EnMAP – Environmental Mapping Programme

The German hyperspectral mission, its obcetives and potential contributions to forest monitoring and REDD

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DLR

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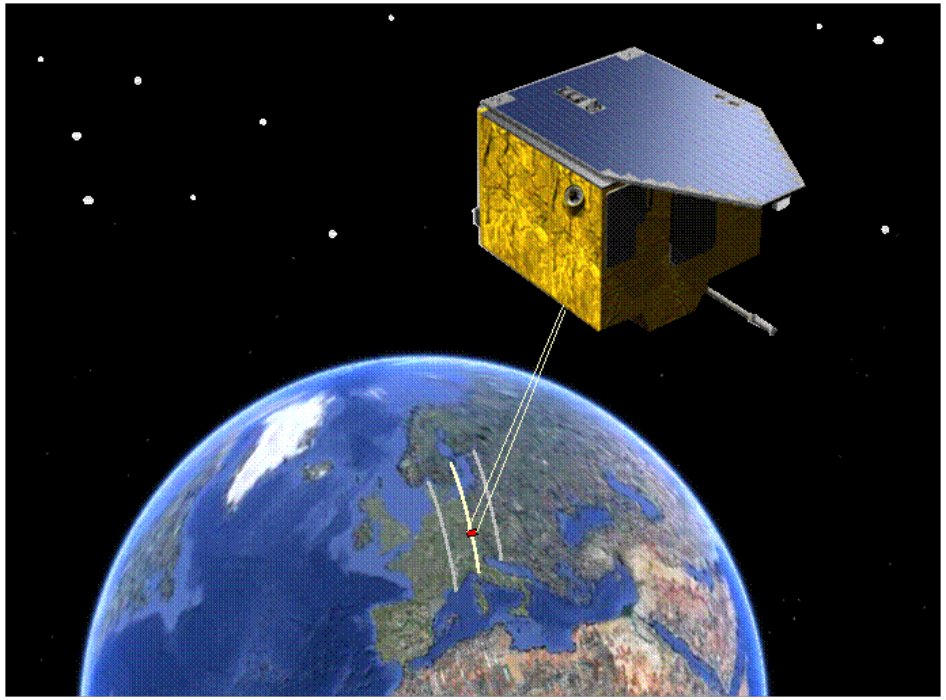
- Mission overview
- Hyperspectral vs. multispectral
- Applications
- Contributions to Forest Ecosystem analysis and REDD
- Outlook

EnMAP – Environmental Mapping Programme



- EnMAP is Germanys first hyperspectral mission
- EnMAP is a scientific ‘Path finder mission‘ for later operational services, based on hyper spectral data sets
- It is funded by the Ministry of Economics and Technology

