Precision Sustainable Agriculture in the European R&D framework: projects and outcomes

Cecilia Sciarretta – e-GEOS

Product Policy strategy at e-GEOS

R&D process as link between Technical Development and Commercial Development

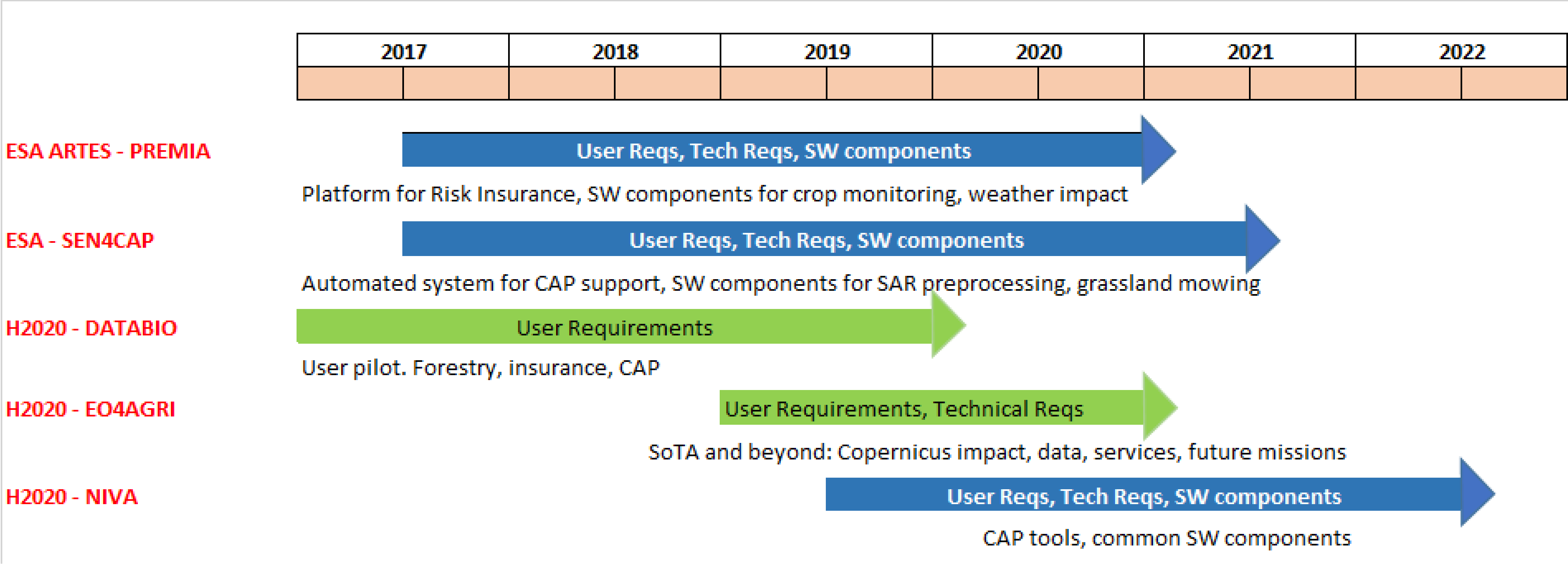| Technical Development	←	R&D	→	Commercial Development

e-GEOS dedicates internal company funds to develop geo-information products, specifically digital platforms to provide vertical services and contents, based on EO data and advanced AI technology, model- and data-driven.

R&D cofunded opportunities main role: tutoring innovation to convey ideas, concepts, solutions towards products viable for commercial exploitation, with a direct interaction with users and technological partners.

H2020 *HORIZON EUROPE*	*DIGITAL EUROPE*	SESAR	SHIFT2RAIL	LIFE	ESA ARTES/BASS	ESA INCUBED	NATIONAL PROGRAMMES

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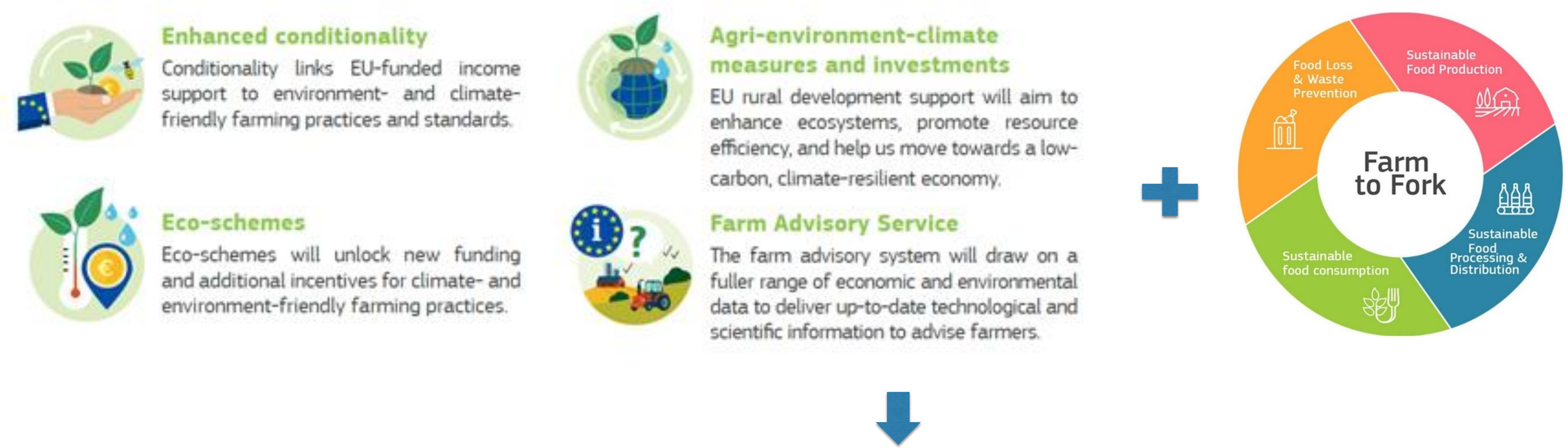
Agriculture R&D roadmap – the "snapshot"

To sustain the development of Agriculture domain products and the dedicated vertical platform AGRIGEO, e-GEOS planned and realized active participation in cofunded projects, with the aim of developing tools and competences in the domain, as well as assess them with end-user needs and requirements.

	2017	2018	2019	2020	2021	2022

ESA ARTES - PREMIA
User Reqs, Tech Reqs, SW components
Platform for Risk Insurance, SW components for crop monitoring, weather impact

ESA - SEN4CAP
User Reqs, Tech Reqs, SW components
Automated system for CAP support, SW components for SAR preprocessing, grassland mowing

H2020 - DATABIO
User Requirements
User pilot. Forestry, insurance, CAP

H2020 - EO4AGRI
User Requirements, Technical Reqs
SoTA and beyond: Copernicus impact, data, services, future missions

H2020 - NIVA
User Reqs, Tech Reqs, SW components
CAP tools, common SW components

New drivers

The European Green Deal: the new CAP and the Farm-to-Fork Strategy – new R&D drivers and macro-trends

New CAP for Green Deal

Enhanced conditionality
Conditionality links EU-funded income support to environment- and climate-friendly farming practices and standards.

Eco-schemes
Eco-schemes will unlock new funding and additional incentives for climate- and environment-friendly farming practices.

Agri-environment-climate measures and investments
EU rural development support will aim to enhance ecosystems, promote resource efficiency, and help us move towards a low-carbon, climate-resilient economy.

Farm Advisory Service
The farm advisory system will draw on a fuller range of economic and environmental data to deliver up-to-date technological and scientific information to advise farmers.

