

# The role of earth observation data and techniques to support the EU's Common Agricultural Policy

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# Agriculture and the Earth (Observation)

- Global population will increase, so too will the demand for meat, fish, and dairy.
- There are an estimated 570 million farms worldwide today (<u>10.5m farms</u> in the EU in 2016), and millions of other people work in food-related jobs.
- Agriculture occupies nearly 50% of the earth's habitable land (51m km<sup>2</sup>), and, in addition, <u>irrigation of crops comprises 70% of</u> <u>global water use</u>, and <u>directly contributes to around 11% of global greenhouse gas (GHG) emissions</u> (cattle).

#### Challenges facing EU/global agriculture

- cope with climate change, soil erosion and biodiversity loss
- satisfy consumers' changing tastes and expectations
- meet rising demand for more food of higher quality
- invest in farm productivity and competitiveness
- adopt and learn new technologies
- stay resilient against global economic factors (income volatility)
- inspire young people to stay in rural areas and become future farmers
- imbalance in value chains



#### Earth Observation can provide benefits to the sector through

- increasing agricultural production through decision support tools
  - phenotyping
  - land use monitoring
  - yield forecasting
- supporting sustainable management of environmental resources
  - ecosystem services
- optimising supply chains to reduce losses and improve food security
  - precision farming (yield optimization)
- increasing accuracy of flood and drought warning systems
- ensuring affordable credit for farming inputs and insurance for crop/livestock losses

sources: oecd.org/agriculture/key-challenges-agriculture-how-solve/, ec.europa.eu/eurostat/statistics-explained/index.php?title=Agriculture\_statistics\_-\_family\_farming\_in\_the\_EU, syngenta.com/en/innovationagriculture/challenges-modern-agriculture, Weiss et al., 2020



# The common agricultural policy and the farmers



#### EU's common agricultural policy (CAP) [requirements]

- new CAP, fairer, greener and more performance-based, achieving the objectives of the EU Green Deal
- monitoring 100 % of farmers for all eligibility requirements, using the Copernicus Sentinel satellite data
  - crop type classification
  - crop diversification
  - agricultural activities (tillage/greening/harvesting dates)
  - maintenance of permanent grassland and the Ecological Focus Areas including fallow lands, catch crops or nitrogenfixing plants
  - maintenance of vegetation cover for the agricultural fields susceptible to soil erosion



#### Farmers' requirement

- saving time and cost
- adjust planning to become more efficient (e.g. weather-based, )
- detect and classify weeds; detect frost damage; provide predictions of yield months prior to harvest; estimate pasture biomass
- soil health (quality) management
- crop-problems due to pests, diseases or irrigation
- increasing output of the sector and mitigating anticipated future effects such as climate change induced extreme weather events or labor shortage



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## How ESA can help? Earth Observation Missions





# Sentinel-1/2/3 missions overview



	at-	Sentinel 1 (A/B/C/D) SAR Imaging	All weather, day/night applications, interferometr		
•	Constellation of two identical SAR C-band (5.405 GHz)				
•	Nea	r-Polar, sun-synchronous (dawn-dusk) orb	bit at 698 km		
•	12-0	day repeat cycle (each satellite), 6 days for	the constellation		
•	Systematic SAR data acquisition using a predefined observation scenario				
•	7 years life time, consumables for 12 years at least				
16		Sentinel 2 (A/B/C/D) Multispectral Imaging	Land applications: urban, forest, agriculture, Continuity of Landsat, SPOT		

- · Constellation of two satellites
- Polar sun-synchronous orbit at an altitude of 786km, with LTDN 10h30
- 10-day repeat cycle (each satellite), 5 days for the constellation
- Swath of 294 km
- Sen2Like, demonstration processor developed by ESA in the framework of the EU Copernicus programme, to generate:
  - Level-2H → allows to increase the theoretical number of acquisitions of this virtual constellation by 30 % with respect to Sentinel-2
  - Level-2F → combines S2 with Landsat in a single fused data stream with S2 characteristics in terms of spatial resolution and spectral response

P. P.	Sentinel 3 (A/B/C/D)	Wide-swath ocean colour, vegetation, sea/land
	Ocean & Global Land Monitoring	surface temperature, altimetry

Sentinel-3 is an ocean and land mission composed of two identical polar orbiting satellites, separated by 180 deg and LTDN 10h00.

The spacecraft carries four main instruments:

- OLCI: Ocean and Land Colour Instrument SLSTR: Sea and Land Surface Temperature Instrument SRAL: SAR Radar Altimeter MWR: Microwave Radiometer Resolution and Swath Width:
- OLCI 1270km (FR: 300m; RR: 1.2km) SLSTR dual view swath (1420km for nadir view and 740km width for oblique view defined at 55°) (VIS/NIR/SWIR 500m; TIR: 1km)

# **Third Party Missions**



ESA's <u>Third Party Mission</u> (TPM) scheme, funded under ESA's Earthnet activity, has operated for 30 years - providing EO data from non-ESA/non-European missions to mainly European users



# **Copernicus: Sentinel Expansion Missions**



## CO2M - Anthropogenic CO<sub>2</sub> Monitoring



# Causes of Climate Change

## LST – Land Surface Temperature Mission



Agriculture & Urban Management

## **CRISTAL – Polar Ice & Snow Topography**



Effects of Climate Change

## CIMR – Passive Microwave Radiometer



Sea: Surface Temp. & Ice Concentration

## **CHIME – Hyperspectral Imaging Mission**



Food Security, Soil, Minerals, Biodiversity

## **ROSE-L – L-band SAR Mission**



Vegetation & Ground Motion & Moisture





The Copernicus Land Surface Temperature Monitoring (LSTM) mission would carry a high spatial-temporal resolution thermal infrared sensor to provide observations of land-surface temperature. The mission responds to priority requirements of the agricultural user community for **improving sustainable agricultural productivity at field-scale** in a world of increasing water scarcity and variability.

