Copernicus programme and Services: opportunities for the agriculture and forestry sectors

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Prague, 10/05/2016

European Commission

COPERNICUS

European Commission

"The Union Earth observation and monitoring programme"

Protect people and assets

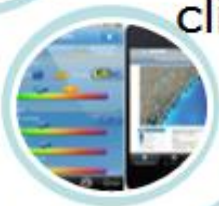
Increase general knowledge on the state of the Planet

Monitor the environment

Improve environmental policy effectiveness

Facilitate adaptation to climate change

Foster downstream applications in a number of fields



Help managing emergency and security related situations

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Copernicus timeline

2014
Start of Copernicus full operations phase

2013
EC proposed Copernicus Regulation Delegated act on Copernicus Data Policy

2012
GMES renamed "Copernicus"

2011
Start of GMES Initial Operations (GIO) phase

2008
EC - ESA agreement on GMES signed.
GMES services presented at Lille Forum

1998
Baveno Manifesto
(first reference to Global Monitoring for Environmental Security)

2005
GMES flagship of EU Space Policy
ESA approves GMES Space Component Programme

2006
EC dedicated unit (GMES Bureau) in charge of Programme development and implementation

2001
Gothenburg EU Summit
(first EC involvement in establishing European capacity for monitoring the environment from space)

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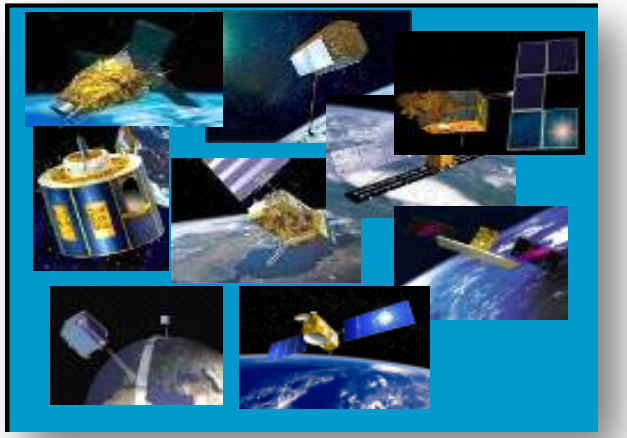
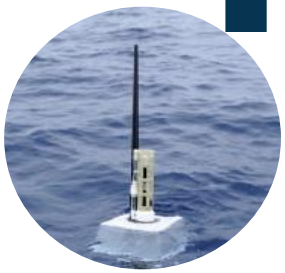
6 services use Earth Observation data to deliver …



Sentinels

Contributing missions



in-situ

…added-value products

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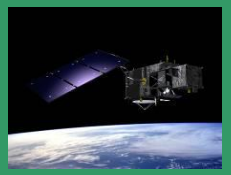
Each Sentinel is technically different to meet the needs of the COPERNICUS services

Sentinel 1 – Radar imaging
All weather, day/night applications

Sentinel 2 – Optical imaging
Land applications: urban, forest, agriculture,..



Sentinel 3 & 6 – Ocean and global land monitoring, high precision ocean altimetry

Sentinel 4 & 5 – Atmosphere composition monitoring, from a geostationary (-4) and a polar orbit (-5)

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Services monitoring Earth Systems

Land

Marine

Atmosphere

Horizontal services

Emergency

Security

Climate Change

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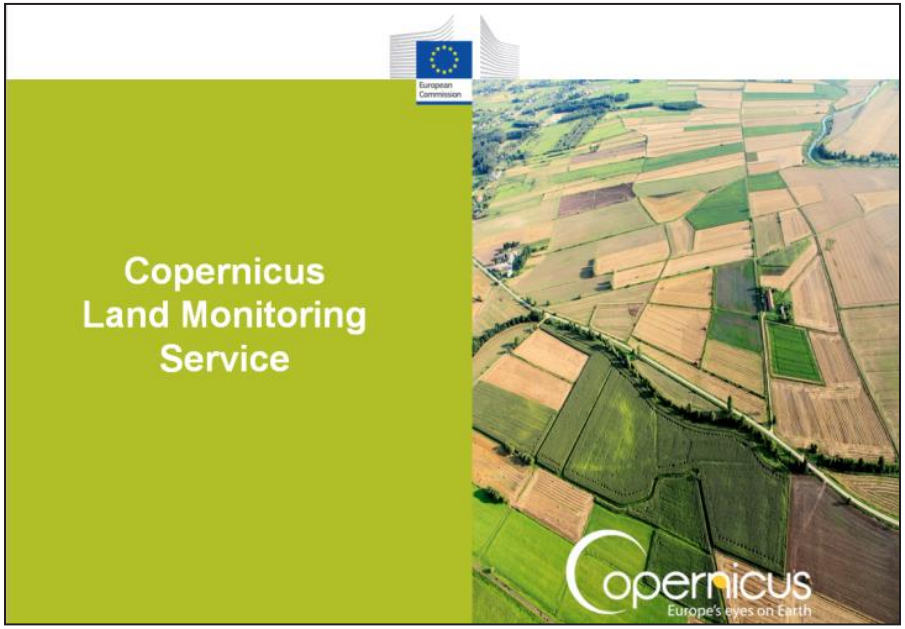
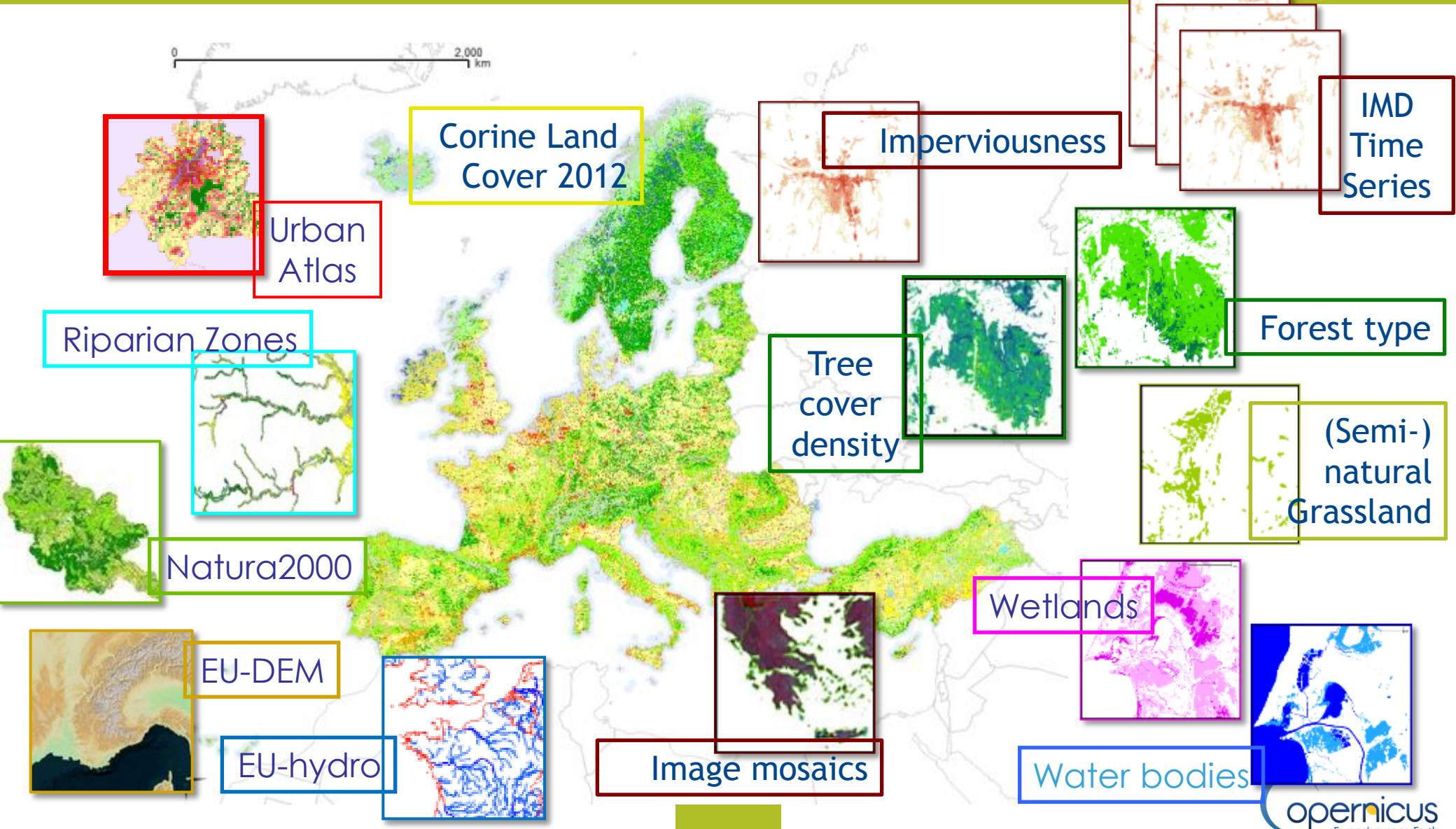


