution Digital Elevation Modell
- First full global coverage completed – necessary multiple coverages expected to be completed by mid 2013
It is intended to offer a global TanDEM-X DEM at a resolution of 90 m to scientific exploitation. Scientists are required to register to order this DEM.
TerraSAR-X and TanDEM-X (5)

Public Private Partnership between DLR and EADS Astrium Germany

**DLR**
- Project & Mission Management
- G/S Development & Ops
- System Engineering Support
- Science Coordination/Exploitation

**Astrium Geo-Information Services**
- Service Infrastructure
- Information Products
- Commercial Exploitation

Actual contribution to relevant international R&D programmes, such as GEO-FCT, JECAM
- FCT and JECAM sites are established as background mission
- Data access along DLR procedures

Potential contribution to operational programmes, such as GFOI and GEO-GLAM
- Framework to be developed
Direct forest biomass estimation using TerraSAR-X and ALOS Palsar

- Combination of two SAR instruments (TerraSAR-X and ALOS Palsar) allows an improved estimation of forest biomass up to 300 t/ha

- Calibration/validation of the model using forest inventory data and LIDAR based biomass estimates

- Published: Englhart et al. 2011, Remote Sensing of Environment

Biomass map, Sebangau catchment, Central Kalimantan, Borneo
TerraSAR-X Coverage of FCT Sites

45 sites observed
157 data takes available in the DLR archive.
StripMap Mode, dual polarized (HH/HV and VV/VH)
TerraSAR-X and TanDEM-X (5)

Health Status

Both satellites – TerraSAR-X and TanDEM-X – are in very good health.

Acquisitions

Acquisition over FCT validation sites
- High frequency acquisition in dual pol pairs over priority VS
- Dual pol over other VS

Future

- Continue/optimize acquisition over test sites (constrains with respect to TanDEM-X)
- Support scientific exploitation of data
- Continuity (TerraSAR-X NG) planned
RapidEye (1)

- Commercial initiative with DLR share
  - Five identical small satellites in one orbital plane
  - Nominal revisit time: 1 day
  - 5 spectral bands (Vis – NIR)
  - Spatial resol.: 6.5 m, Swath width: 78 km
  - Launch: 08/2008, operational since 02/2009
  - Nominal life-time: 7 yrs, good health status
  - Global Forest and Agricultural Monitoring among priorities of RapidEye
  - Data provision for scientific exploitation by DLR
    - Limited data volume

[Image of RapidEye satellites and Earth]
RapidEye  Global Coverage 2010
RapidEye  Global Coverage 2011
RapidEye: Monitoring forest degradation and illegal logging

- Improved monitoring of forest degradation due to the very high temporal and spatial resolution of the RapidEye System

Temporal progression of illegal logging activities in a peat swamp forest in Central Kalimantan, Borneo

Multitemporal assessment of illegal logging and forest degradation in Central Kalimantan, Borneo using RapidEye data

Funded by: DLR/RESA: 267
Data access for scientific purposes

- TerraSAR-X: DLR Science Service Seg.: [http://sss.terrasar-x.dlr.de/](http://sss.terrasar-x.dlr.de/)
- TanDEM-X (DEM) data access: [https://tandemx-science.dlr.de/](https://tandemx-science.dlr.de/)
  - Scientific proposals/proposer needed
- For GEO FCT/GFOI Validation Sites, COFUR costs are waived, CEOS coordination is in place
  - Scientific proposals/proposer needed, no costs, coverage limited
- Data also available through ESA Third Party Programme
EnMAP

- National Science Mission
- Mission objective: Research on ecosystem parameters (Vegetation, Geology, Water...)
- Cutting-edge Hyperspectral Imager, > 200 Channels, Vis/NIR & SWIR
- 30 m x 30 m spatial resolution
- Launch in 2016
EnMAP

EnMAP Sampling Areas

NASA MODIS image of Eastern Angola 26 April 2003

Forest Biochemistry: Canopy Reflectance Models
Forest Structure: Multiple Spectral Mixing Models
Forest Species: Advanced Classification Algorithms
Forest Resources: Robust Biomass and Timber Volume Estimators

2002

1994

Optimized Assessments of Forest Degradation through Specific Hyperspectral Imaging Capacities

„The Future Okavango“
Mapping Forest Degradation with Advanced Spectral Unmixing Concepts Efficiently Builds on the Hyperspectral Information Content

\[ F = A^{-1} \cdot R \]

Unmixing and RMS Calculation

If \( n_{EM} > 1 \) then repeat with reduced pixel EM set

Remove EM with \( F_{min} \) (pos or neg)

Output EM Abundance Image

Pixel EM Abundance

Reduced Pixel EM Set

Continue to next pixel

EnMAP Hyperspectral Imager

EnMAP