#### Areas of Application

Agriculture - Land Monitoring - Disaster and Crisis Management, water resources management

#### Mission Overview

- Operation
- Instrument
- Revisit time
- Spatial resolution
- Orbit
- Data policy
- Program

- October 2028
  - VIS/NIR/SWIR/TIR
  - 1-3 days (geometric: 2 days with 2 satellites)
- <50 m
  - Sun synchronous, ~651 km
  - free and open
  - Copernicus



## CHIME



The Copernicus Hyperspectral Imaging Mission for the Environment (CHIME) is one of six new missions that the EU and ESA are developing to expand the current suite of Copernicus Sentinels.

CHIME will carry a unique visible to shortwave infrared spectrometer to provide routine hyperspectral observations to support new and enhanced services for **sustainable agricultural** and biodiversity management, as well as soil property characterisation.

#### Areas of application

Agriculture - Land Monitoring - Georesources and geohazards - Environmental and Nature Protection - Forest and Forestry, vegetation and soil degradation monitoring

#### Mission Overview

<ul> <li>Operation</li> </ul>	
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- Instrument
- Revisit time
- Spatial resolution
- Orbit
- Data policy
- Program

Q3/2028 Imaging spectrometer (400 – 2500 nm) 11.5 day revisit (2 satellites) 30 m Sun synchronous, ~630 km free and open Copernicus



## **ROSE-L**



The Copernicus L-band Synthetic Aperture Radar (ROSE-L) would carry an L-band SAR. Since the longer L-band signal can penetrate through many natural materials such as vegetation, dry snow and ice, the mission would provide additional information that cannot be gathered by the Copernicus Sentinel-1 C-band radar mission. It would be used in support of forest management, to monitor subsidence and soil moisture and to **discriminate crop types for precision farming and food security**.

#### Areas of Application

Land Monitoring - Disaster and Crisis Management - Forest and Forestry - Traffic and Mobility, yield estimation

#### Mission Overview

- Operation
- Instrument
- Refresh rate
- Spatial resolution
- Orbit
- Data policy
- Program

Q1/2028 L band SAR every 6 days (2 satellites) 50 m<sup>2</sup> Sun synchronous, ~707 km

- Sun synchionous, ~707 i
- free and open
- Copernicus



# Multiple digital sensor platform





source: Queensland Alliance for Agriculture and Food Innovation

# **Technology workflow**

eesa



sources: Blue Sky Analytics (modified), Loudjani et al., AIA: Artificial Intelligence and EU Agriculture, 2020, JRC120221

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# Sen4CAP, a user-driven approach with use cases



Design and prototyping 2017 – local sites Demonstration and validation 2018 & 2019 – nationa

User uptake and system evolution

- use cases selection
- products specifications
- benchmarked methods
- algorithm & system design
- prototype products
- validation





sources: http://esa-sen4cap.org/, UCLouvain - Belgium

- use cases demonstration
- national scale
- continuous monitoring
- validation & fitnessto-use assessment
- capacity building and training
- system qualification





- 330 downloads and 20+ users testing the system on CREODIAS
- training with 44 participants from 20 different countries
- monthly webinars
- users' support
- system evolution
- new use cases



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# ESA's support to agriculture monitoring



#### Sen2-Agri

Designed to develop, demonstrate and facilitate the Sentinel-2 time series contribution to the EO component of agriculture monitoring.



#### ESA WorldCereal





### ESA SEN4STAT SENTINELS FOR AGRICULTURE STATISTICS

Development and demonstration of agricultural Earth Observation (EO) products and workflows based on the Sentinel missions of the European Union (EU) Copernicus program which support the agricultural statistics and can be integrated in the National Statistical Offices (NSO) environment



Invitations to Tender User:

Invitation to Tender: "Pioneer Earth observation applications for the environment (PEOPLE)"

PEOPLE series is to develop innovative high-quality EObased products, indicators, methods, tools and/or services, targeting specific high-priority research and development matters raised by the international environmental policy agenda and with a distinct connection to the European Union (EU) Green Deal.

The present activity consists of 4 parallel and independent projects tackling:

- 1.Sustainable Blue Economy;
- 2. Ecosystem Accounting;
- 3.New CAP and Agriculture Eco-schemes;
- 4. Ecosystem Restoration.

https://eo4society.esa.int/2021/12/09/invitation-to-tender-pioneer-earth-observation-applications-for-the-environment-people/



# Thank you

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