- Pan-European land component
- Local land component

- Global land component

Portfolio

European Commission



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CORINE Layer

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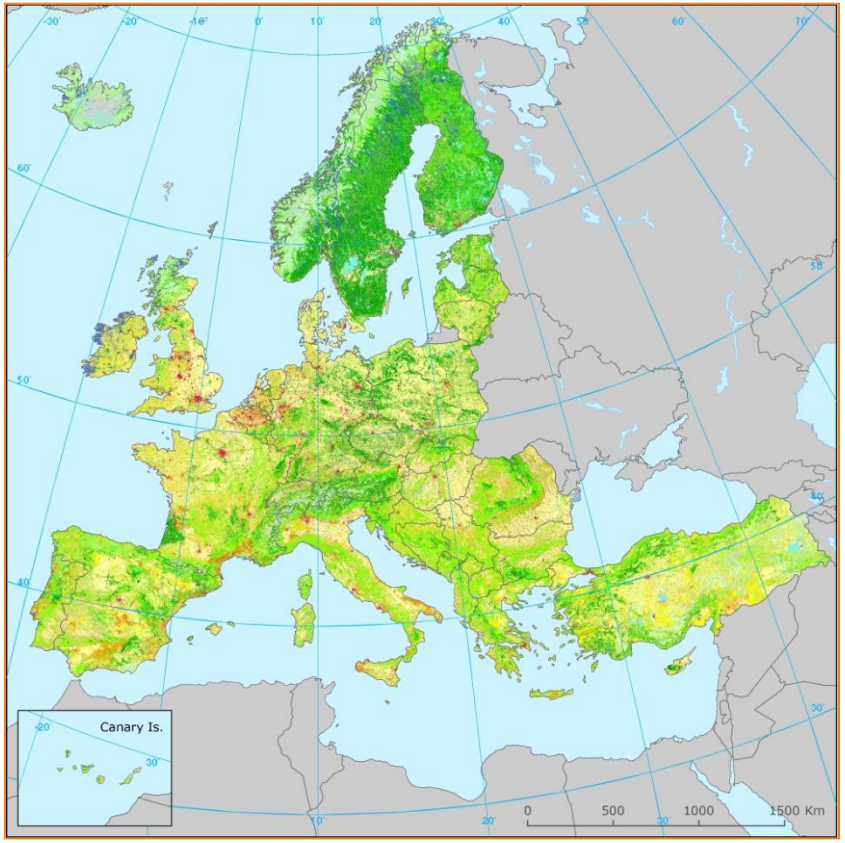
CORINE Land Cover



- Mapping ~permanent surface features at scale 1:100.000 based on physical characteristics (changes > 1 year)
- MMU: 25 ha (5 ha for changes); MMW: 100 m
- Nomenclature: 5 main groups, three levels, 44 level-3 LU/LC classes (representing Europe)
- Basic data support: satellite imagery
- Ancillary (in-situ) data: national ortho-photos, topographic maps, VHR imagery…
- Implemented by national teams
- Inventories: 1990, 2000, 2006, **2012**

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High Resolution Layers

European Commission

Imperviousness

Degree of Imperviousness 2012 (20 m and 100 m)	Degree of imperviousness, values from 1-100 %
Impervious density change 2009-2012 (100 m)	Mapping degree of change over time, values from -100 to +100 %

Forest

Tree cover density (20 m and 100 m)	Tree cover density, values from 1-100 %
Forest Type (20 m and 100 m)	Mapping dominant leaf type: coniferous and broadleaved

Natural and semi-natural grassland

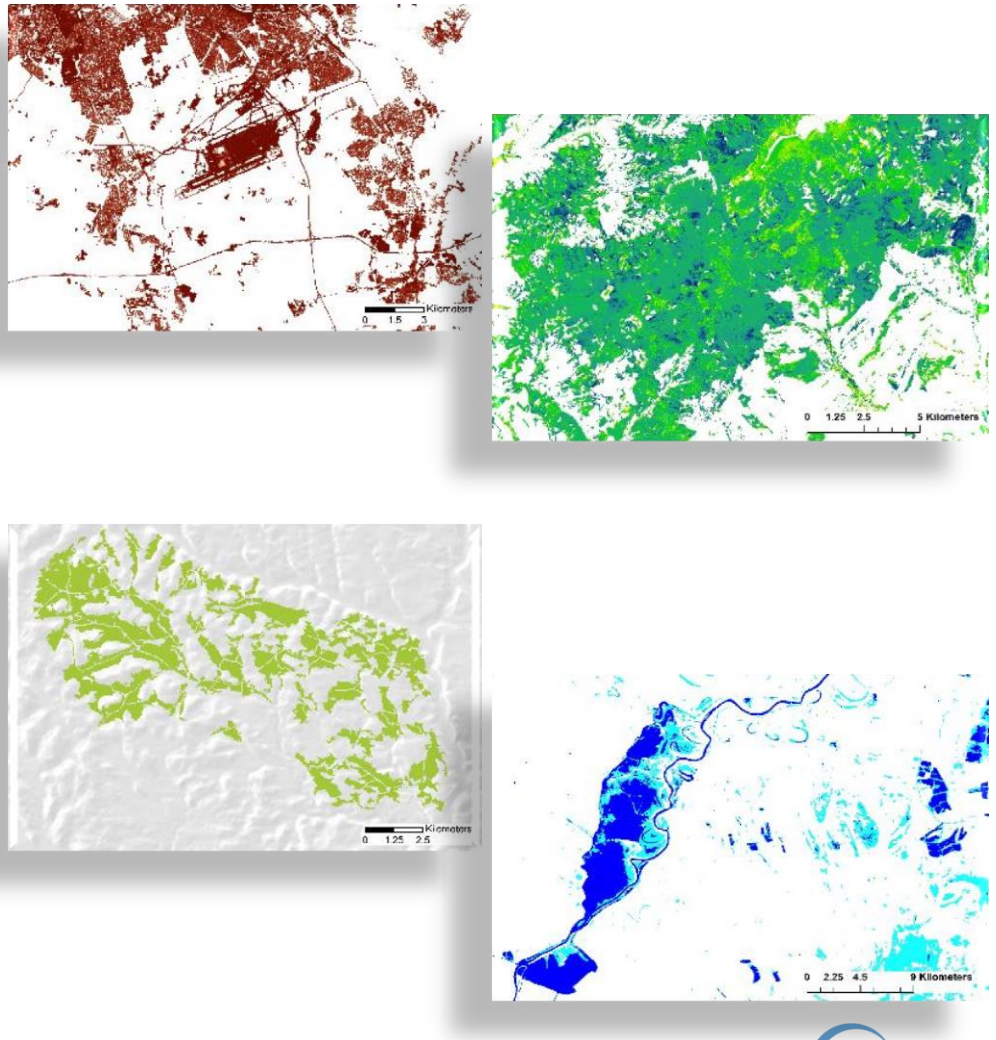
Natural and semi-natural grassland (20 m and 100 m)	Mapping natural and semi-natural grassland