Project organization

Scientific Principal Investigator
GFZ

EnMAP Core Science Team
GFZ, DLR, HU Berlin, Uni Trier, LMU Munich, GKSS

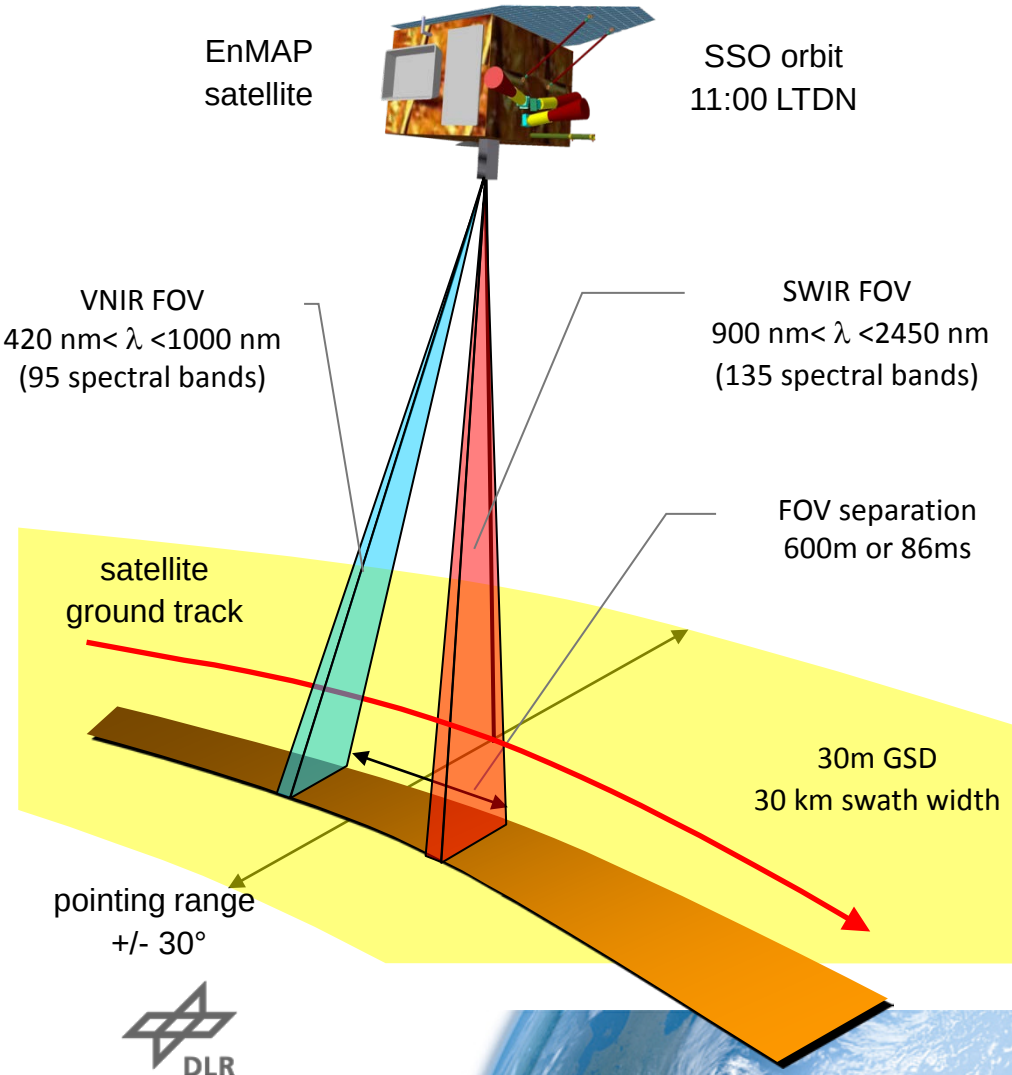
Project Management
DLR Space Agency

EnMAP Space Segment
Satellite: *OHB*
Instrument: *KT*

Science Advisory Group
EnSAG

EnMAP Ground Segment
DLR
DFD *IMF* *GSOC*

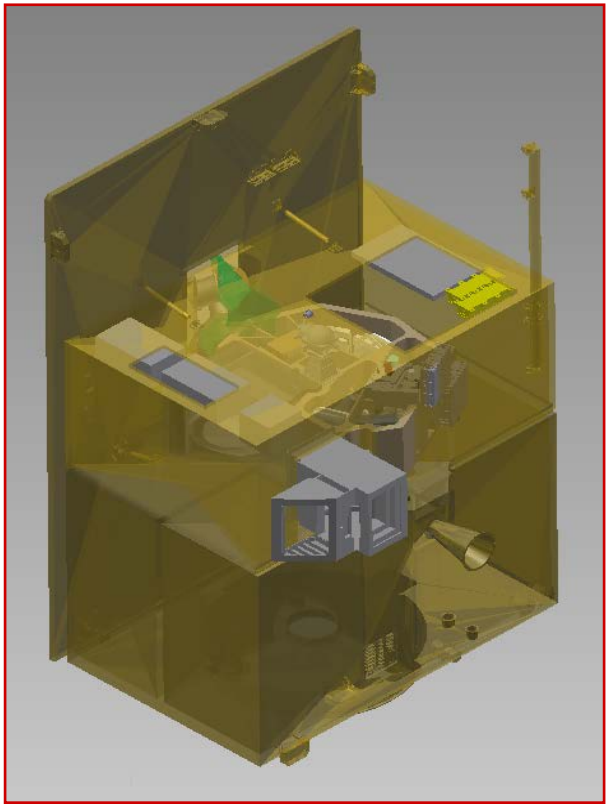
EnMAP – mission characteristics

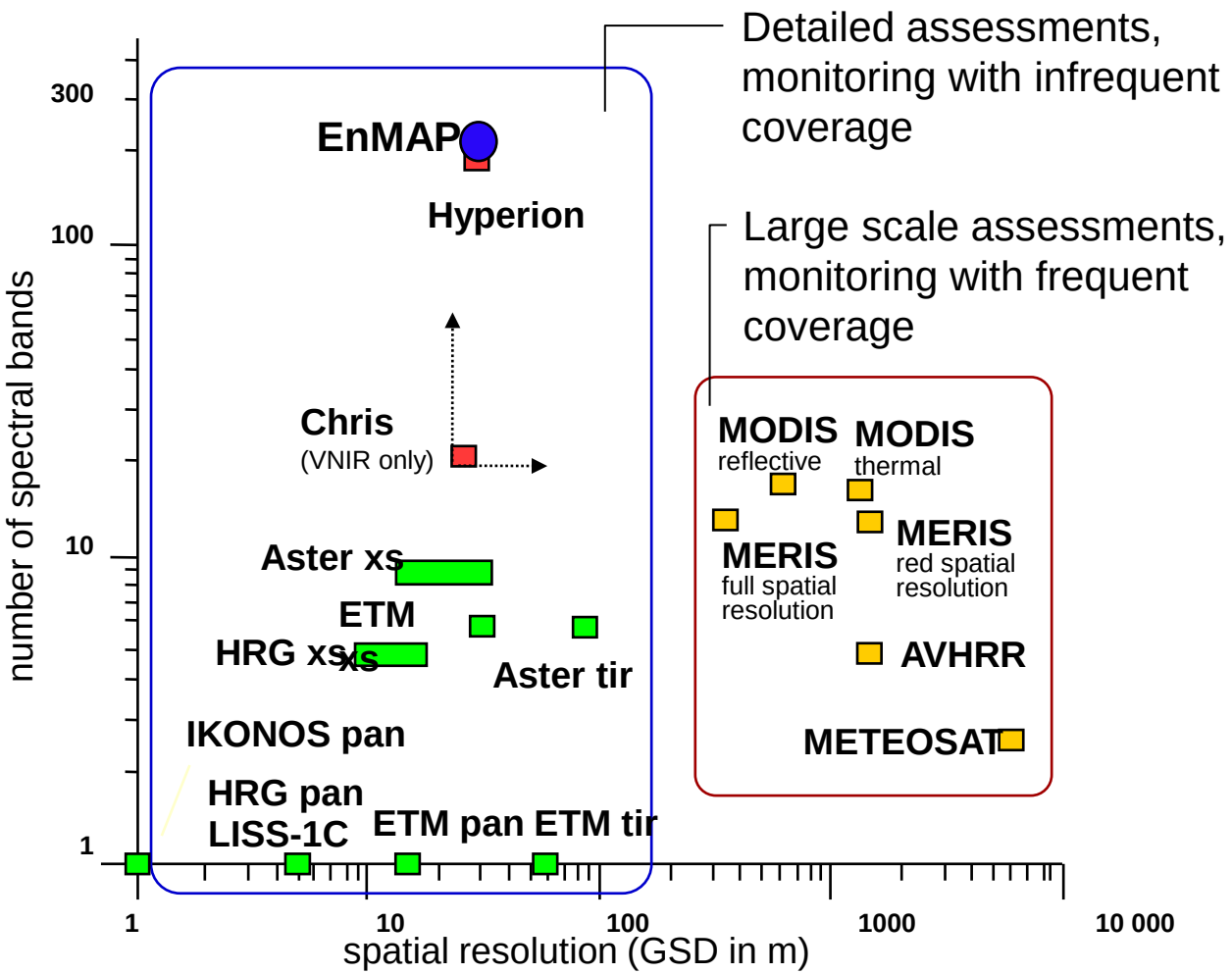


- 234 spectral bands
- Spectral range from
  - 420 nm to 950 nm (VNIR)
  - 950 nm to 2450 nm (SWIR)
- Swath width 30 km, GSD 30 m