+

Farm to Fork
- Sustainable Food Production
- Sustainable Food Processing & Distribution
- Sustainable food consumption
- Food Loss & Waste Prevention

Supporting sustainable agriculture with actionable information about crop & soil needs: how much, where and when

Farm-to-Fork strategy as a frame for research in the Agrifood domain

EUROPEAN COMMISSION actions vs needs

The use of pesticides in agriculture contributes to pollution of soil, water and air.
- ➤ reduce by **50%** the use and risk of chemical pesticides by 2030
- ➤ reduce by **50%** the use of more hazardous pesticides by 2030

The excess of nutrients in the environment is a major source of air, soil and water pollution, negatively impacting biodiversity and climate.
- ➤ reduce nutrient losses by at least **50%**, while ensuring no deterioration on soil fertility
- ➤ reduce fertilizer use by at least **20%** by 2030

Antimicrobial resistance linked to the use of antimicrobials in animal and human health leads to an estimated 33,000 human deaths in the EU each year.
- ➤ reduce by **50%** the sales of antimicrobials for farmed animals and in aquaculture by 2030

Organic farming is an environmentally-friendly practice that needs to be further developed.
- ➤ boost the development of EU organic farming area with the aim to achieve **25%** of total farmland under organic farming by 2030

FARM TO FORK drivers for Key research areas

- **Food:** microbiome, food from the oceans, urban food systems, availability and source of alternative proteins such as plant, microbial, marine and insect-based proteins and meat substitutes.

- **EO space contents:** monitoring **soil health** and the **climate/meteorological conditions**, relevant to the **excess/plenty of water** and its impact on the irrigation matter.

- **ICT: DLT** and **Blockchain** to guarantee the correctness of the path up to the consumer desk

New application & technology challenges

- Resources management
- Water management
- Fertilizers and pesticides management
- Plant phenology cycle monitoring
- Climate Change impact on agriculture activity and mitigation actions
- Risk assessment in extreme natural hazardous events
- Yield prediction

Precision farming tasks by IBF collaboration

Offered services:

Coloured: through RS and AGRIGEO platform support;

No colour: through in situ and proximal activities
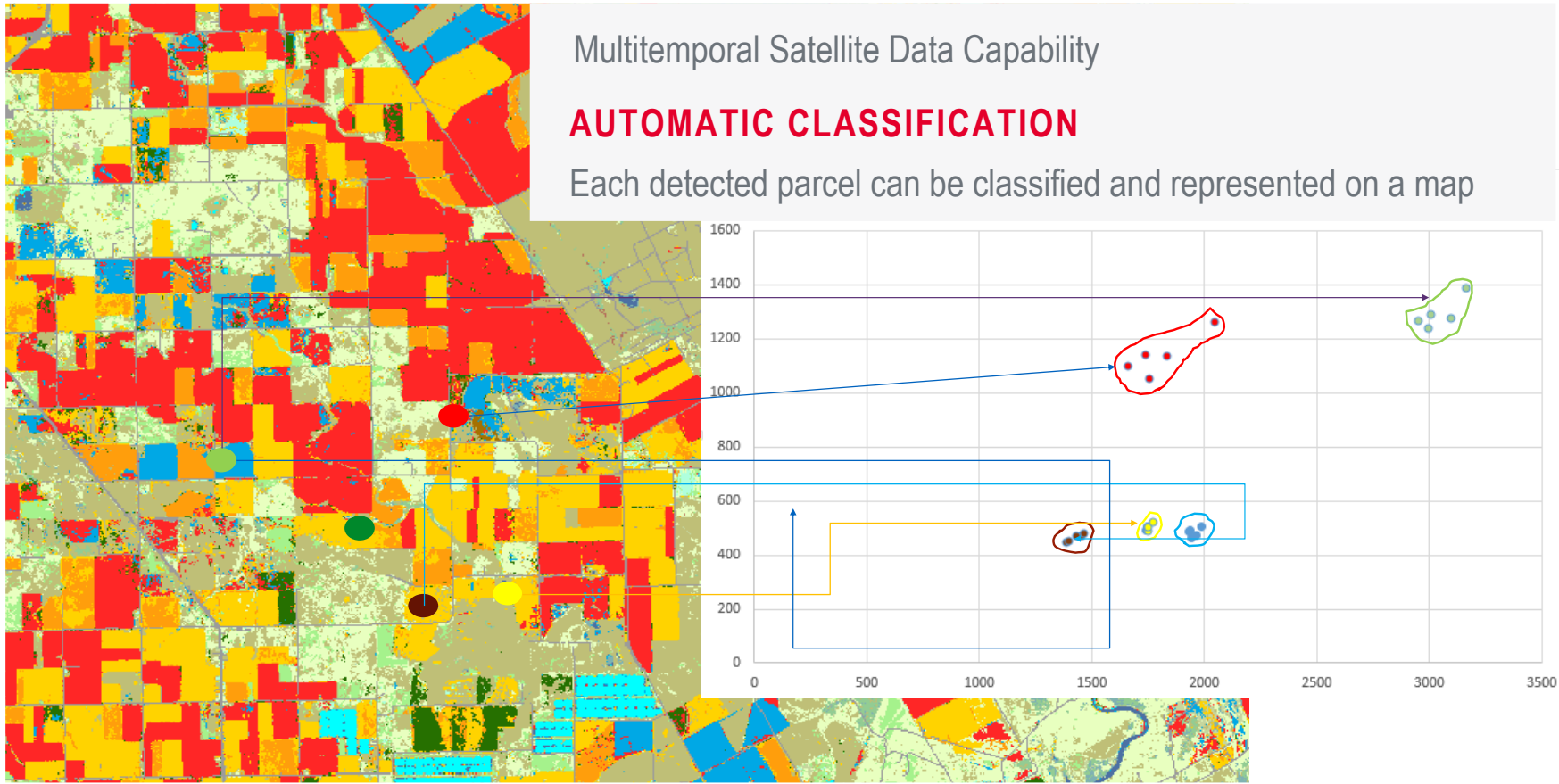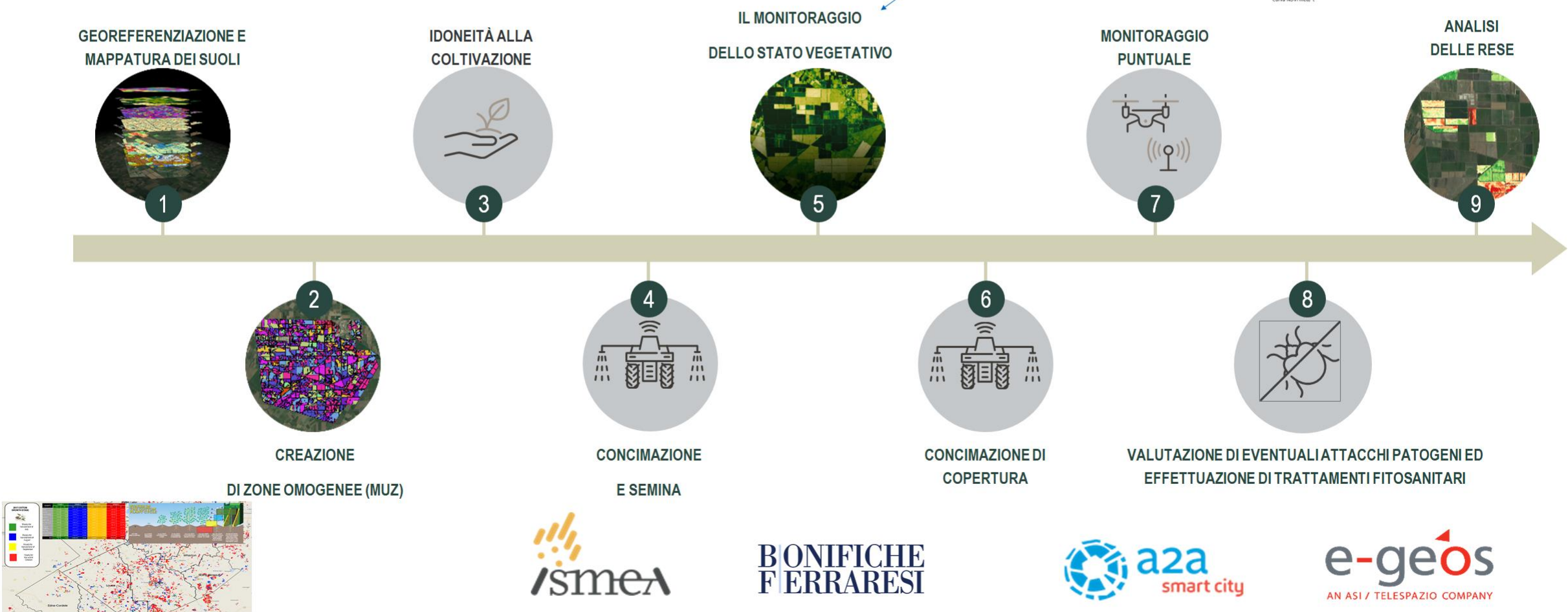
- New in-situ, IoT proximal sensors
- Full exploitation of EO satellite missions
- RPAS on-board sensors
- 5G exploitation
- Meteo data at different spatial resolution
- Multisource Data integration
- AI technology exploitation
- …