Wetlands

Wetland (20 m and 100 m)	Mapping wetlands

Water bodies

Permanent water bodies (20 m and 100 m)	Mapping permanent water bodies, including small water bodies



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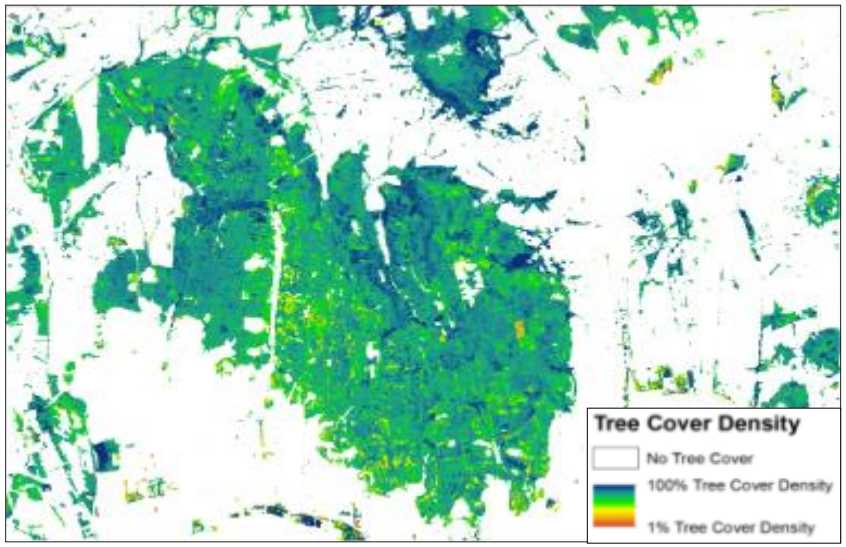
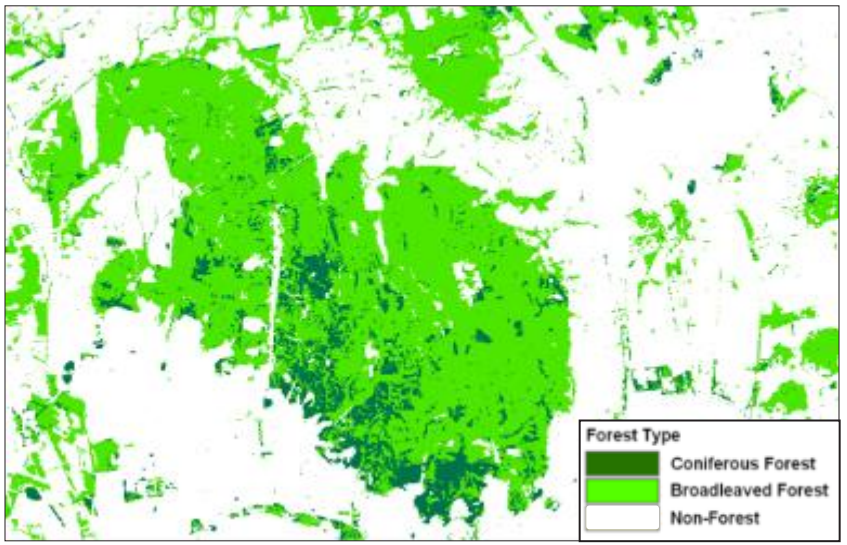
Hungary

Tree Cover Density (TCD) (20m, 100m)



- No MMU (pixel resolution)
- Min. Mapping Width: 20m
- TCD range: (1)-100%
- Includes orchards, olive groves, trees in urban context, etc.

Dominant Leaf Type (20m) Forest Type (FTY, 100m)



- MMU: 0.5 ha
- Min. Mapping Width: 20m
- TCD threshold: ≥10%-100%
- Support Layer (non-forest trees)
- 100m prod. excludes orchards, olive groves, trees in urban context, etc.