- ± 30° off-nadir pointing

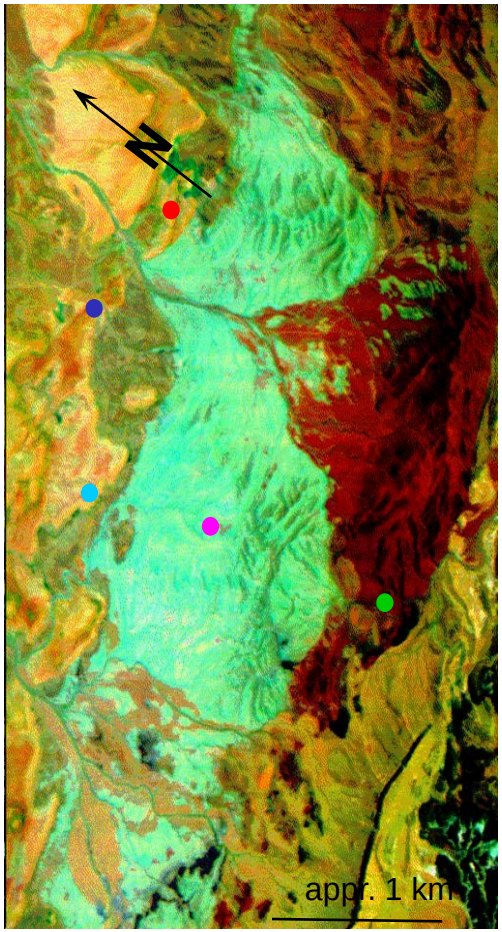
- global accessibility
- target revisit capability
  - 4 days ± 30 deg off-nadir
  - 21 days ± 5 deg off-nadir
- up to 50 data takes per day / total length 5000 km
- 5 years mission lifetime

EnMAP in Comparison with other optical missions



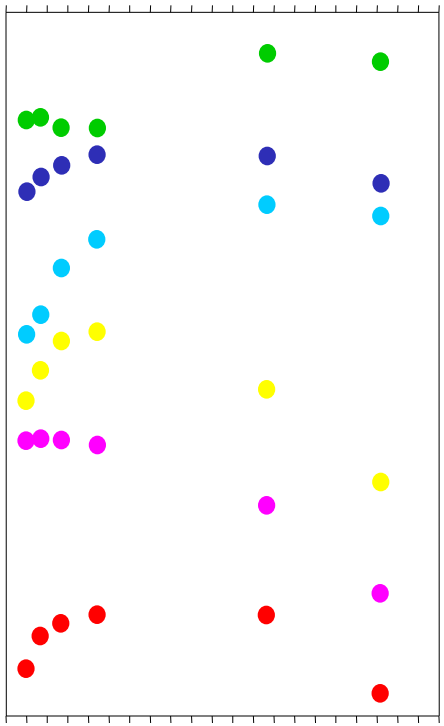


Multi- vs Hyperspectral potentials



Makhtesh Ramon
Farbdarstellung der Bänder 1, 20, 48

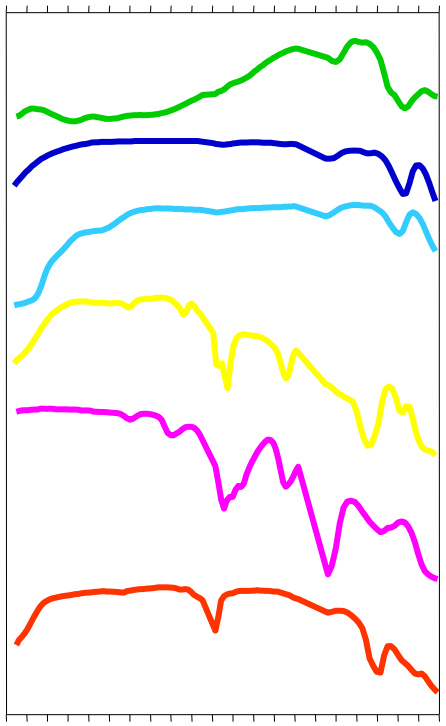
Multispectral



Few fixed Bands

- minimum Identification
- Field knowledge and lab analysis necessary
- Low confidence