Our support to Farm-to-Fork strategy: new planned R&D activities
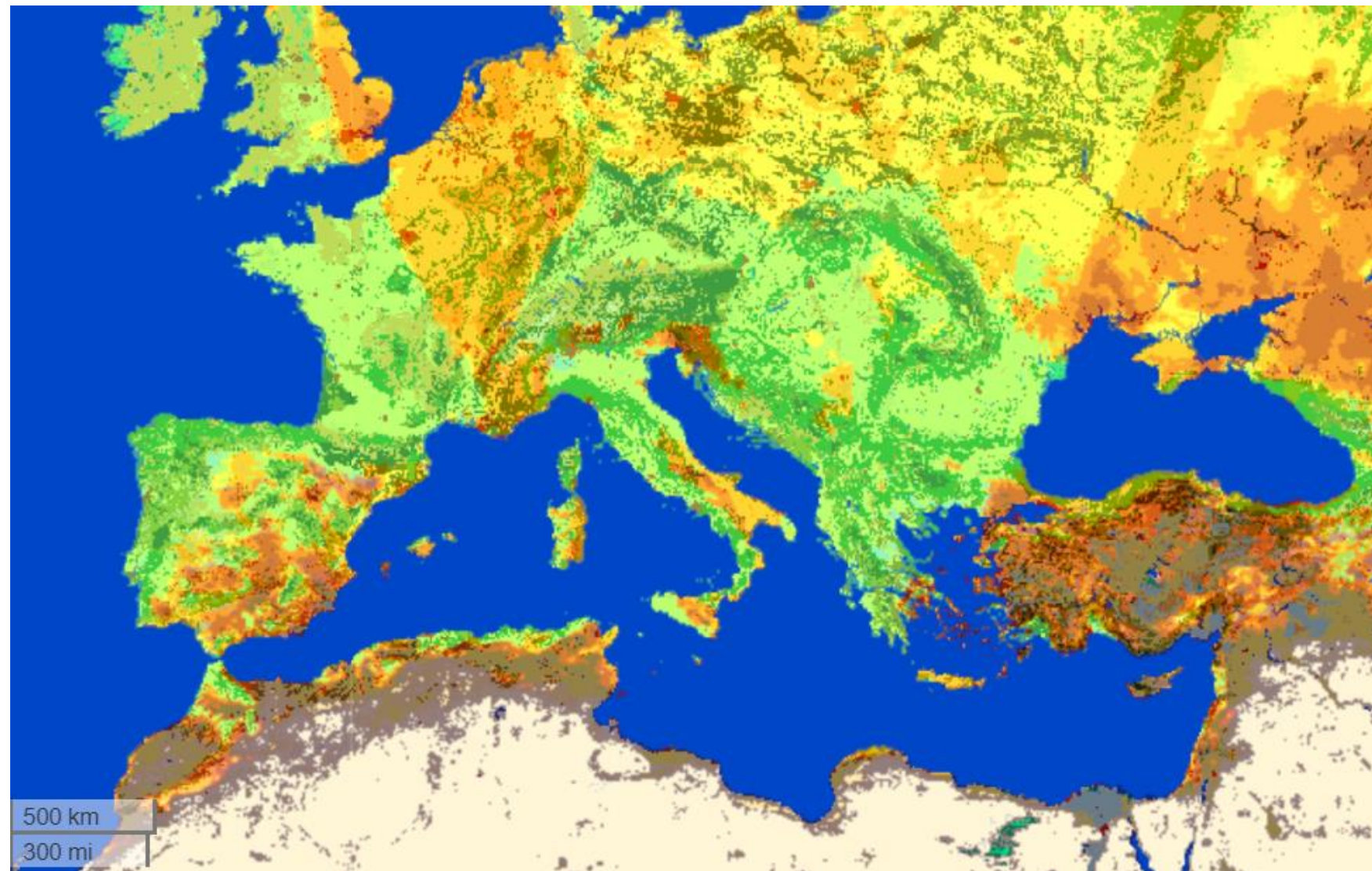
Drought factor & CCI Landcover (from Copernicus EFFIS)

The drought problem

Systemic drought problem affects Mediterranean basin, including European countries and impacts agriculture production, being the antonymic problem of flood, more frequent in European continental areas.
Both problems benefit of EO space products devoted to the **map of soil** and **water management**.

CLEXIDRA R&D project, exploits the combination of **C, L, X band SAR data** (Sentinel 1, SAOCOM, CSK) to derive **Soil Moisture Content**, a fundamental quantity to monitor the water management of cultivated areas. The project, awarded by ASI, involves Universities (**RM1, TOV, Tuscia**) and **IBF**, a partnership between **Bonifiche Ferraresi** and **ISMEA**, two main actors in the Agrifood domain.

The pesticides and nutrient excess problem

Setting up a systemic solution to monitor, prevent and control this issues needs an integrated approach, including the intervention of EO satellite and RPAS solution.

The approach is going to characterize a **R&D proposal within H2020 – Green Deal Farm-to-Fork opportunity**, including new **EO multispectral/hyperspectral products**, by satellite and RPAS sensors and the activation of RPAS services (es. **GeoAdventice**) through the **T-DROMES** platform.
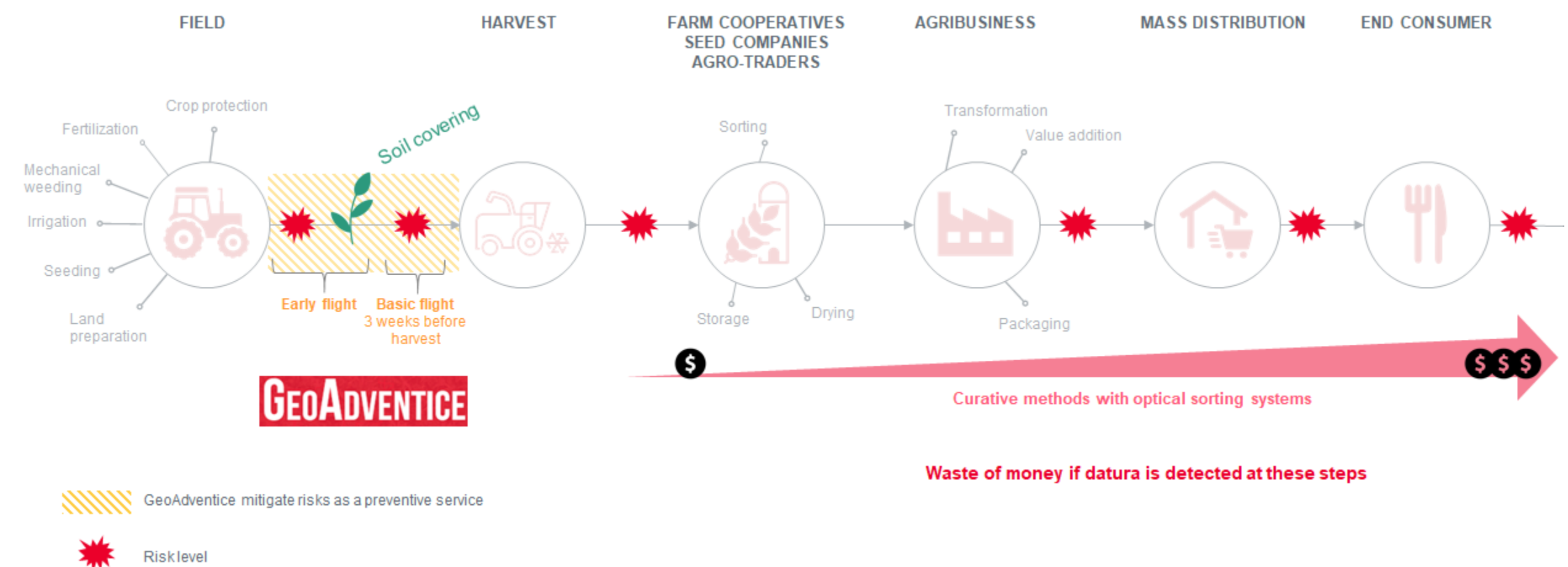
GEOADVENTICE a preventive service