Local land

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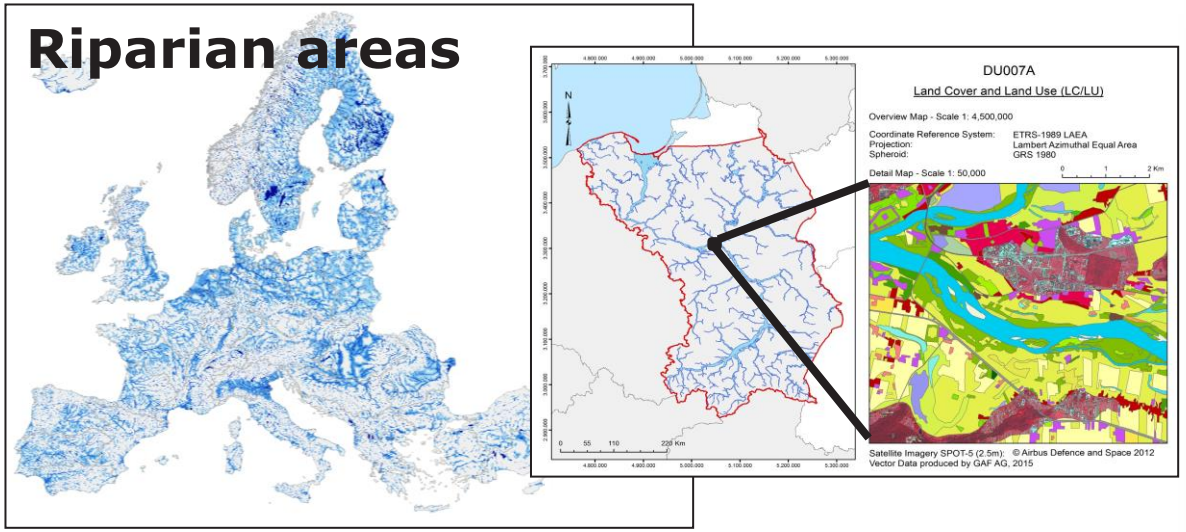
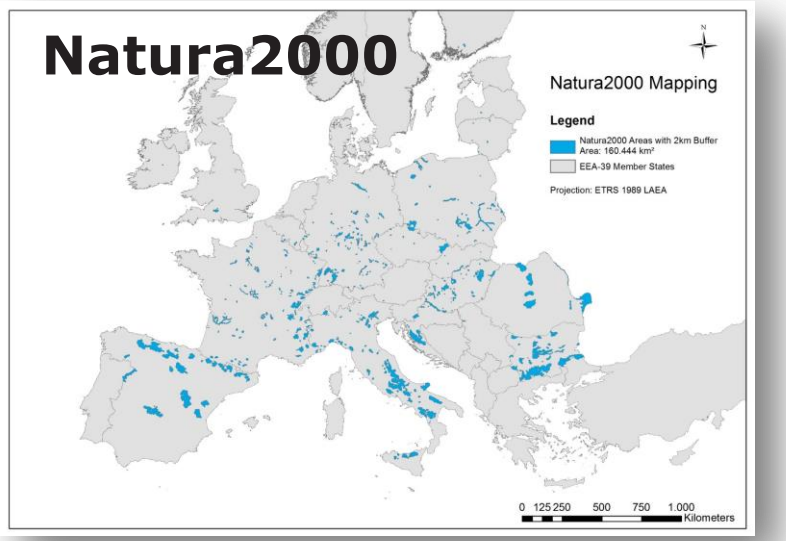
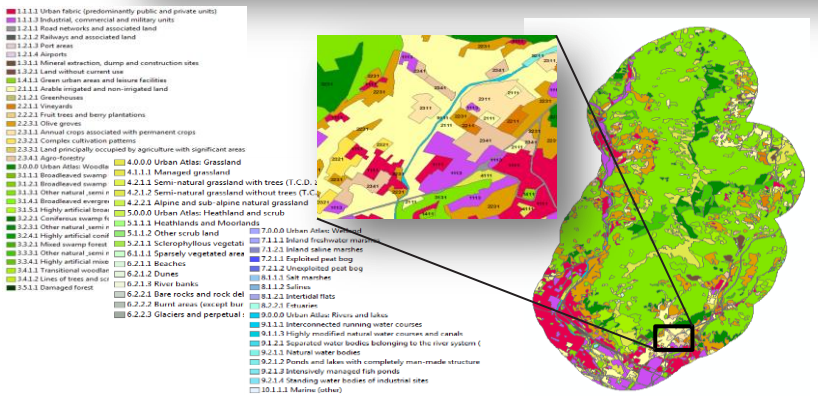
Riparian areas



Natura2000





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Dissemination

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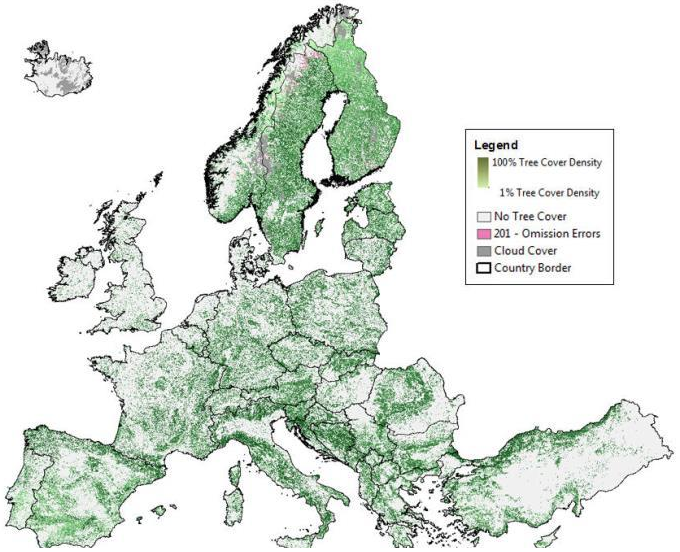
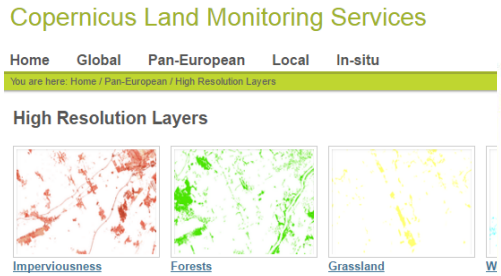
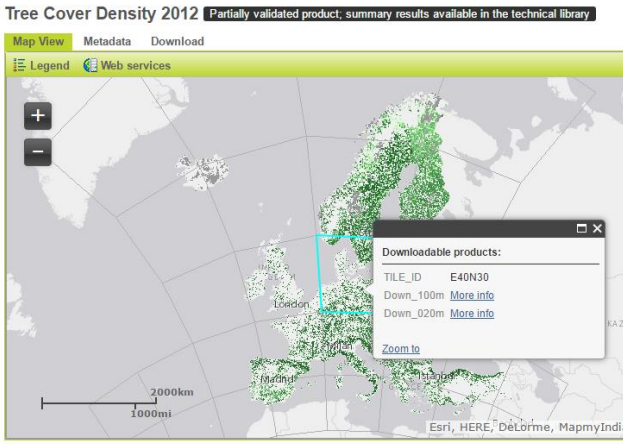
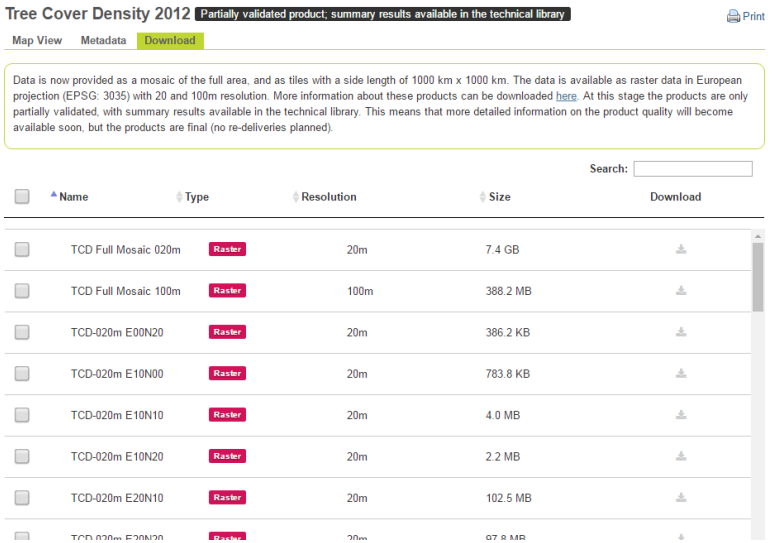


- **All products**, 20m and 100m pixel size **available for download**
- Semi-natural and natural grassland (NGR) available
- **Final semantic checks** all finished successfully
- **Partial validation** results available in “technical library” section