Hyperspectral

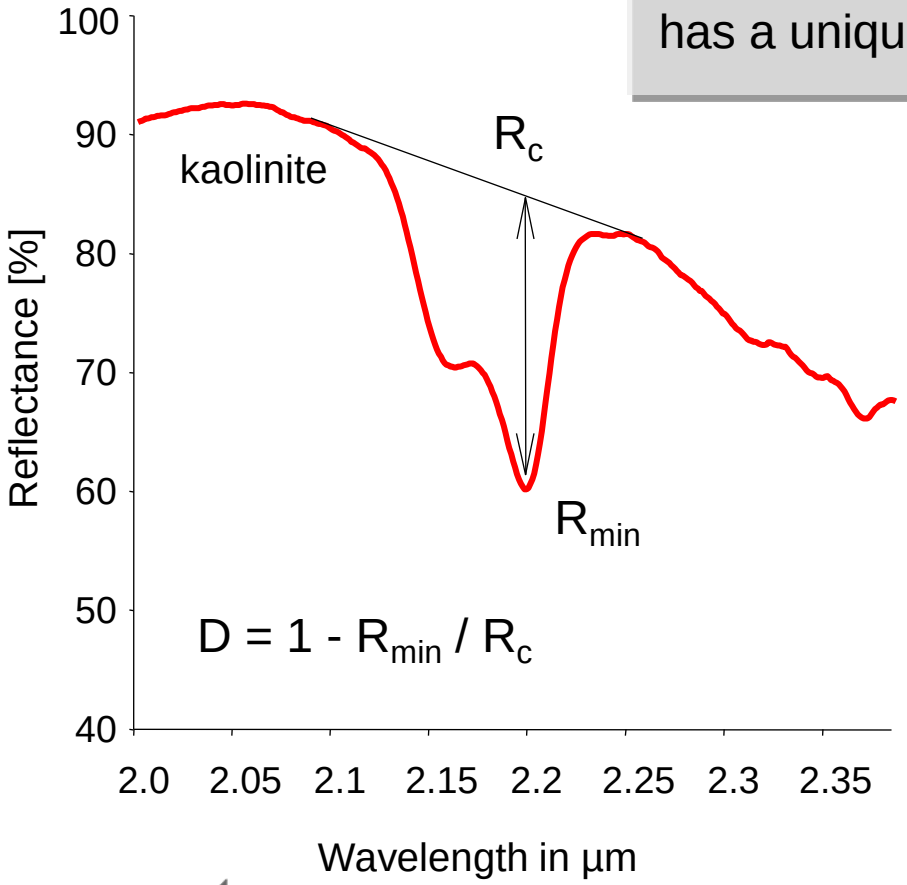


Continous Bands

- maximum Identificiation
- Increased classification accuracy
- High confidence

Identification / Quantification → Diagnosis

Each material on the Earth's surface has a unique spectral characteristic



Individual Absorption

of Pigments, Minerals, man made objects

Shape
Position
→ Identification

Depth → Quantification

Overall Mission Goals

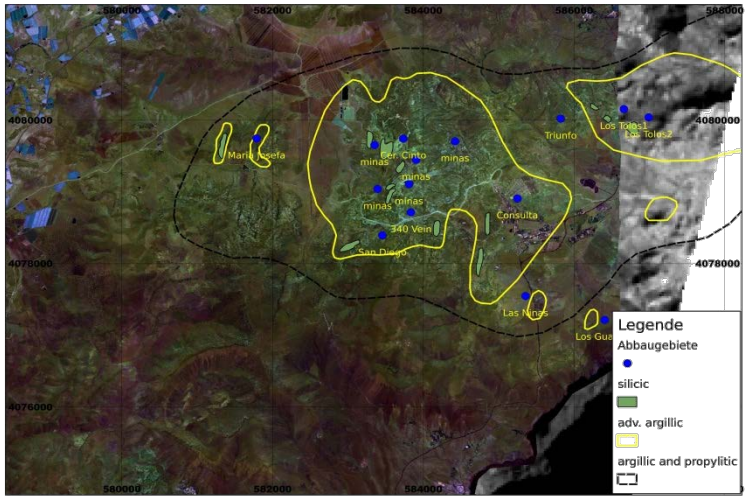
- To provide high-quality calibrated data and data products to be used as inputs for improved modeling and understanding of biospheric /geospheric processes

- To observe a wide range of ecosystem parameters encompassing agriculture, forestry, soil/geological environments and coastal zones/inland waters

- To extend the scientific and technical know-how, based on airborne hyperspectral sensors enabling operational services and contributing to international programmes, e.g. GMES and GEOSS

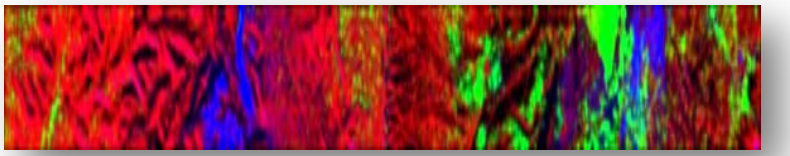
Lithosphere: Geology

- Develop expert systems for **mineralogical mapping** with emphasis on waste deposits, alteration zones and index minerals of metamorphic zonations;
- Quantitatively estimate the influence of external (weathering crusts, lithobionts) and internal (organic matter, opaque accessory minerals) parameters on the spectral signature of rocks and soils – creation of **pedo-transfer functions**;
- Investigate the effects of mineral-induced stress on the spectral signature of dense vegetation canopies to establish a link between **vegetation stress** and specific mineralisation
- Develop geospatial tools and integration techniques for sustainable **mine site management**.



