



# WHEN SPACE MEETS AGRICULTURE

14-15 November 2016 | Matera,  
Italy

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#WSMA16

What can Copernicus do for farmers  
and for the European Agricultural  
Policy

Catharina Bamps, Copernicus unit – DG GROW

Image from ESA Sentinel



REGIONE BASILICATA



in collaboration with



and the support of





Copernicus

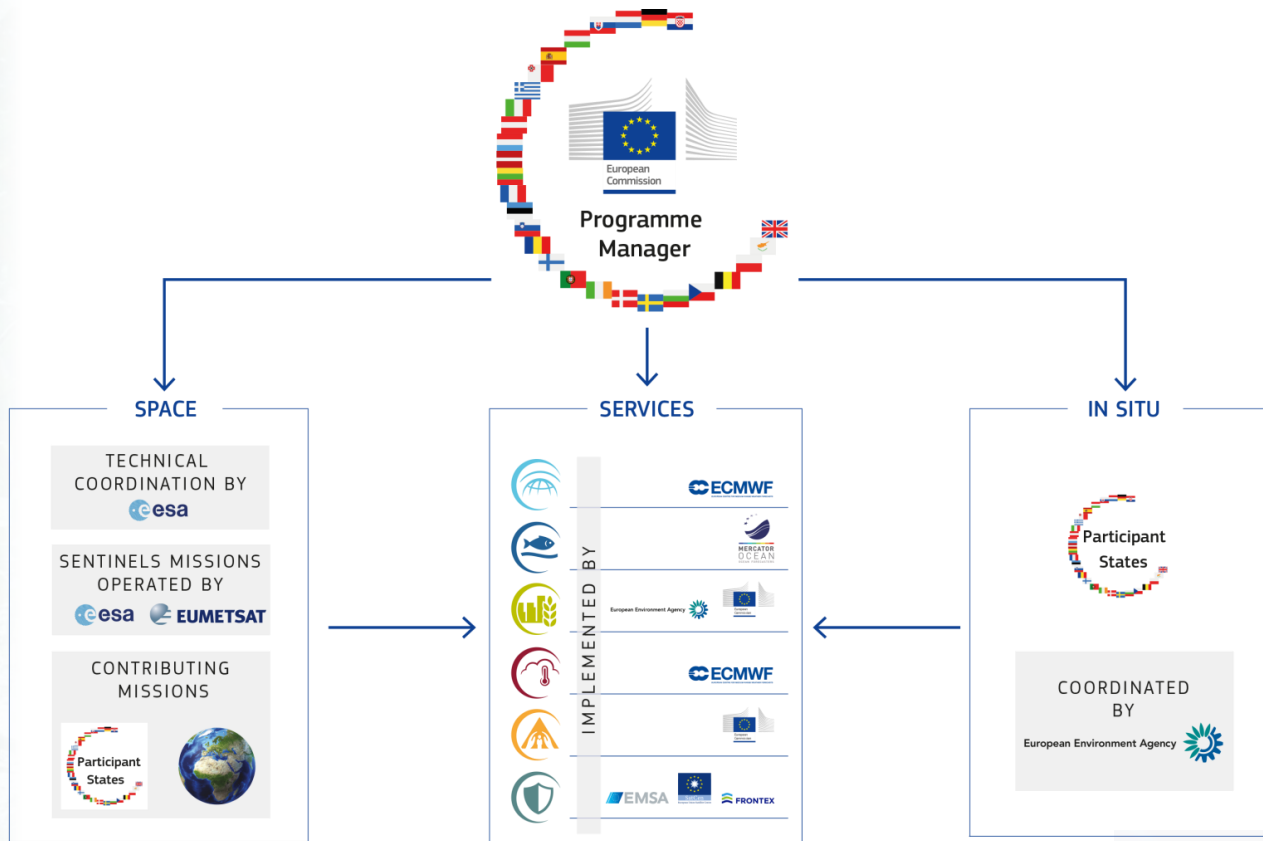
## C O P E R N I C U S   I N   B R I E F

- **The Copernicus programme** is a cornerstone of the European Union's efforts:
  - To monitor **the Earth**, its environment and ecosystems
  - To ensure its citizens are prepared and protected for **crises, security risks** and **natural or man-made disasters**
- Places a world of insight about our planet at the disposal of citizens, public authorities and policy makers, scientists, entrepreneurs and businesses on a **full, free and open basis**
- Is a tool for **economic development** and a driver for the **digital economy**