Global land

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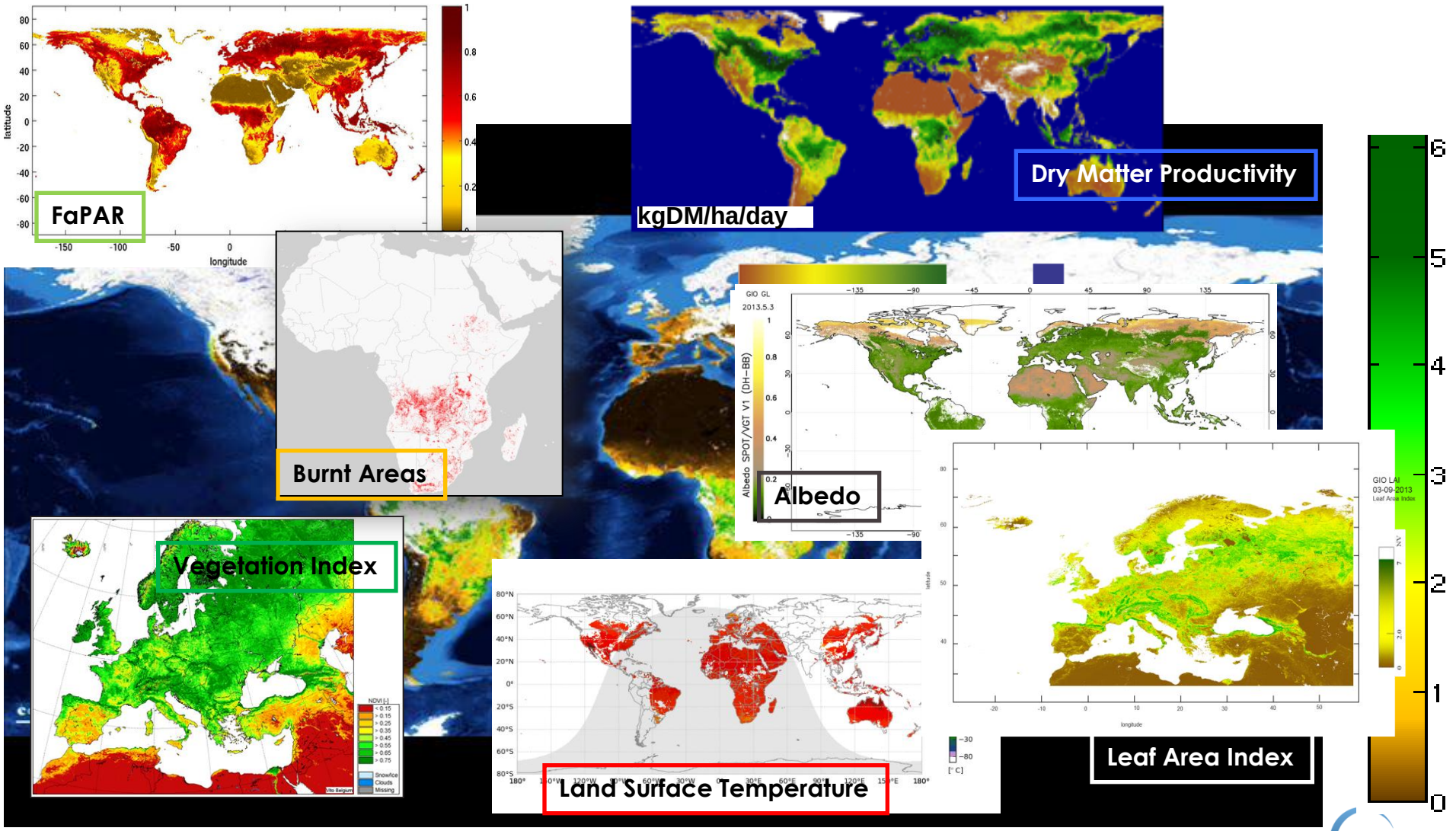

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WP 2017 Portfolio

European Commission

Objective : Global Systematic Monitoring Service

29 products (vegetation-energy-water-snow) providing a picture of the world every ten days

Product Family	Product (Variable) Full name	Acronym
Vegetation	Leaf Area Index	LAI
	Fraction of absorbed photosynthetically active radiation	FAPAR
	Fraction of vegetation cover	Fcover
	Normalized Difference Vegetation Index	NDVI
	Vegetation Condition Index	VCI
	Vegetation Productivity Index	VPI
	Greeness Evolution Index	GEI
	Dry Matter Productivity	DMP
	Phenology metrics	PHENO
	Evapotranspiration	ET
	Radiation fluxes	
	Global Land Cover	GLC
	Active Fires	AF
	Burnt Areas	BA
Energy Budget	Top Of Canopy Reflectance	Toc-R
	Surface Albedo	SA
	Land Surface Temperature	LST

Product Family	Product (Variable) Full name	Acronym
Water	Surface Soil Moisture	SSM
	Soil Water Index	SWI
	Water Bodies	WB
Snow	Snow water extend	SE
	Snow water equivalent	SWE
Lake	Lake ice coverage	
	Lake surface water temperature	
	Lake and river water level	
	Lake surface reflectance	
	Lake turbidity	
	Lake trophic state	
Coastal	Erosion	

Resolution from 1km to 300m

PROBA V and SPOT VGT satellite sensors

ARCHIVE time series and NRT production

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Products Uptake

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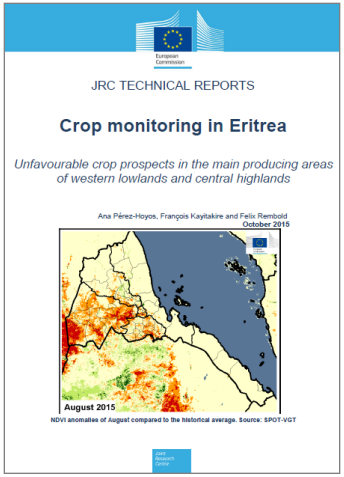
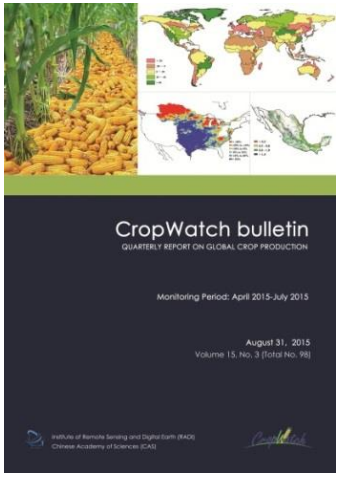
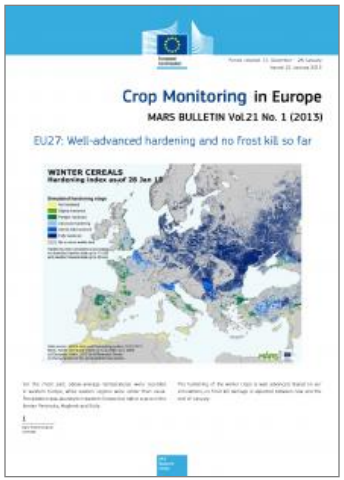
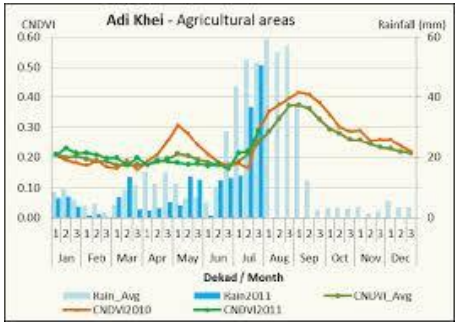
Agriculture