Gold mining sites Rodalquilar Caldera; Spain; HyMAP, Hyperion; Geology after Arribas (1989)

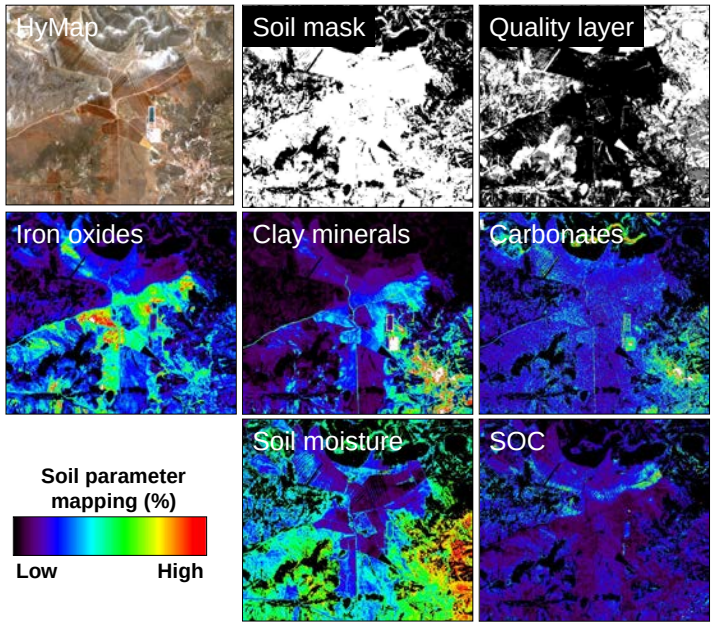
Hyperspectral image



L3-Product: abundant minerals (red-carbonates, blue – epidotes, green-clays

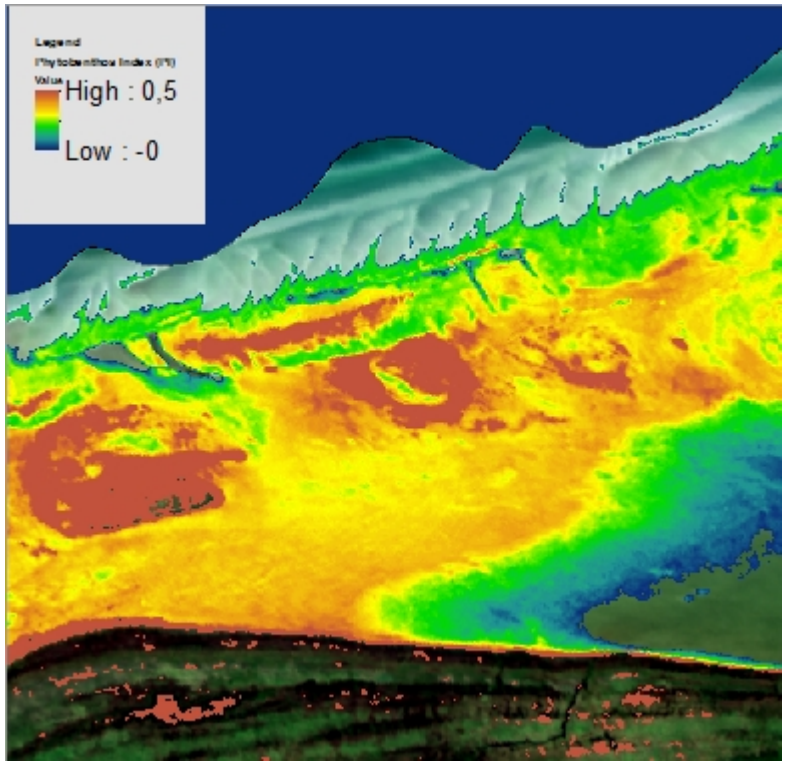
Pedosphere: Soils

- Monitor **land degradation processes** (erosion and deposition) by providing regular maps of soil status such as organic matter (TOC), $CaCO_3$, iron content, infiltration rate, salinity, and physical crusting development;
- Calibrate remote sensing-based **soil condition indices** against soil reference samples to better link spectral parameters with soil development models;
- Identify and quantify various **soil contaminants** through their specific spectral signatures or indicators (e.g., bio-indicators based on eco-toxicological effects on vegetation) linked to change in chemical composition of the polluted soil;
- Develop new algorithms and optimisation of existing modelling approaches for mapping coherent **indicators of the erosional state of soils.**



Hydrosphere: Coastal Zones, Inland Waters

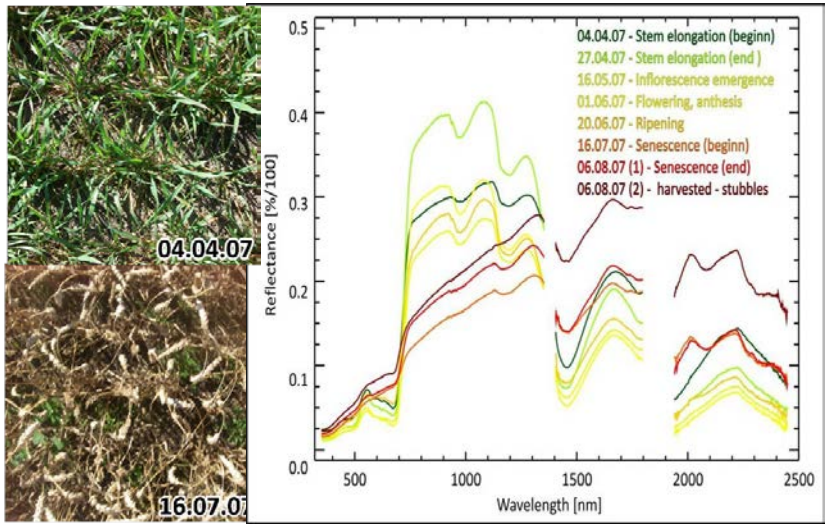
- Improve **quantification of water contents**, e.g. chlorophyll, differentiation between different phytoplankton groups, dissolved organic compounds, fractions of suspended mineral and organic particles;
- Monitor and analyze the variety of **algal species** esp. potentially toxic algal blooms in space and time as a bio-indicator of changing lake ecology;
- Estimate processes such as **primary production** in inland and coastal waters and **suspended matter transport** and its impact on coastal ecosystems;
- Monitor the **distribution of sediments** in tidal flats and their phytobenthos, wetlands, mangrove forests and submerse and emerse macrophytes distribution;
- Monitor **coastal erosion and changes in coastal morphology;**