Copernicus

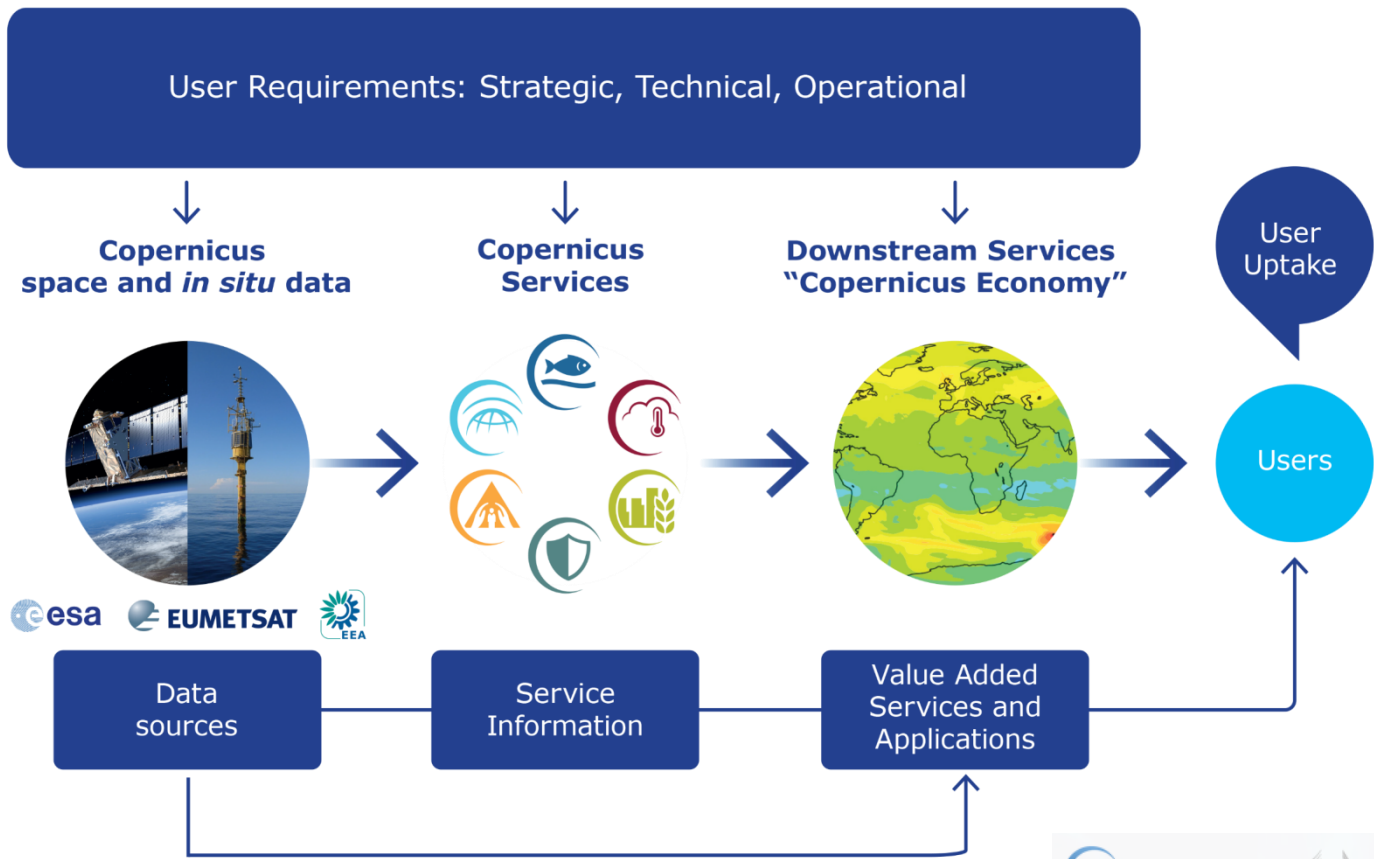
# COPERNICUS GOVERNANCE





Copernicus

# COPERNICUS IS DRIVEN BY THE USERS






Data  
Access

# COPERNICUS DATA and INFORMATION ACCESS

Access to Satellite data: <https://sentinel.esa.int/web/sentinel/sentinel-data-access>