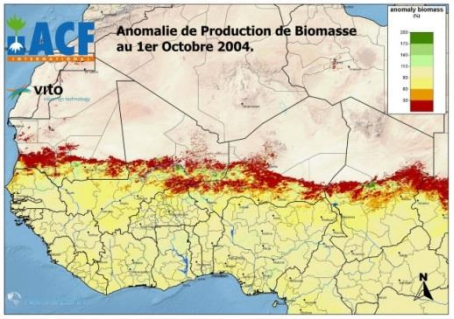
- Crop monitoring
- Yield forecasting
- Rangeland monitoring











Some agriculture users (from our download records) :

- INRA France, FAO, WFP, MESA (AUC-Africa), Action Contre la Faim (NGO), CONAB Brazil, EMBRAPA Brazil, MARS JRC, Chinese Academy of Agricultural Sciences, INRA Morocco, SRI Ukraine, Wageningen University, ISRO India, ARC South Africa, CIRAD France …

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Dissemination

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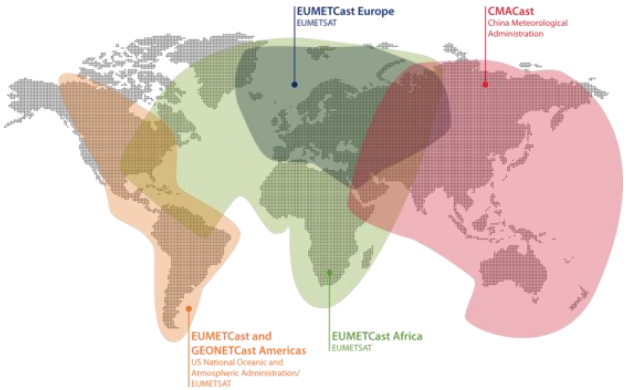
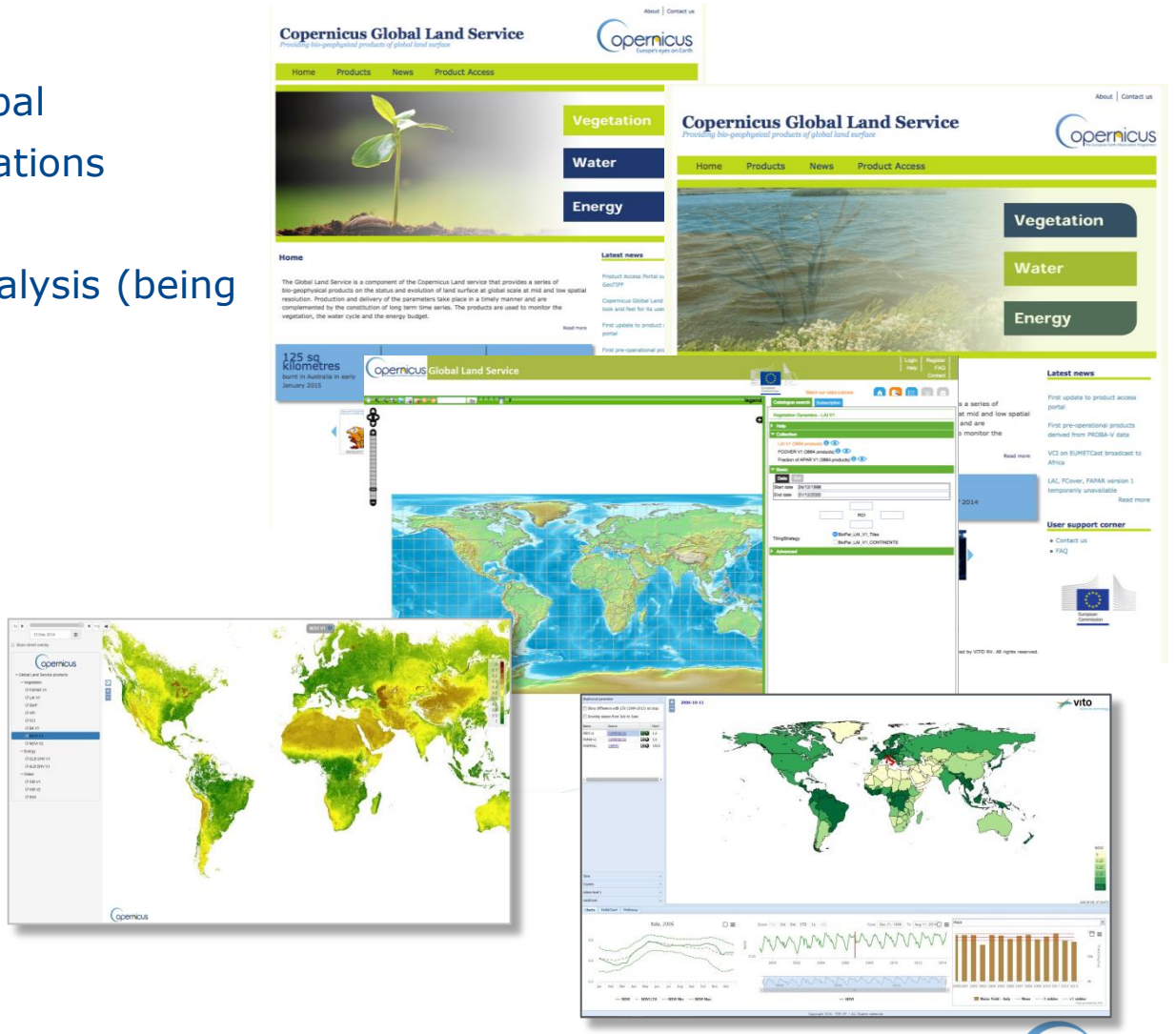
- Http://land-copernicus.eu/global
- EUMET cast – GEONET cast stations
- Free and open product access
- On line product time series analysis (being implemented)