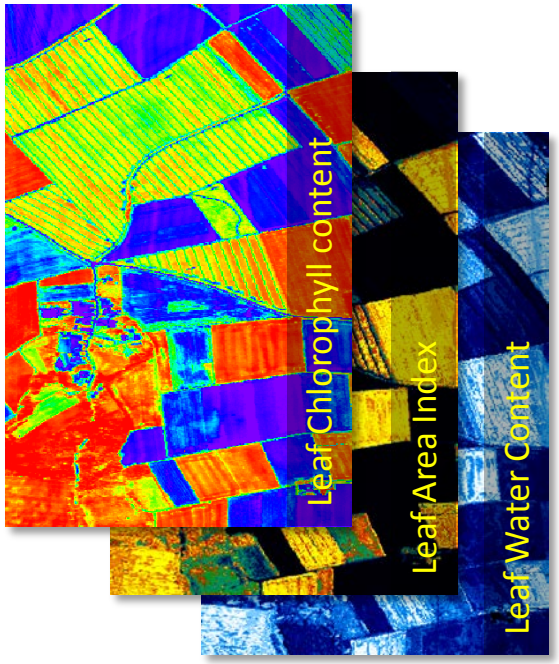


Windwatt - Map of Phytobenthos Distribution

Biosphere: Agriculture

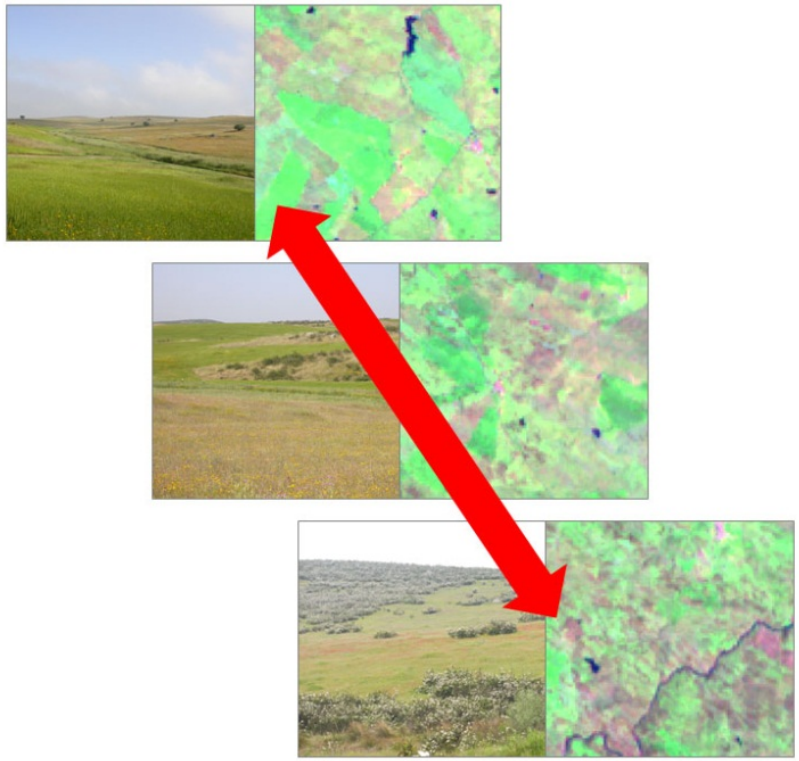
- Improve **crop parameter retrieval** (crop type, LAI, APAR, chlorophyll content, plant water content, canopy geometrical structure);
- Develop methods for **quantitative mapping of soil parameters** for precision farming;
- Map crop species distribution using spectro-temporal information content;
- Improve discrimination of **crop stress** caused by nitrogen deficiency, crop disease, insect infestation, water stress, and chlorosis; and
- Develop operational methodologies for **yield and biomass estimation and forecasting** based on EnMAP and ancillary data.





Biosphere: Ecosystem gradients

- Monitoring of the spatial pattern of **ecosystem and diversity distributions**
- Investigating the effect of climate change and other anthropogenic and non-anthropogenic forces on **global vegetation gradients**
- Assessing the **above ground carbon sequestration potential** of ecosystems,
- Retrieving of biochemical and biophysical parameters as input in **ecosystem models**