**FULL, FREE AND OPEN**



Scientific and Other Access

<https://scihub.copernicus.eu/>


**RESTRICTED**



Access for Copernicus Services

*Restricted to the Copernicus Service Projects*

**RESTRICTED**



Access for Collaborative Ground Segment

*Copernicus Space Component Data Access Portal\**

**RESTRICTED**



Access for International Agreements

*Restricted to international partners*

Access to Copernicus Services Data and Information

- Land-related data: <http://land.copernicus.eu>
- Atmosphere-related data: <http://atmosphere.copernicus.eu>
- Marine-related data: <http://marine.copernicus.eu>
- Emergency-related data: <http://emergency.copernicus.eu>
- Climate change-related data: <http://climate.copernicus.eu> (Beta version)

**FULL, FREE AND OPEN**

(\*) Includes instructions on how to access Contributing Missions data



User Uptake



# Agricultural sector: Examples of benefits

## More affordable applications based on **Free Sentinels 1, 2 (and 3) Data and the Land Service Products**

- **Precision farming** applications such as yield mapping, input management, farm management recording, etc.
- **Seasonal mappings** of cultivated areas
- **Field scale and crop dynamics** mapping
- **Irrigation management** and drought monitoring
- **Food security** monitoring
- **Agriculture development** in Africa



€40-200M

More efficient use of agricultural inputs



Better quality food production



More efficient and appropriate use of fertilizers



Expected Copernicus enabled revenues



User  
Uptake

## Use of satellite imagery in agriculture

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

**Full, Free & Open** → (points to the 10-30 m row)

**Commercial, but plenty choice** → (points to the 0.5-5 m row)



User  
Uptake

## Use of Copernicus data & information

*DG JRC concept note "Towards Future Copernicus service components in support to Agriculture", April 2016"*

"The Sentinels radically improve the technical feasibility for wide-area consistent crop mapping and monitoring:

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





User  
Uptake

## Use of Copernicus data & information

*DG JRC concept note "Towards Future Copernicus service components in support to Agriculture", April 2016"*

"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"**



User  
Uptake

# Use of Copernicus data & information

## Communities of practice:

- Global monitoring programs “agriculture and food security”
- E.g. FAO GIEWS, AMIS, US FEWSNET, EU MARS
- Essential component in Sustainable Development Goals (SDGs)
- EU Common Agricultural Policy monitoring and control (IACS)
- Wide range of private actors in farm services, food chain applications

## Uptake favored by:

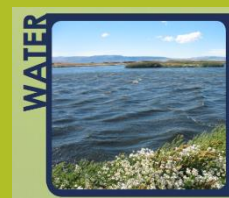
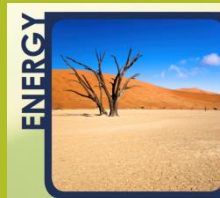
- Trends to open access to in situ data (e.g. Land Parcel Identification Systems (LPIS))
- “Big Data” processing solutions, capacities of open source software
- Novel technology in mobile data collection and sharing (crowd sourcing)



Land  
Monitoring

# Copernicus Land monitoring service

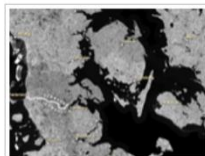
## Global



## Pan-European



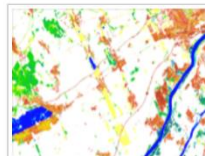
European Environment Agency



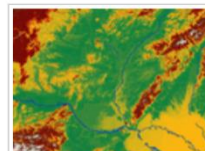
[Image Mosaics](#)



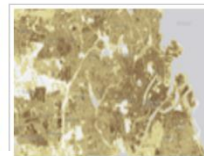
EU Land Cover



High Resolution Layers



Hydrographic and  
elevation reference maps



% of built-up area

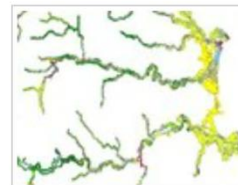
## Local



European Environment Agency



[Urban Atlas](#)



[Riparian Zones](#)