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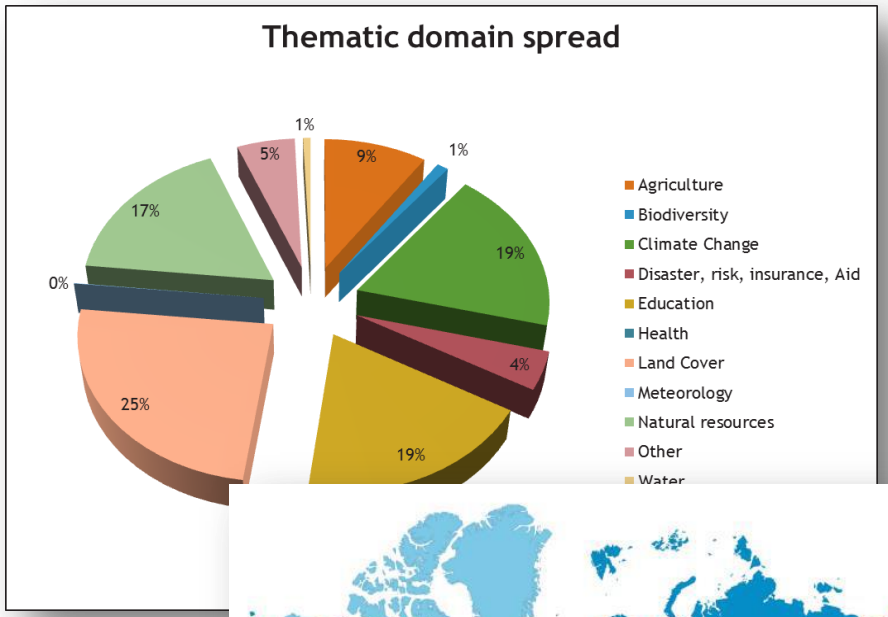
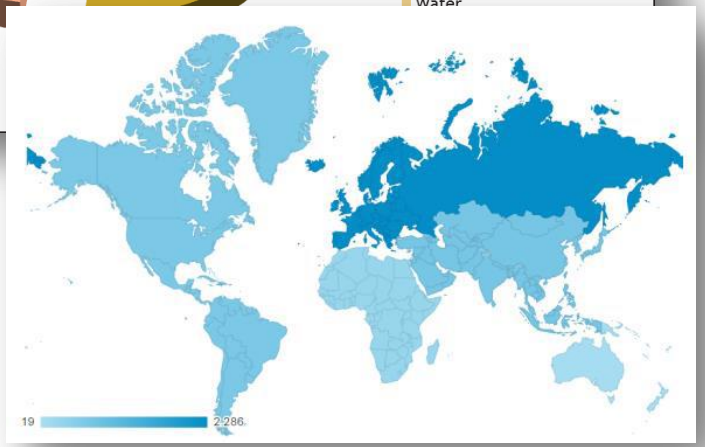
Uptake Statistics

European Commission





Geographic distribution of new users (Q4-2015) visiting
the main Global Land website (left) and the Product distribution portal (right)

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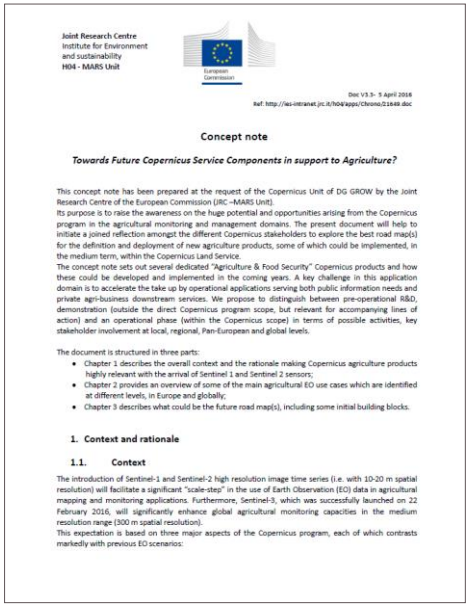
Agriculture

The High Resolution Sentinels satellites radically improve the technical feasibility for wide-area crop mapping and monitoring:

- **Superior radiometric and geometric data quality**
- **Revisit frequencies matching the dynamics of the crop cycle**
- **Complementarity of SAR series with optical imagery**
- **Full, free and open access**

Leading to expansion of applications in:

- **National and regional crop area and yield statistics**
- **Capacities to follow crop specific phenology at parcel level**
- **Derived information products for public and private use**



Joint Research Centre
Institute for Environment and sustainability
H04 - MARS Unit

Concept note

Towards Future Copernicus Service Components in support to Agriculture?

This concept note has been prepared at the request of the Copernicus Unit of DG GROW by the Joint Research Centre of the European Commission (JRC –MARS Unit).
Its purpose is to raise the awareness on the huge potential and opportunities arising from the Copernicus program in the agricultural monitoring and management domains. The present document will help to initiate a joined reflection amongst the different Copernicus stakeholders to explore the best road map(s) for the definition and deployment of new agriculture products, some of which could be implemented, in the medium term, within the Copernicus Land Service.
The concept note sets out several dedicated "Agriculture & Food Security" Copernicus products and how these could be developed and implemented in the coming years. A key challenge in this application domain is to accelerate the take up by operational applications serving both public information needs and private agri-business downstream services. We propose to distinguish between pre-operational R&D, demonstration (outside the direct Copernicus program scope, but relevant for accompanying lines of action) and an operational phase (within the Copernicus scope) in terms of possible activities, key stakeholder involvement at local, regional, Pan-European and global levels.

The document is structured in three parts:

- Chapter 1 describes the overall context and the rationale making Copernicus agriculture products highly relevant with the arrival of Sentinel 1 and Sentinel 2 sensors;
- Chapter 2 provides an overview of some of the main agricultural EO use cases which are identified at different levels, in Europe and globally;
- Chapter 3 describes what could be the future road map(s), including some initial building blocks.

1. Context and rationale

1.1. Context

The introduction of Sentinel-1 and Sentinel-2 high resolution image time series (i.e. with 10-20 m spatial resolution) will facilitate a significant "scale-step" in the use of Earth Observation (EO) data in agricultural mapping and monitoring applications. Furthermore, Sentinel-3, which was successfully launched on 22 February 2016, will significantly enhance global agricultural monitoring capacities in the medium resolution range (300 m spatial resolution).
This expectation is based on three major aspects of the Copernicus program, each of which contrasts markedly with previous EO scenarios:

Evolution of the land service proposed by the COM (JRC) with a concept note at the COPERNICUS User Forum (19.04.16)

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Use of satellite imagery in agriculture

Resolution	Revisit	Application	Limits
300 m – 1 km	**Daily**	**Global crop production trends**	**Not crop specific, difficult to separate area and phenology**
10-30 m	**Weekly**	**Crop area, crop type, phenology, crop diversity/rotation**	**Requires** massive data processing, **globally consistent methodology**
0.5-5 m	**On demand**	**Area measurement, detailed measures, precision farming**	**Costly, on sample basis only**

Free & Open

Commercial, but plenty choice

- Global monitoring programs "agriculture and food security"
- EU Common Agricultural Policy monitoring and control (IACS)
- Wide range of private actors in farm services, food chain applications

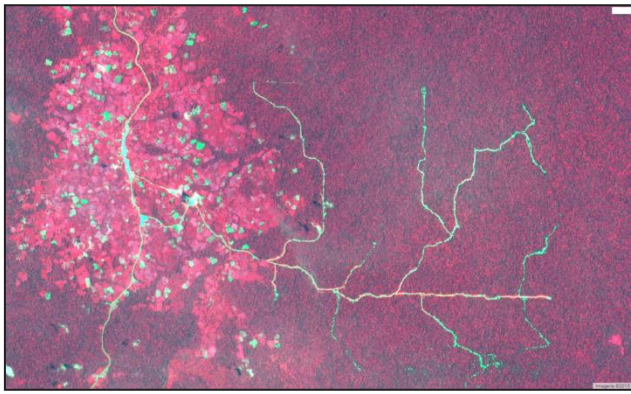
Ideas for implementation

- A number of exploratory activities already underway.
- Copernicus focus on products that benefit both public and private users, with specialization and tailoring in down-stream activities.
- Respect the mandate linked to the EU CAP
- Further stimulate discussion on open access to reference - in situ data / LPIS
- Component anchor in Copernicus European and Global Land Services