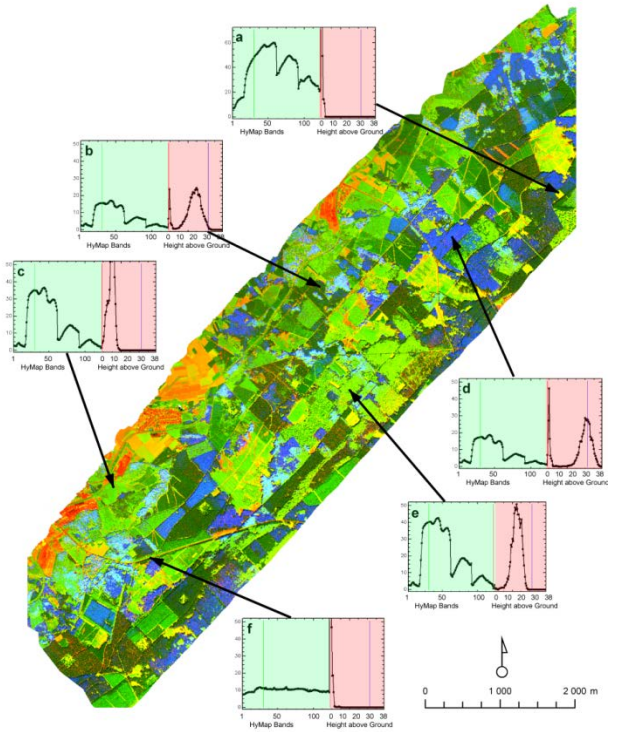


Forest ecosystems analysis

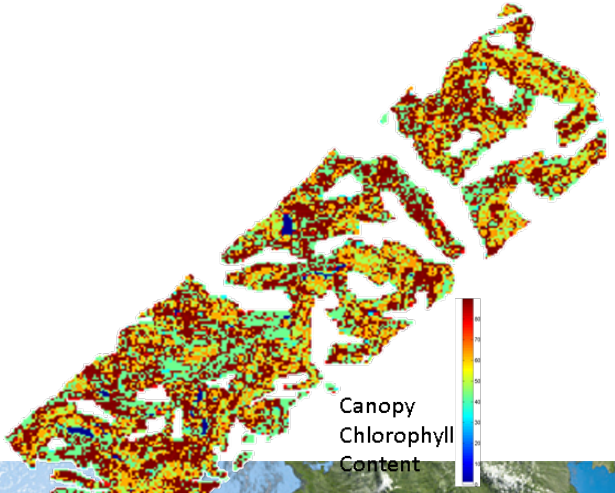
Development methods for modelling the biophysical description of forest structure

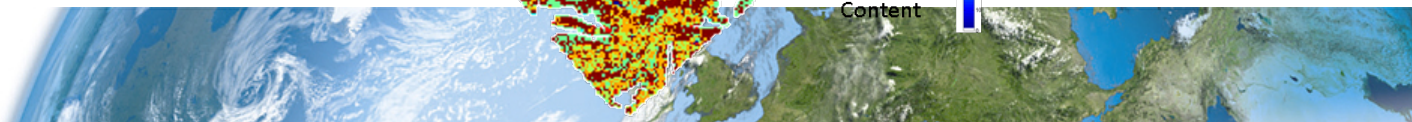
In combination with well-characterised ground data, EnMAP will allow comprehensive mapping of

- Tree species and age classes
- Leaf Area Index and Biomass
- Water and Chlorophyll content
- Timber volume