Focus on technology development – SAR & Optical EO data

SEN4CAP -> IGARSS 2021 conference (UCL)

Automatic detection of **grassland mowing events** through:

- temporal series of **Sentinel-1 SAR** amplitudes and coherences;
- temporal series if indexes extracted from **Sentinel-2** (e.g. NDVI)
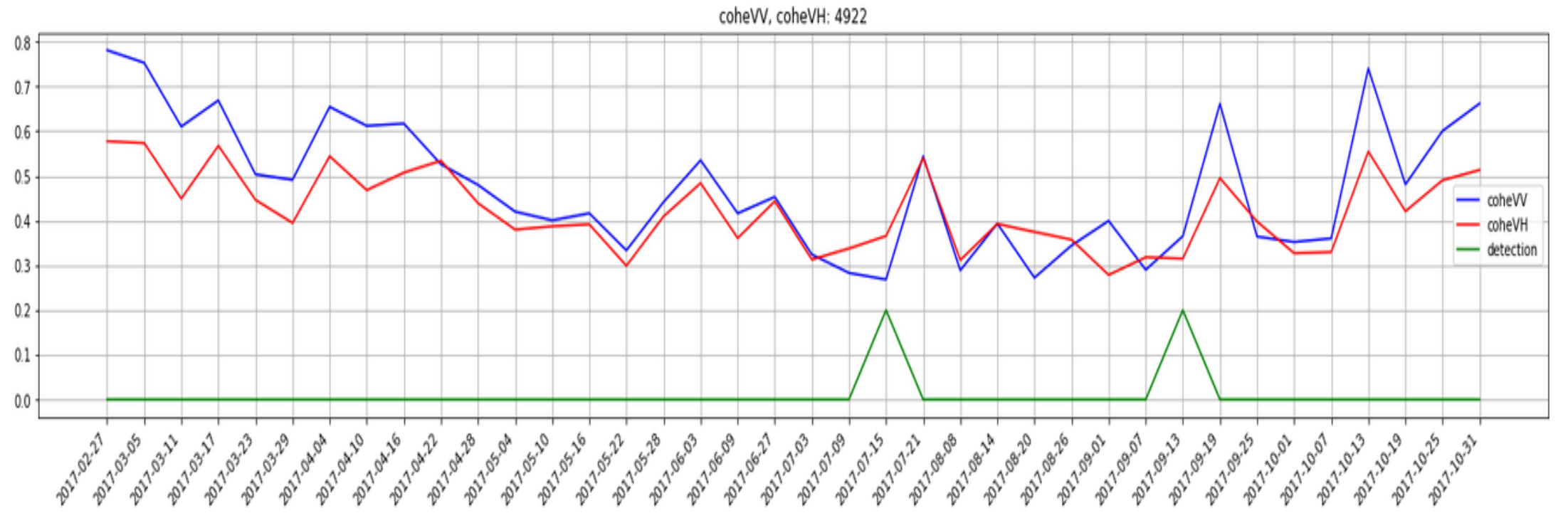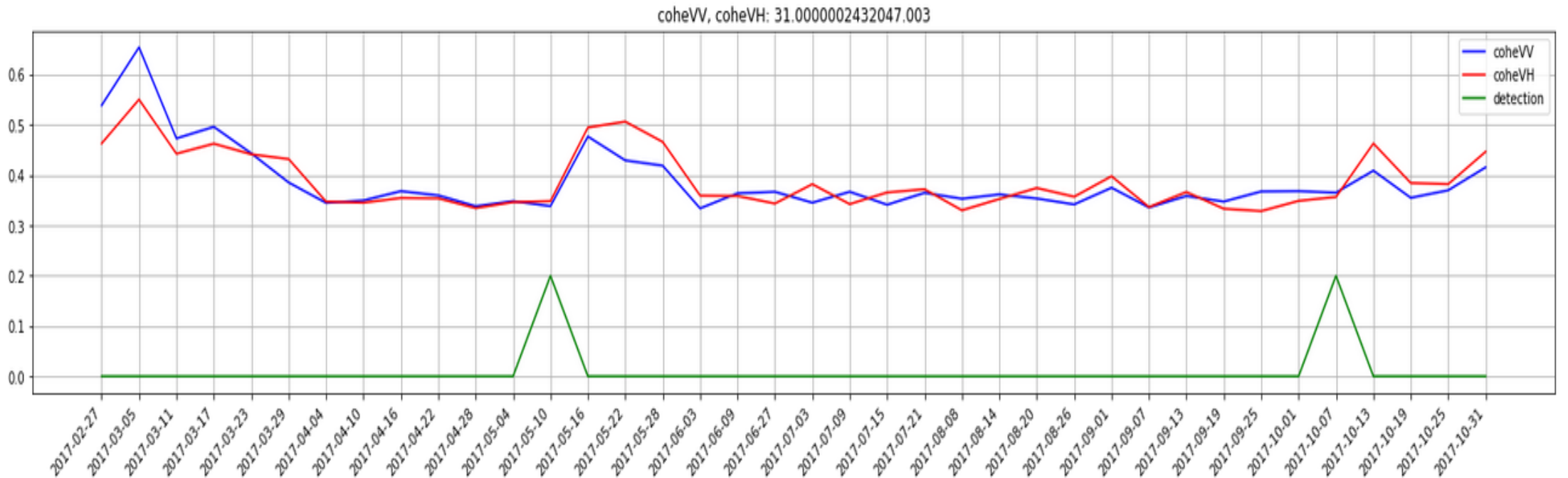
Temporal series extraction

Parcel geometries

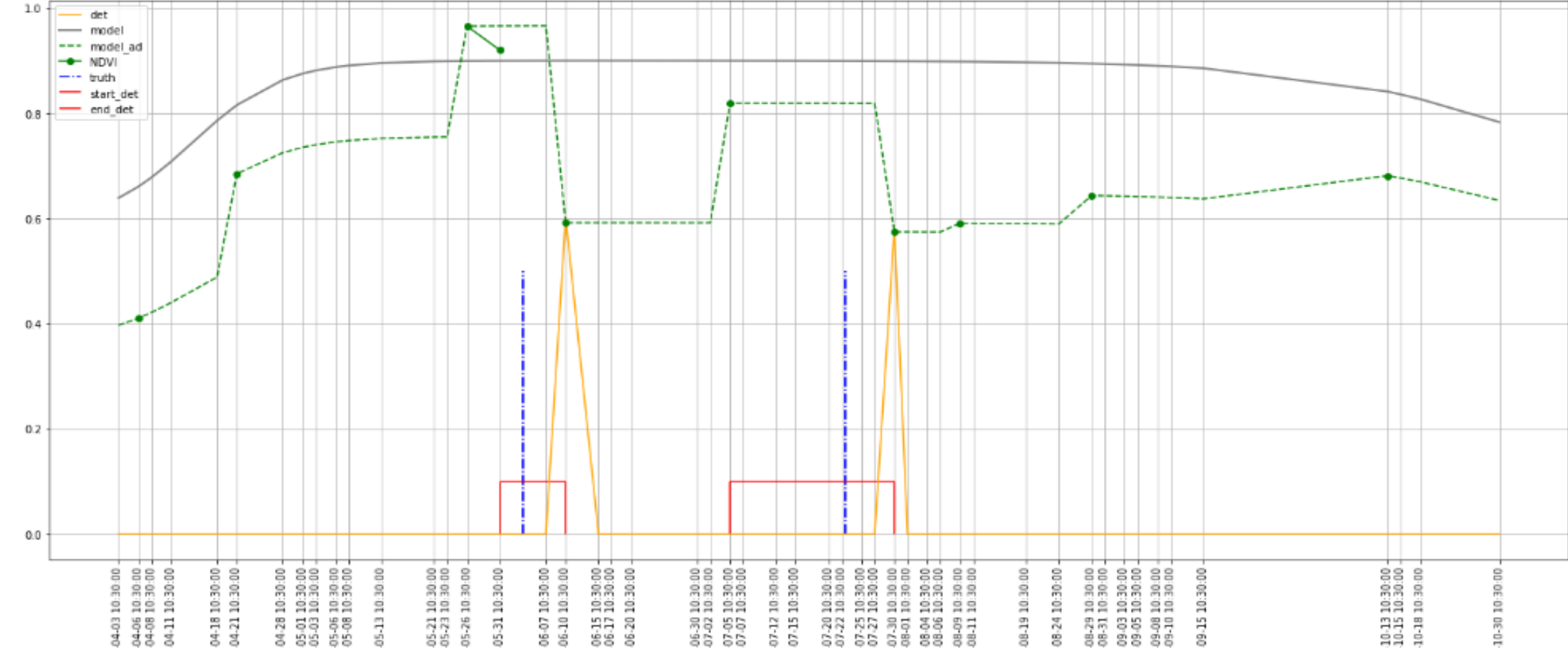**Compliancy results**

Processing chain architecture

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Focus on technology development – SAR full potential exploitation