Service Evolution

European Commission

Forest



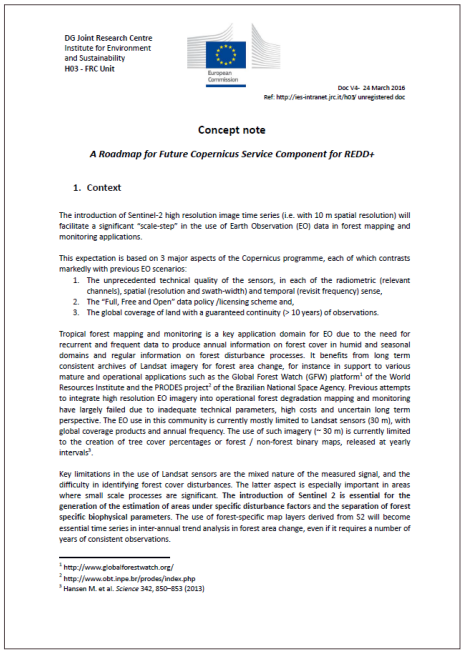
Rational for evolution : the High Resolution Sentinels satellites:

- **Radiometric and geometric data quality**
- **Revisit frequency**
- **Complementarity of SAR series with optical imagery**
- **Full, free and open access**

Leading to expansion of applications in REDD+ MRV context:

- **Supporting the Paris Outcome** (Paris Agreement: *"(All) Parties encouraged to take action to implement and support the REDD+ framework"*, to be Measured, Reported and Verified (MRV) at national level.
- **Forest Monitoring Systems and capacities**

Evolution of the land service proposed by the COM (CLIMA) with a concept note at the COPERNICUS User Forum (19.04.16)



DG Joint Research Centre
Institute for Environment and Sustainability
H03 - FRC Unit

European Commission

Doc V4- 24 March 2016
Ref: http://ies-intranet.jrc.it/h03/ unregistered doc

Concept note

A Roadmap for Future Copernicus Service Component for REDD+

1. Context

The introduction of Sentinel-2 high resolution image time series (i.e. with 10 m spatial resolution) will facilitate a significant "scale-step" in the use of Earth Observation (EO) data in forest mapping and monitoring applications.

This expectation is based on 3 major aspects of the Copernicus programme, each of which contrasts markedly with previous EO scenarios:

1. The unprecedented technical quality of the sensors, in each of the radiometric (relevant channels), spatial (resolution and swath-width) and temporal (revisit frequency) sense,
2. The "Full, Free and Open" data policy /licensing scheme and,
3. The global coverage of land with a guaranteed continuity (> 10 years) of observations.

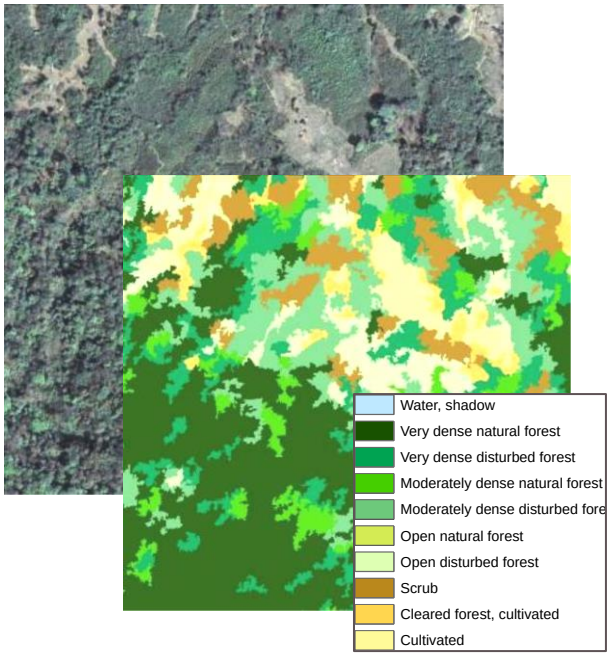
Tropical forest mapping and monitoring is a key application domain for EO due to the need for recurrent and frequent data to produce annual information on forest cover in humid and seasonal domains and regular information on forest disturbance processes. It benefits from long term consistent archives of Landsat imagery for forest area change, for instance in support to various mature and operational applications such as the Global Forest Watch (GFW) platform[1] of the World Resources Institute and the PRODES project[2] of the Brazilian National Space Agency. Previous attempts to integrate high resolution EO imagery into operational forest degradation mapping and monitoring have largely failed due to inadequate technical parameters, high costs and uncertain long term perspective. The EO use in this community is currently mostly limited to Landsat sensors (30 m), with global coverage products and annual frequency. The use of such imagery (~ 30 m) is currently limited to the creation of tree cover percentages or forest / non-forest binary maps, released at yearly intervals[3].

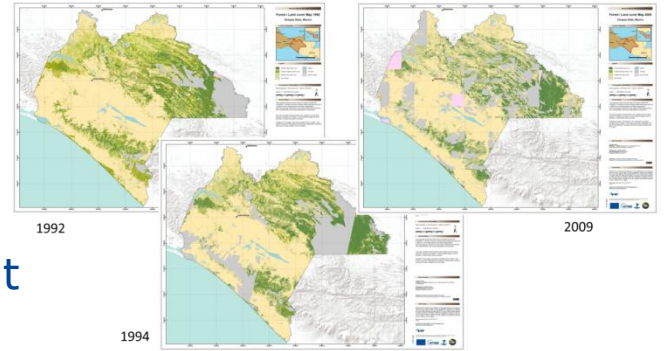
Key limitations in the use of Landsat sensors are the mixed nature of the measured signal, and the difficulty in identifying forest cover disturbances. The latter aspect is especially important in areas where small scale processes are significant. The introduction of Sentinel 2 is essential for the generation of the estimation of areas under specific disturbance factors and the separation of forest specific biophysical parameters. The use of forest-specific map layers derived from S2 will become essential time series in inter-annual trend analysis in forest area change, even if it requires a number of years of consistent observations.

[1] http://www.globalforestwatch.org/
[2] http://www.obt.inpe.br/prodes/index.php
[3] Hansen M. et al. *Science* 342, 850–853 (2013)

REDD+ Service component

- Production of S-2 level 3 products (e.g. monthly cloud free image mosaics and dedicated distribution platform)
- Automated annual forest map at 10m resolution supporting assessment of "natural forest"
- A phased approach, starting with representative countries
- Potential of radar for detection and law enforcement in cloudy areas
- Promote and distribute Analysis Ready Data, maximizing interoperability in data supply and exchange from different sources.





Conclusions

European Commission

- Free and Open Access to S1-S2-S3 data for downstream applications
- Availability of mid resolution biophysical variable for crop conditions monitoring and yield forecasting at national and regional level
- Proposal for service evolution with the agriculture concept note (test case in Czech Republic)
- Continuity of Forest High Resolution Layer production (3 years frequency) with temporal profile analysis challenge
- Forest Monitoring / REDD+ support at Global level including the production of multi-purposes Sentinel Level 3 cloud free mosaic

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Thank you

COPERNICUS, DG GROW, EC

http://www.copernicus.eu/