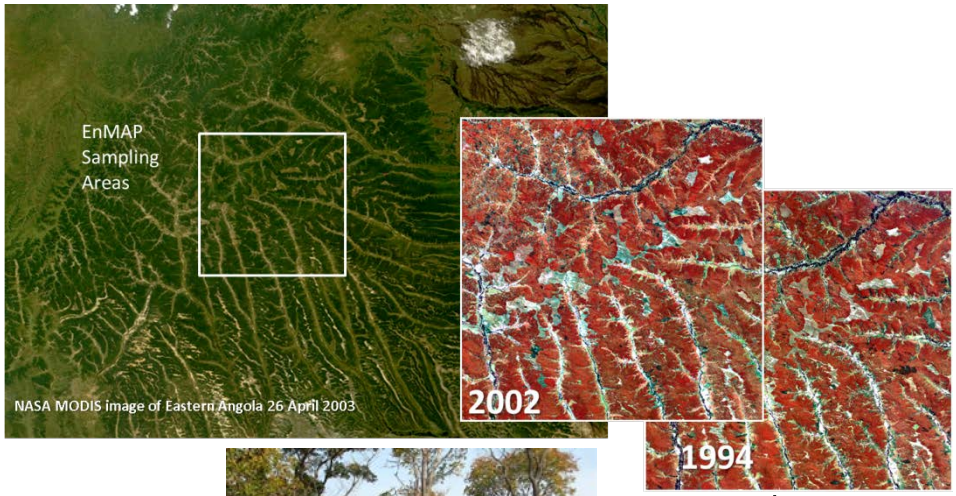


Development of biomass models based on combined lidar-hyperspectral datasets

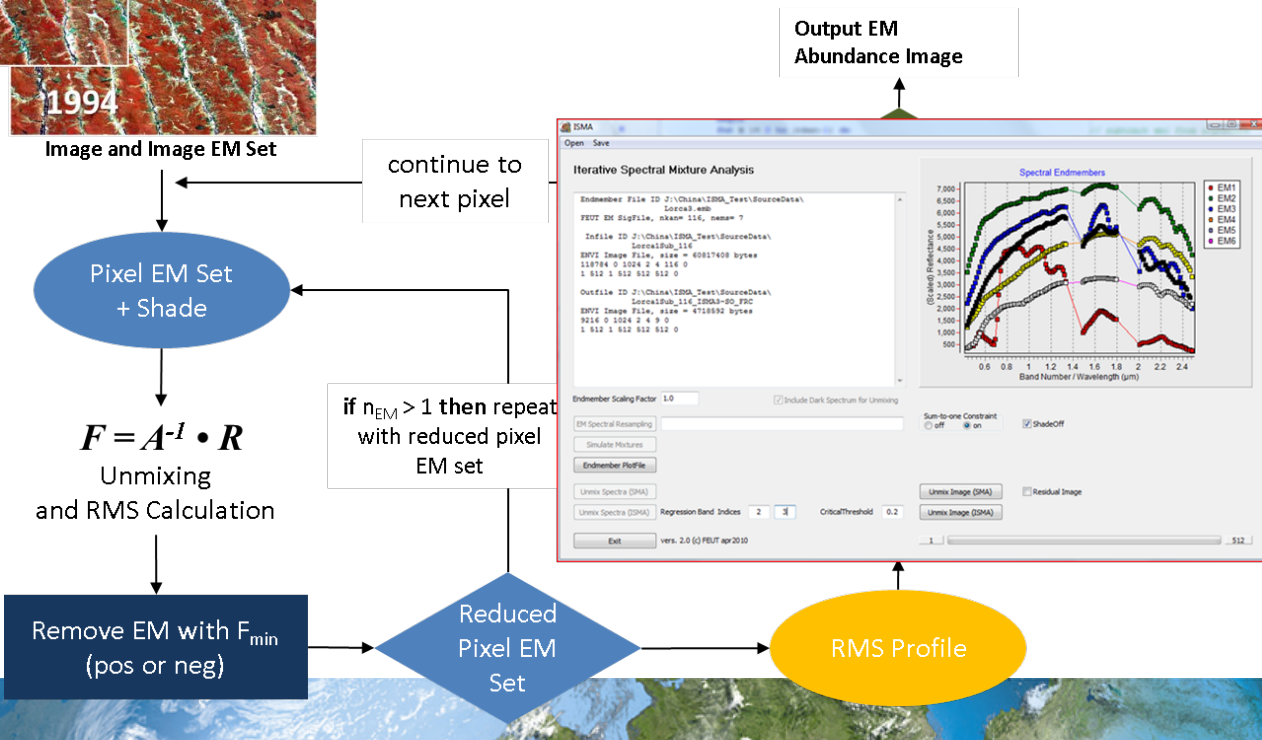




Mapping Forest Degradation



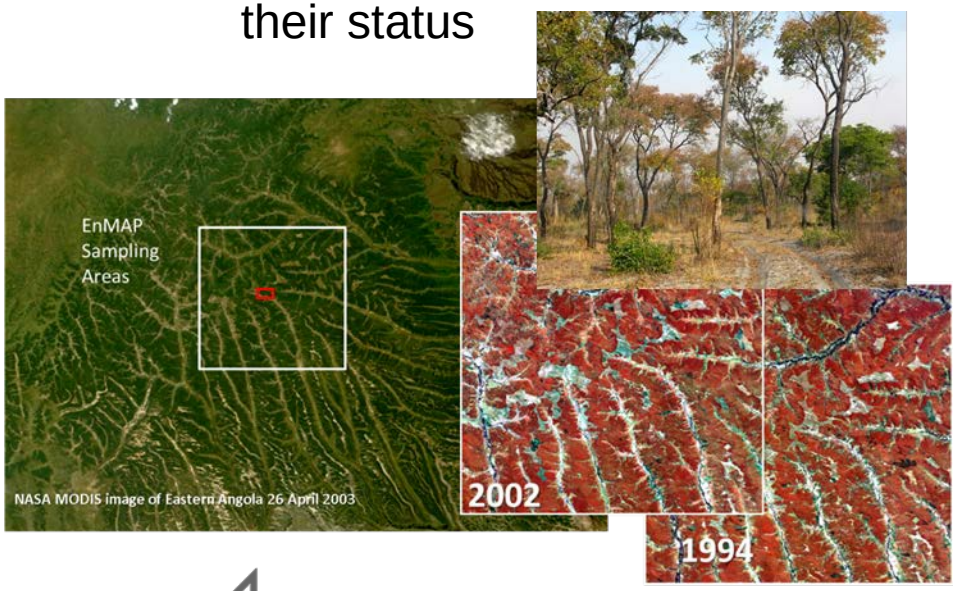
Optimized Assessments of Forest Degradation through advanced unmixing concepts for analysis of abundance of different vegetation and soil cover

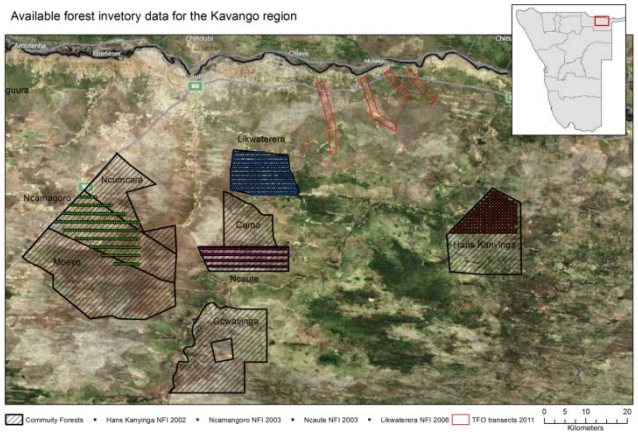


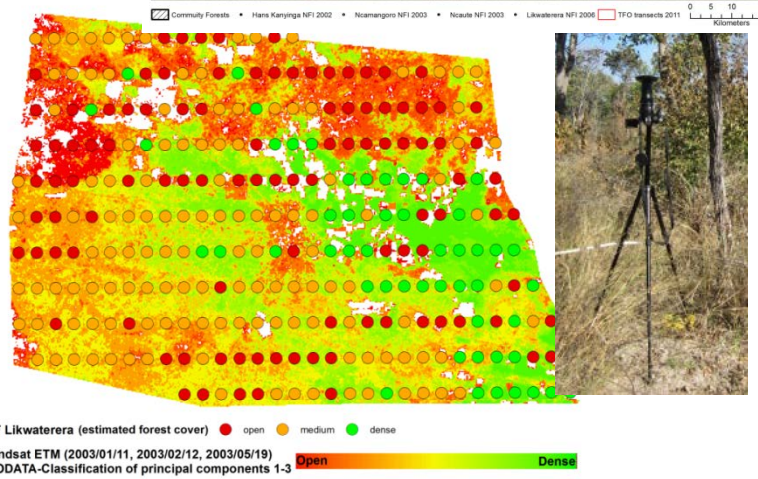
Retrieval of REDD- relevant parameters

Through its global aquistion capacity the EnMAP mission will support the

- Identification and characterisation of representative forest types
- Upscaling with large area coverage of multispectral EO data allows better analysis of spatial distribution of different forest types and their status







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Thank you!