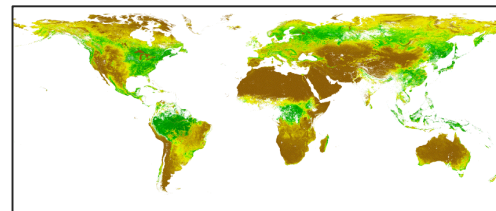


[Natura 2000 \(N2K\)](#)



## Biophysical variables for more application fields

13 products (vegetation-energy-water-snow) providing a picture of the world every ten days, with move from 1km resolution to 300m, soon to be expanded to 29 products,



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
	Greenness 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	



## APPLICATION FIELDS

### Land information to Climate change

- Carbon flux forecast

### Agriculture

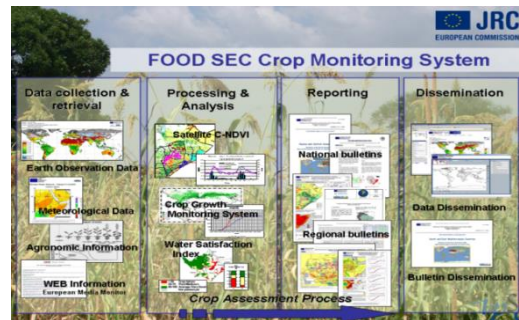
- Crop monitoring
- Yield forecasting
- Biomass conditions

### Monitoring extreme events

- Droughts
- Frost conditions
- Heat waves

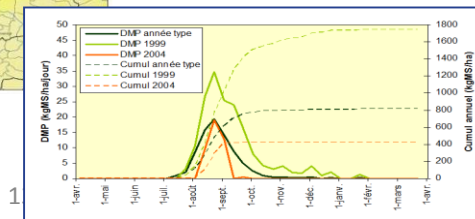
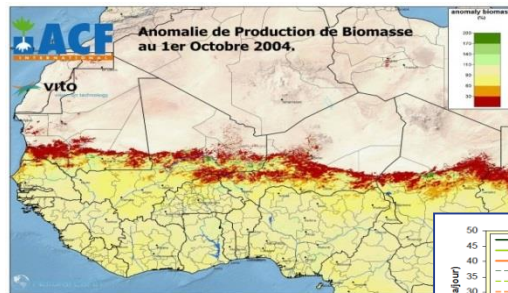
### Hydrology