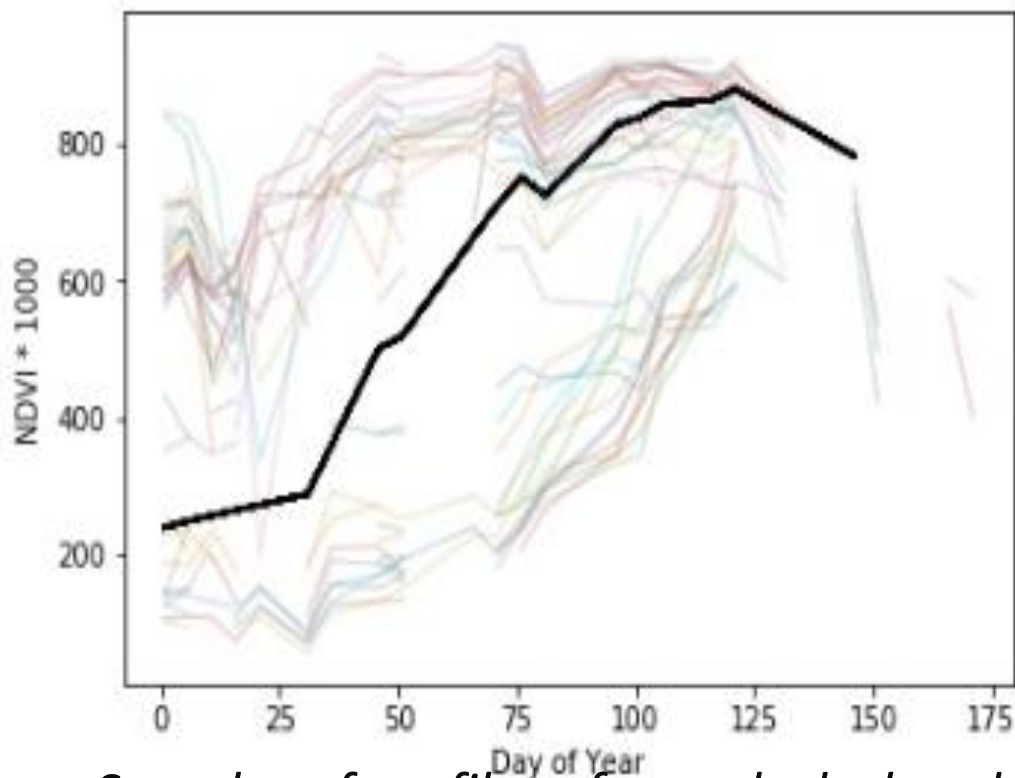**JRC grassland mapping**: **Classification** based on temporal stack of **SAR and multispectral optical** data

AGEA: Support to the european national CAP through: **grassland monitoring and anomaly detection**