- Water management
- River discharge



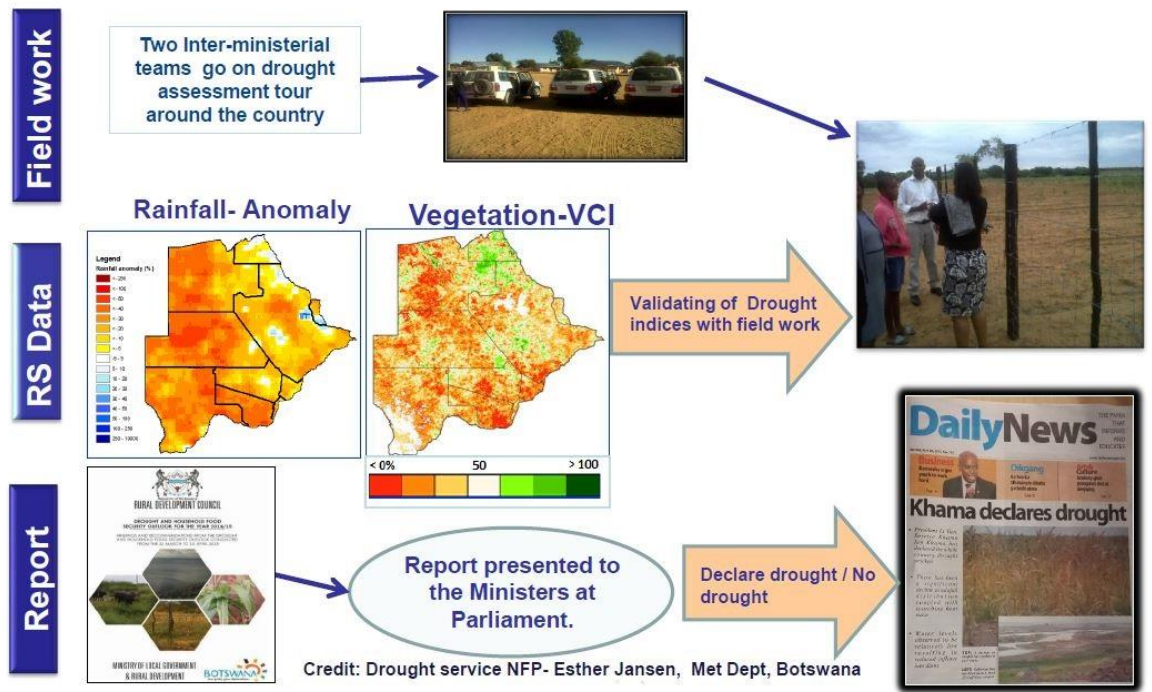
### Fire ecology

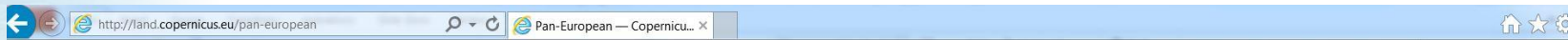
- Monitoring of fires and burned areas on a daily basis
- Development of indices of fire management and efficiency
- Bulletins developed at





## Usage examples: Botswana Drought Assessment



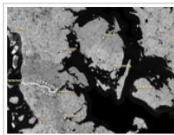


## Copernicus Land Monitoring Services

Home Global Pan-European Local In-situ

You are here: Home / Pan-European

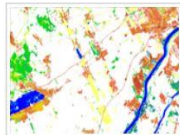
### Pan-European



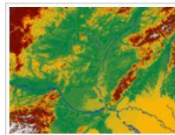
[Image Mosaics](#)



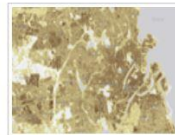
[CORINE Land Cover](#)



[High Resolution Layers](#)



[Reference Data](#)



[Related Pan-European products](#)

The pan-European component is coordinated by the European Environment Agency (EEA) and produces satellite image mosaics, land cover / land use (LC/LU) information in the CORINE Land Cover data, and the High Resolution Layers.

The CORINE Land Cover is provided for 1990, 2000, 2006 and 2012. This vector-based dataset includes 44 land cover and land use classes. The time-series also includes a land-change layer, highlighting changes in land cover and land-use. The high-resolution layers (HRL) are raster-based datasets which provides information about different land cover characteristics and is complementary to land-cover mapping (e.g. CORINE) datasets.

Five HRLs describe some of the main land cover characteristics: impervious (sealed) surfaces (e.g. roads and built up areas), forest areas, (semi-) natural grasslands, wetlands, and permanent water bodies. The High-Resolution Image Mosaic is a seamless pan-European ortho-rectified raster mosaic based on satellite imagery covering 39 countries.

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### User corner

- [➤ Ask the service desk](#)
- [➤ Contract opportunities](#)
- [➤ EAGLE ▾](#)
- [➤ Events](#)
- [➤ Land use cases](#)
- [➤ News](#)
- [➤ Partners](#)
- [➤ Publications](#)
- [➤ Technical library](#)

### Partners





## Pan-European component

Information about the land cover and land use (LC/LU), LC/LU changes and LC characteristics;

- pan-European high-resolution layers (2006-09-12-15-18) (39 European countries): info on specific LC characteristics;  
produced from 20 m resolution satellite imagery, regrouped into 100 x 100 m grid cells for final products;  
5 themes (~ Corine\* Land Cover)
  - Artificial surfaces, Forests (tree cover density, forest type), Grasslands (grassy and non-woody vegetation products), Waterproducts and wetness (multi-annual approach for wetness), Small woody features
- CLC change mapping, CLC2012;

\* Corine: Co-ordination of Information on the Environment





The screenshot shows the Copernicus Land Monitoring Services website. The browser address bar displays 'http://land.copernicus.eu/local'. The page title is 'Copernicus Land Monitoring Services'. The navigation menu includes 'Home', 'Global', 'Pan-European', 'Local', and 'In-situ'. The 'Local' component is selected. The page content is organized into a main section and a right-hand 'User corner' sidebar. The main section features three map thumbnails: 'Urban Atlas', 'Riparian Zones', and 'Natura 2000 (N2K)'. Below these is a paragraph explaining the local component's coordination by the European Environment Agency and its focus on hotspots. A bulleted list provides details for each of the three components. The 'User corner' sidebar contains a 'Print' button and a list of links: 'Ask the service desk', 'Contract opportunities', 'EAGLE', 'Events', 'Land use cases', 'News', 'Partners', 'Publications', and 'Technical library'. Below the sidebar is a 'Partners' section with logos for the European Commission and the EEA. The footer contains copyright information and a 'Top' link.