LDO LABs on AI
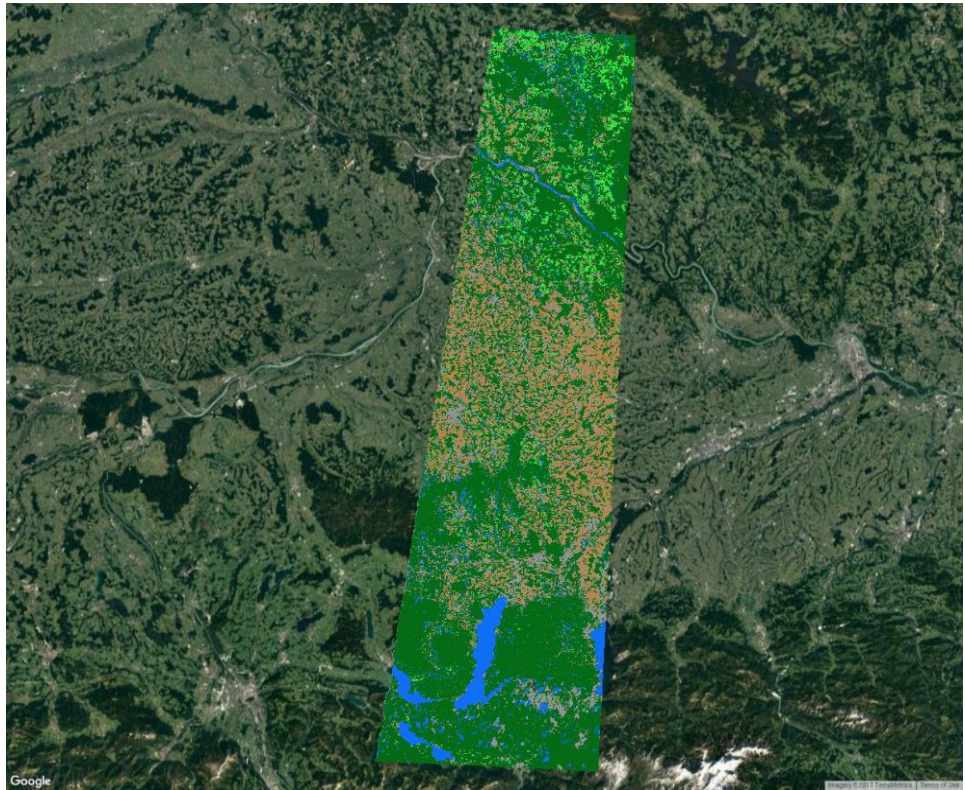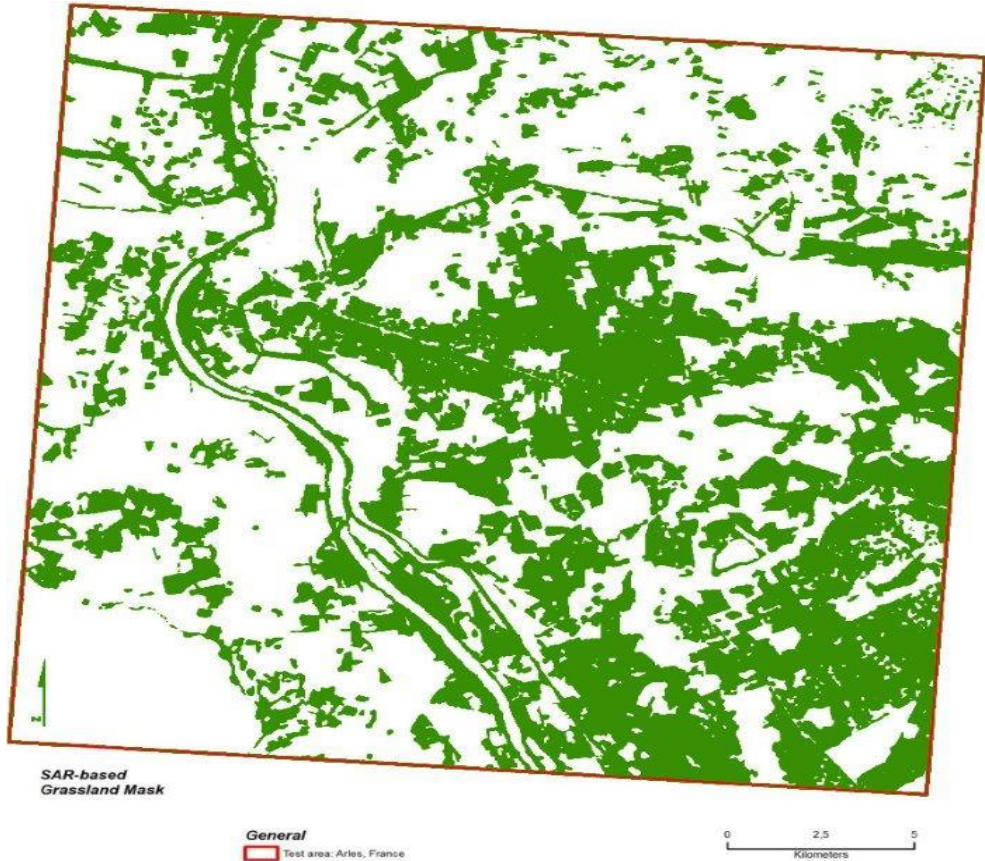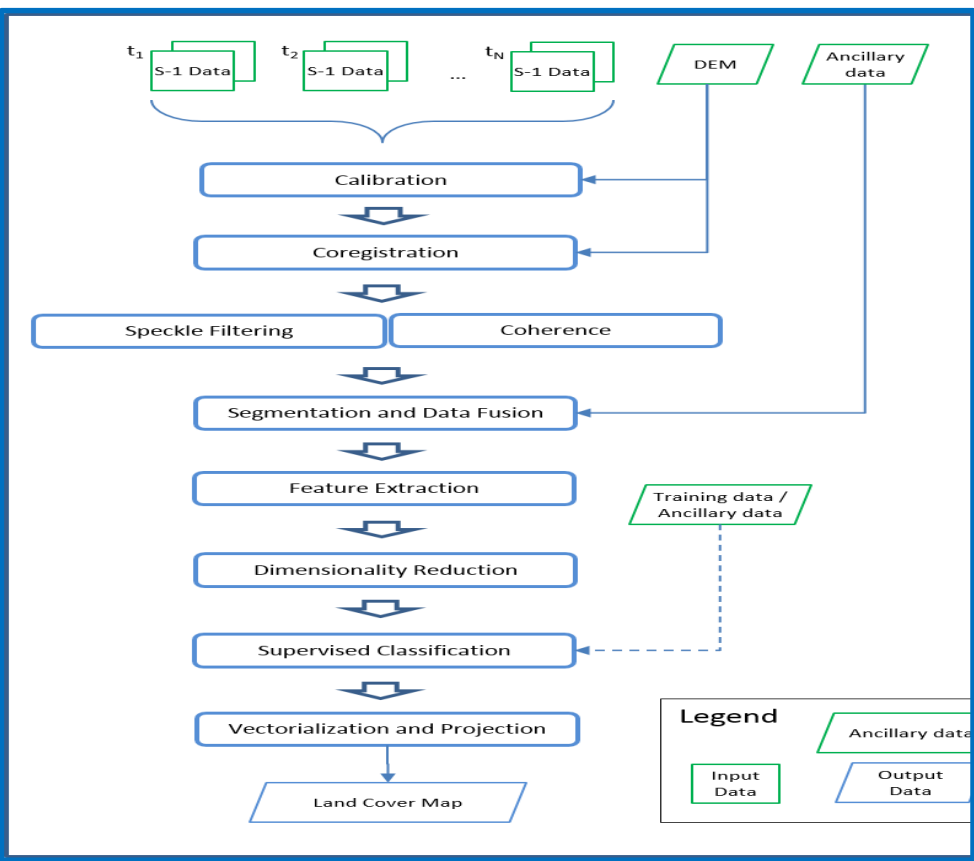
Grassland classification over Europe area + Turkey: JRC funded project GRASSLAND
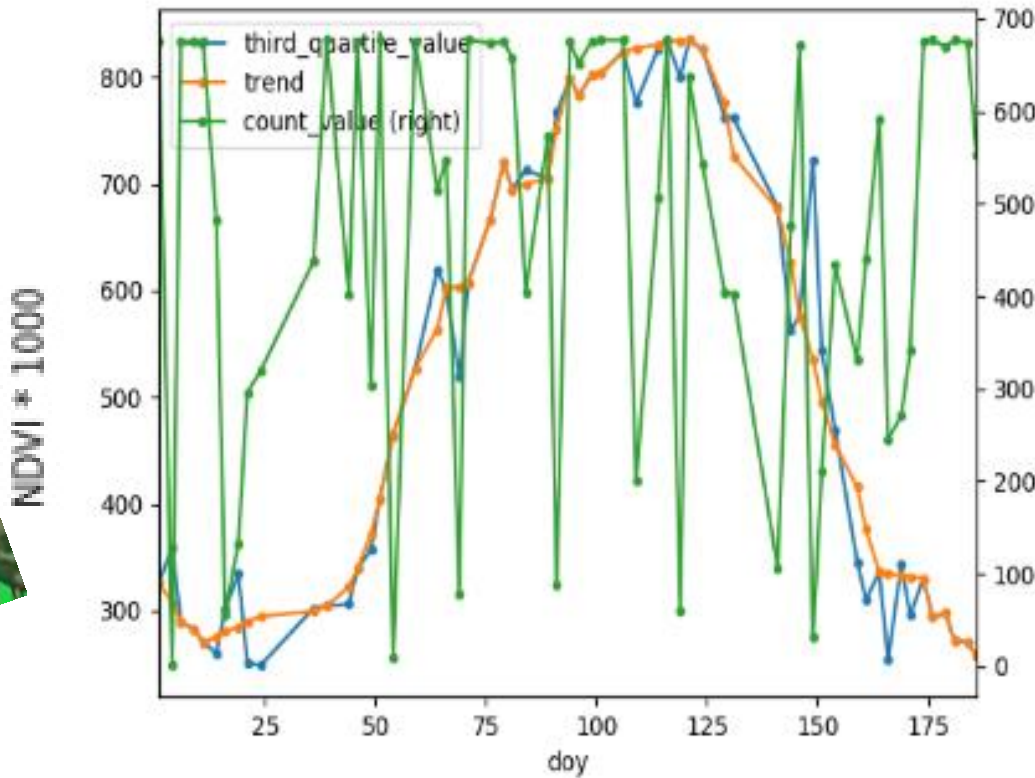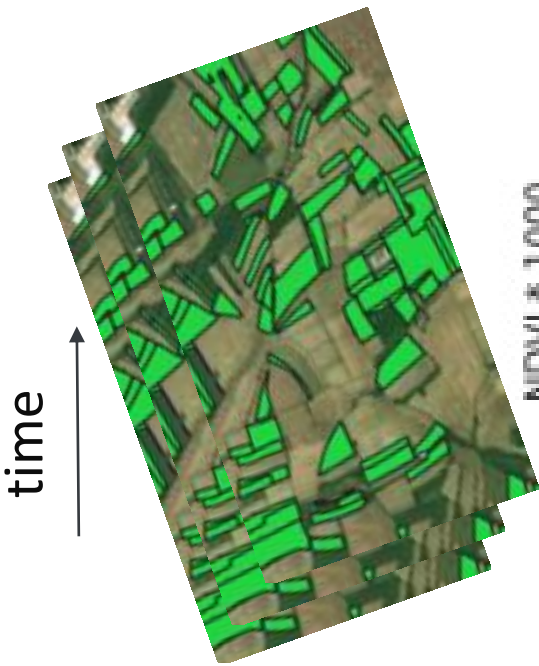
Reference trend of wheat (in orange) in the province of Viterbo.

Samples of profiles of parcels declared as wheat. Reference trend of wheat (in black) in the province of Chieti.

Samples of potential incongruences with respect to farmers' declarations of wheat.

Soil Moisture Content based on **SAOCOM (SAR L band) + COSMO SkyMed (SAR X band) + Sentinel 1 (SAR C band)**
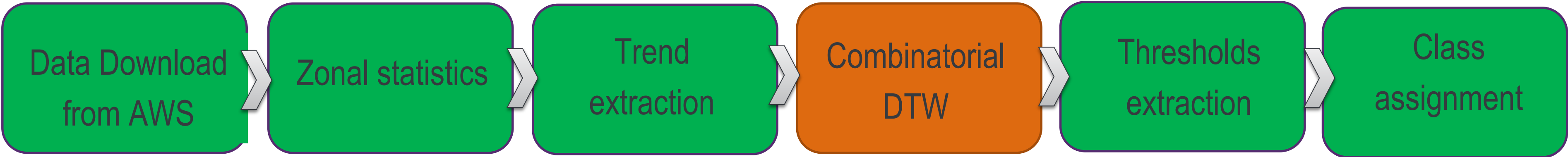**-> ASI R&D PROJECT CLEXIDRA, MISE TESEO, H2020 GD Farm-to-Fork**

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Focus on technology development – AI techniques exploitation

Reference trend of wheat (in orange) in the province of Viterbo.