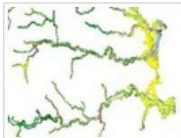

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## Copernicus

Home Global Pan-European Local In-situ

You are here: Home / Local

### Local

 [Urban Atlas](#)  [Riparian Zones](#)  [Natura 2000 \(N2K\)](#)

The local component is coordinated by the European Environment Agency and aims to provide specific and more detailed information that is complementary to the information obtained through the Pan-European component. The local component focuses on different *hotspots*, i.e. areas that are prone to specific environmental challenges and problems. It will be based on very high resolution imagery (2,5 x 2,5 m pixels) in combination with other available datasets (high and medium resolution images) over the pan-European area. The three local components are:

- **Urban Atlas** EU regional policy justifies the production and maintenance of detailed land cover and land use information over major EU city areas. The Urban Atlas provides pan-European comparable land use and land cover data covering a number of Functional Urban Areas (FUA). In 2012, an additional layer (Street Tree Layer - STL) was produced for a selection of FUAs.
- **Riparian Zones** The next local component addresses land cover and land use in areas along rivers, i.e. the riparian zones. The rationale for this local component is provided by the need to monitor biodiversity at European level, amongst other in the framework of improving the “green” and “blue” infrastructures in the European Union.
- **Natura 2000** The Natura 2000 (N2K) areas are also important hotspots to have in consideration. The aim of the first N2K project was to assess whether Natura2000 sites are effectively preserved and whether a decline of certain grassland habitat types is halted.



More information can be found in the Technical library under the User Corner.

Print

#### User corner

- ➔ Ask the service desk
- ➔ Contract opportunities
- ➔ EAGLE ▾
- ➔ Events
- ➔ Land use cases
- ➔ News
- ➔ Partners
- ➔ Publications
- ➔ Technical library

#### Partners





In situ

## In situ data needs

- All Copernicus services need access to in-situ data to ensure efficient and effective use of Copernicus space-borne data.  
e.g. Copernicus Land Monitoring service - Pan-European and local component
- Land Use-Land Cover Area Frame Survey (LUCAS) : harmonised data on LC/LU, agro-environmental topics and soil.
- Land Parcel Identification Systems (LPIS): feasibility study (2015) on accessibility to LPIS data in a generalised format (non-sensitive parts) for CLMS

Most common accessible info: delineations permanent grasslands and arable lands



Table 4: Information required from LPIS for Copernicus

<b>Required information</b>	<b>Copernicus product</b>
Waterlogged soil	HRL Wetness
Arable vs. grassland	HRL Grassland, Riparian Zones, Natura 2000
Arable vs. sealed	HRL Imperviousness
Arable vs. forest	HRL Forest, Natura 2000
Grassland vs. forest (esp. low Tree Cover Density areas)	HRL Forest, HRL Grassland
Agricultural vs. non-agricultural trees	HRL Forest
Permanent vs. annual crops	Urban Atlas
Grassland management intensity	HRL Grassland, Natura 2000, Riparian Zones
Crop types/various arable classes	Natura 2000
Green Linear Feature identification	Green Linear Features, GLE/small linear features
Greenhouses	HRL Imperviousness



User  
Uptake

# Czech - Agri Copernicus project - Objectives

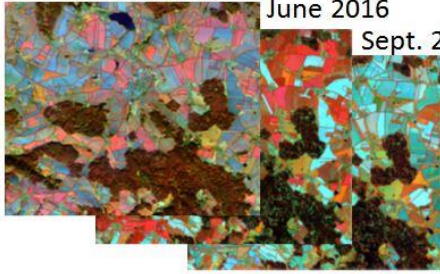
- Demonstrate potential of S1 & S2 data for national scale agriculture mapping & monitoring
- R&D preparation for Copernicus agriculture products – combination of Sentinels and IACS

## Sentinel-2 time series

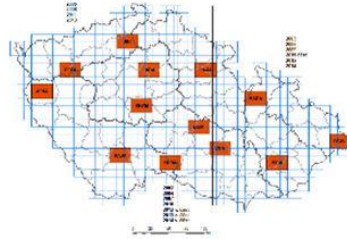
March 2016

June 2016

Sept. 2016



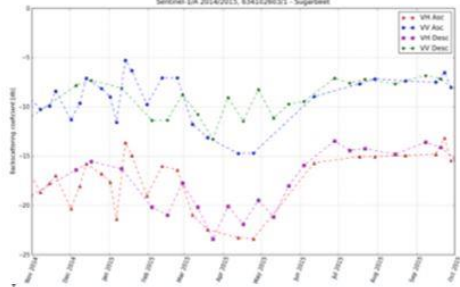
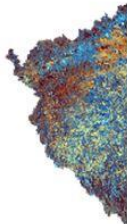
## Land Parcel Identification System (2300 parcels for calibration & validation)



## National crop type map



## Sentinel-1 time series







## CZECH AGRICOPERNICUS PROJECT:



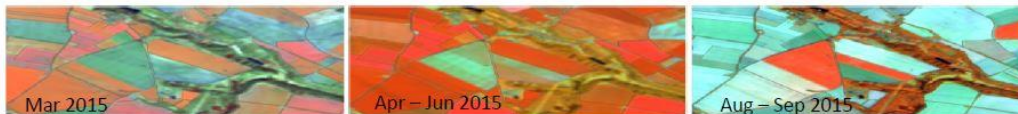
### ADDED VALUE OF THE SENTINEL DATA for the PAYING AGENCY IACS AGENDAS:

- Whole range of IACS activities (process cycle);
- NOT the resolution but the wide coverage and time series allowing frequent monitoring;
- Mainly automated processing minimising manual inputs;



**Shift from checks on sample at a certain date to ongoing monitoring at national scale (better corresponding to agricultural ongoing activities, heterogeneity of land characteristics and soil parameters);**

*Involvement in further project studies: defining concrete applications and limitations, definition of frequency of time series, cost x benefits, etc.*





User  
Uptake

# Use - case

## CZECH AGRI Copernicus Project:



### THE POTENTIAL of SENTINEL DATA (user's point of view):

- ❑ Use in Agricultural sector, providing useful information in supporting the **administration and control** of the **European Common Agriculture area related subsidies and commitments**;
- ❑ The high frequency of the Sentinel data capture allow regular **monitoring of agricultural production via time series** and therefore **bring added value to both public and private sector** and may serve as a support tool in daily farming activities and Paying Agency tasks;