TOR – Trend Outlier Removal

Automatic identification of not compliant parcels in farmers' declarations to support CAP

Workflow   **LDO LABs on AI**

Samples of profiles of parcels declared as wheat. Reference trend of wheat (in black) in the province of Chieti.

Data Download from AWS	Zonal statistics	Trend extraction	Combinatorial DTW	Thresholds extraction	Class assignment

Sentinel -2 time series and potentially Sentinel-1

time

Extraction of **zonal statistics** on rasters within geometries of parcels declared by farmers. Before the extraction, data are masked and geometries are **buffered**.

Extraction of **trend** for each crop of interest.

The trend is extracted taking into account only the "best days" in terms of overall reduced cloud coverage.

DTW (Dynamic Time Warping) has been chosen as distance for comparing temporal series.

DTW is robust to temporal variations, due to different farming practices, for instance.
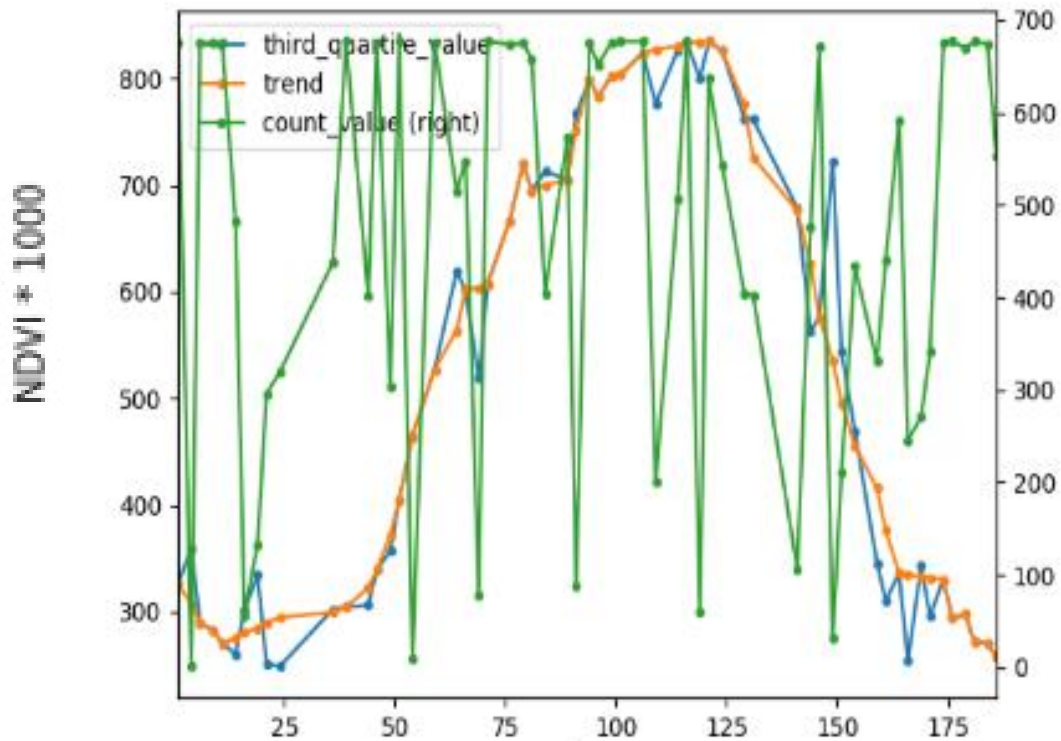
Thresholds extraction from **Precision-Recall curve** and from **Receiver Operating Characteristic curve.**
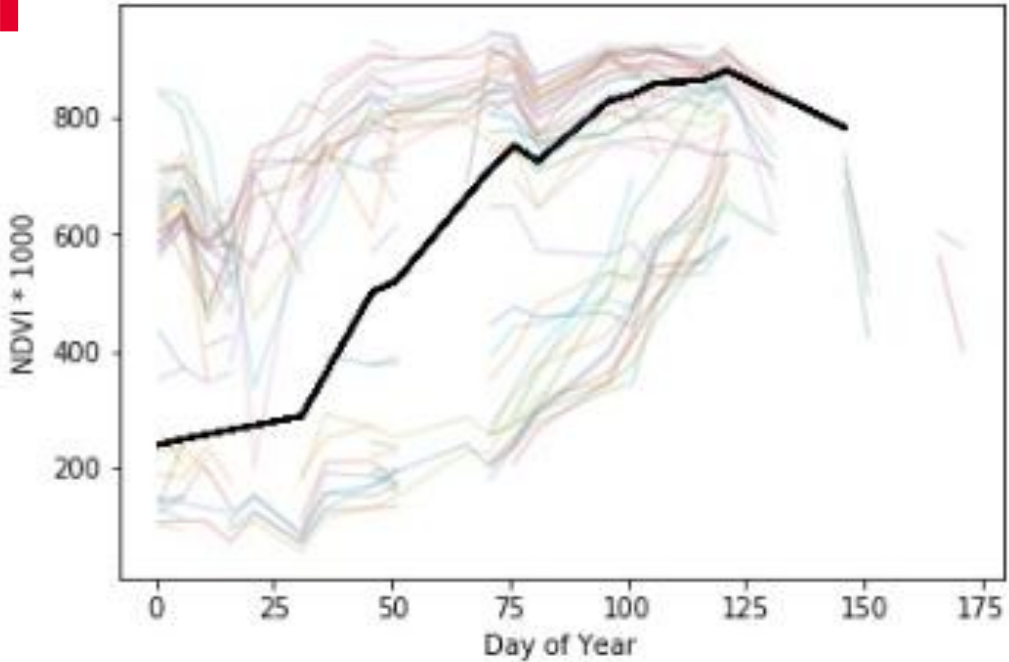
Each parcel can be classified as:
- **Not anomaly**
- **Anomaly**
- **To be checked** (user requirement)

*Samples of potential incongruences with respect to farmers' declarations of wheat.*

Focus on technology development – hyperspectral data

- Phase A of SHALOM mission
- PRISMA image simulator HSIS
- PRISMA/SHALOM products development in progress