Multi-temporal  
composites





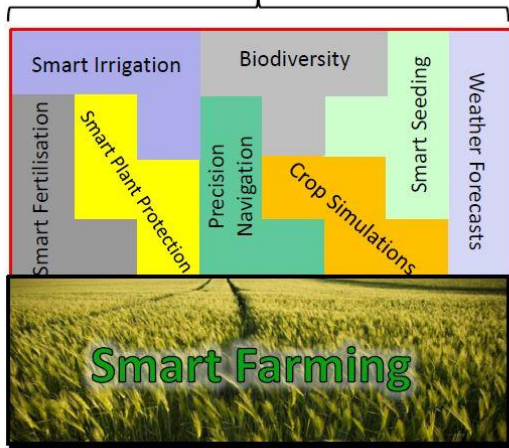
# Use - case

User Uptake

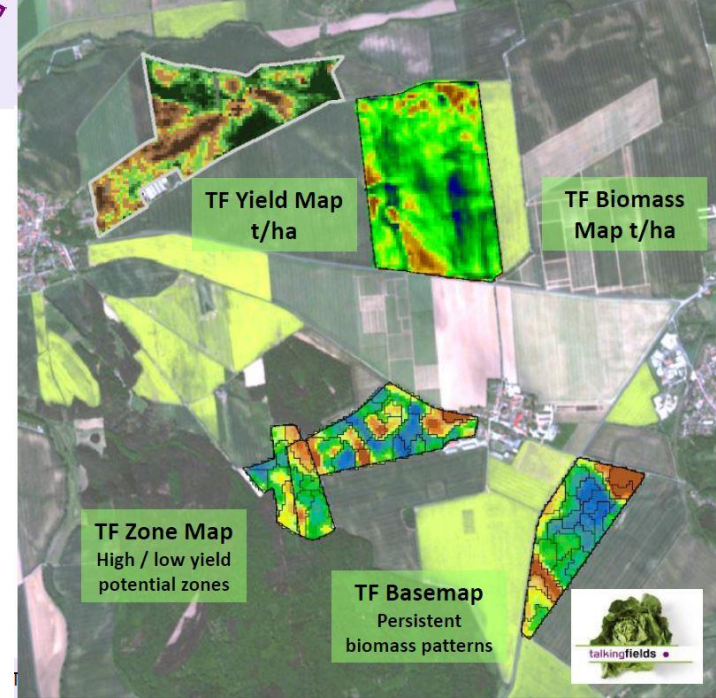
## Smart Farming Techniques to close the Yield Gap



Services of Vista with central contributions of Sentinel data



Yield Potential  
Current Yield



© Vista Remote Sensing in Geosciences GmbH (German SME)





User Uptake

# Use - case

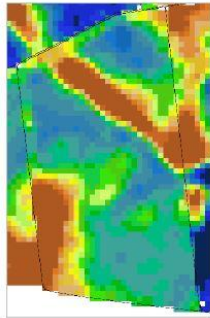


## Smart Fertilization

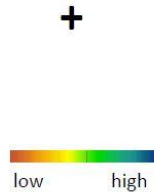
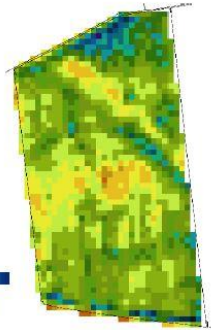
The added-value (satellite map-overlay approach)



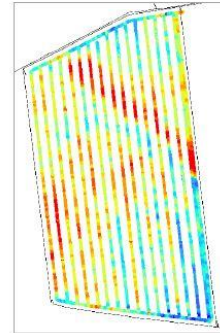
Yield Potential



Current Biomass



Smart Fertilization (Map Overlay)



- 0.0 - 31.0 N in Kg/ha
- 31.0 - 41.0
- 41.0 - 51.0
- 51.0 - 56.0
- 56.0 - 61.0
- 61.0 - 66.0
- 66.0 - 71.0
- 71.0 - 76.0
- 76.0 - 81.0
- 81.0 - 86.0
- 86.0 - 91.0
- 91.0 - 96.0
- 96.0 - 100.0

Fertilization Strategy	Yield	Nitrogen applied	Net Profit: Revenue – N-costs
Uniform (conventional)	84.1 dt/ha	246 kg N	1 294 €/ha
Map-Overlay Site-specific	87.1 dt/ha	242 kg N	1 353 €/ha

**+4.5%**

Yield increase of 3% - 6% could be achieved even on best soils = 60 – 120 €/ha more net profit

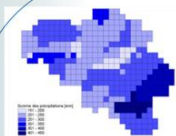
Scientifically approved by multi-year research results of the TU Munich (Maidl, 2012)



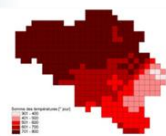
User Uptake



# Potato monitoring with Sentinel-2



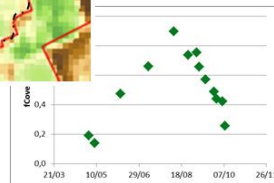
- Photosynthetic activity of the crop
- Vegetation moisture
- Soil moisture
- Temperature, rainfall, solar radiation



Risk of yield or quality losses?



Problems? Where? Priority list for field visits?

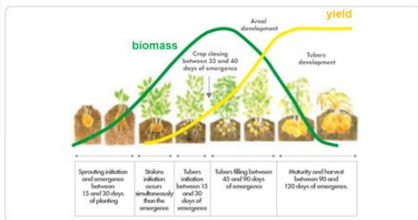


Contract negotiations! Expected yield?

- Early yield estimates



Planning! Crop development stage?



- Development stage
- Emergence: Emergence date & degree of canopy closure
- Senescence: % of non-photosynthetically active vegetation

## Data access via iPot web application





# Thank you!

<http://www.copernicus.eu/>



<https://twitter.com/CopernicusEU>



<https://www.facebook.com/Copernicus>