Vegetation indicators based on PRISMA hyperspectral

H2020 Green Deal «Firefighting», «Farm to Fork», ESA BASS SES5G, ASI R&D PROJECT THERA, ASI PROJECT IPERSPETTRALE
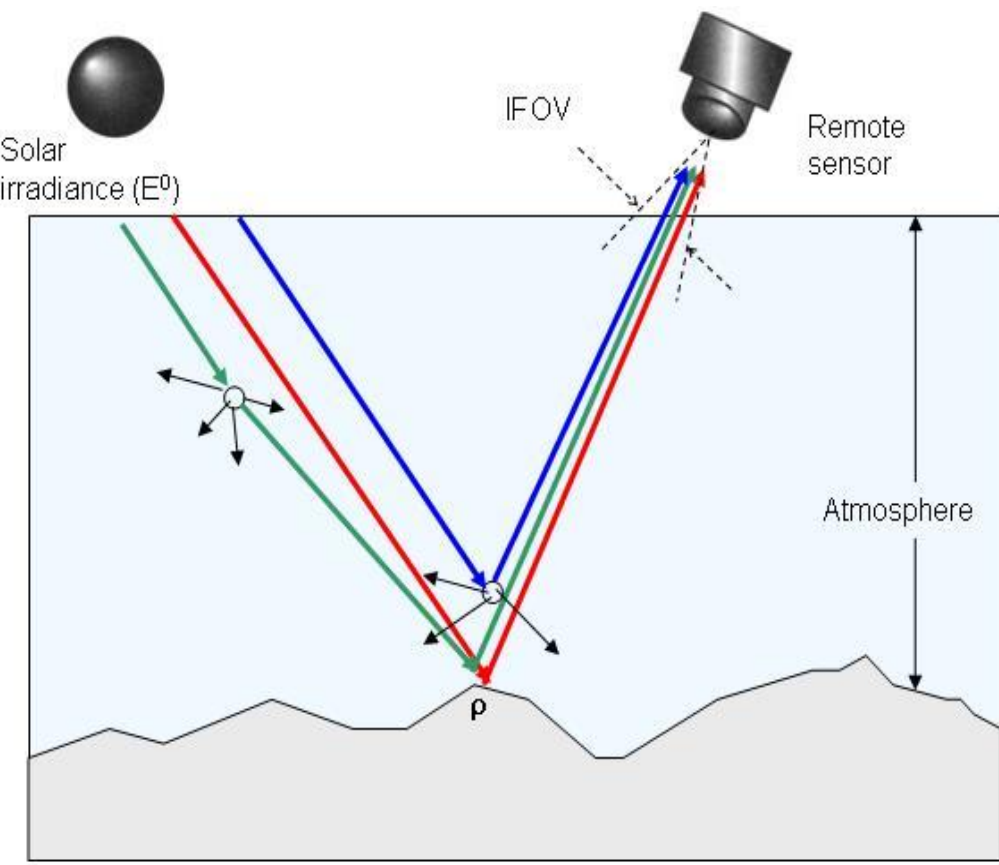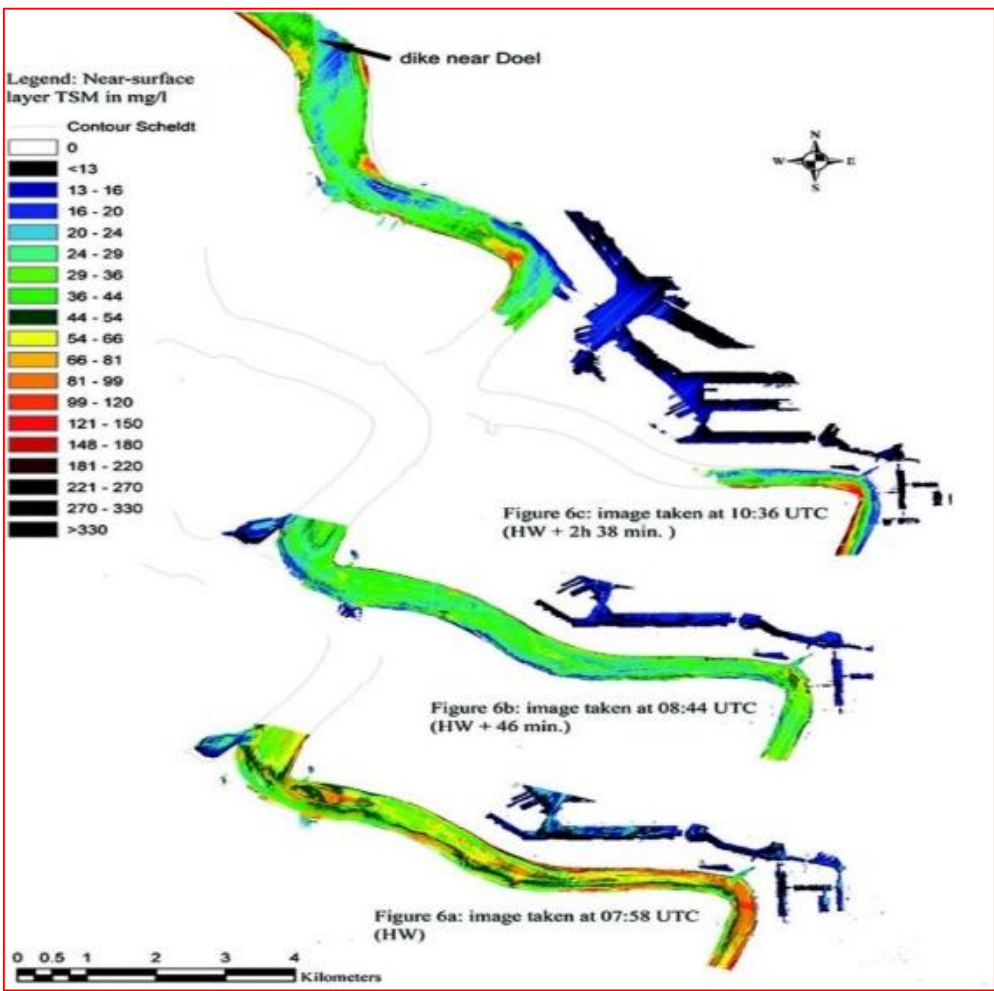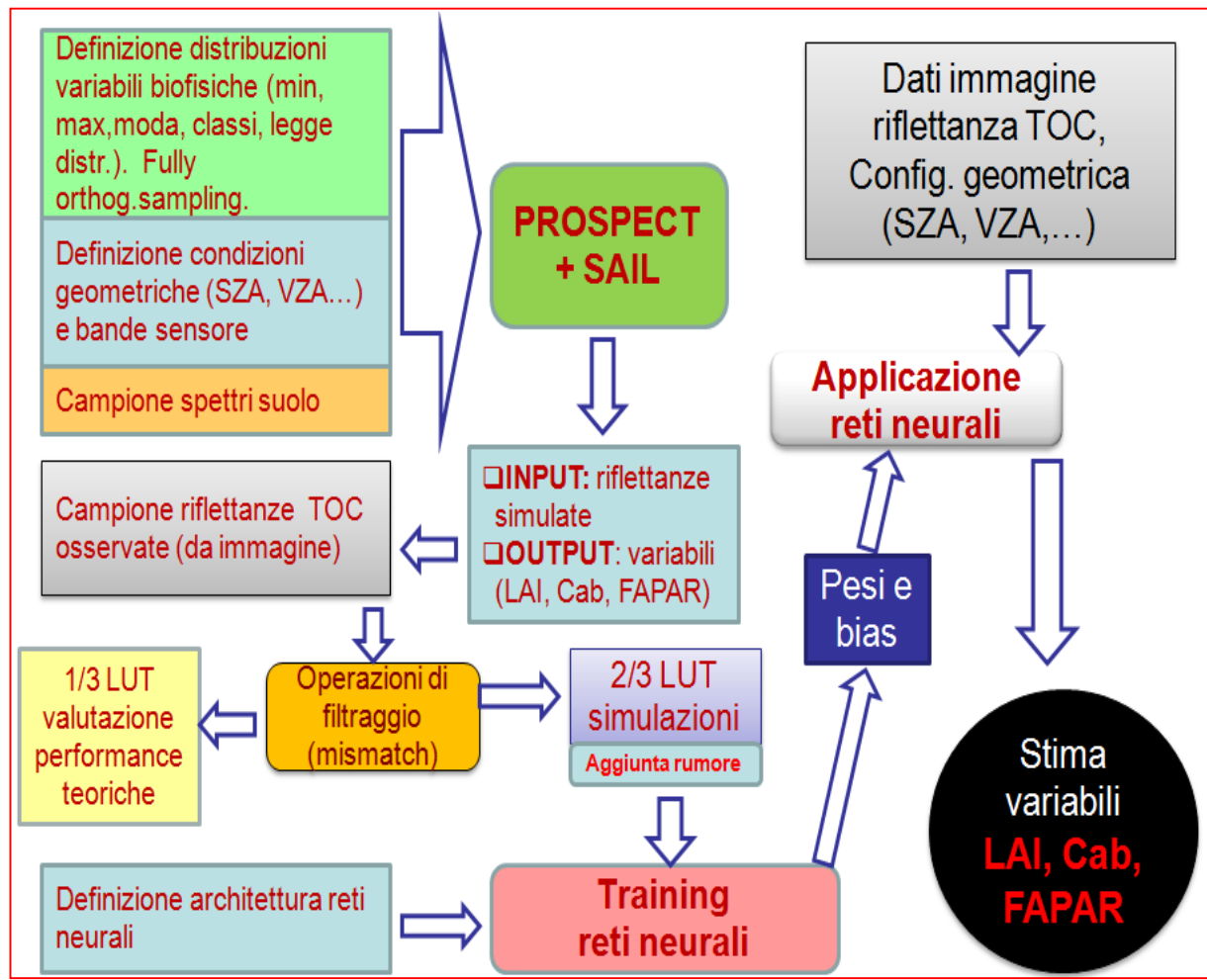

radiative transfer model
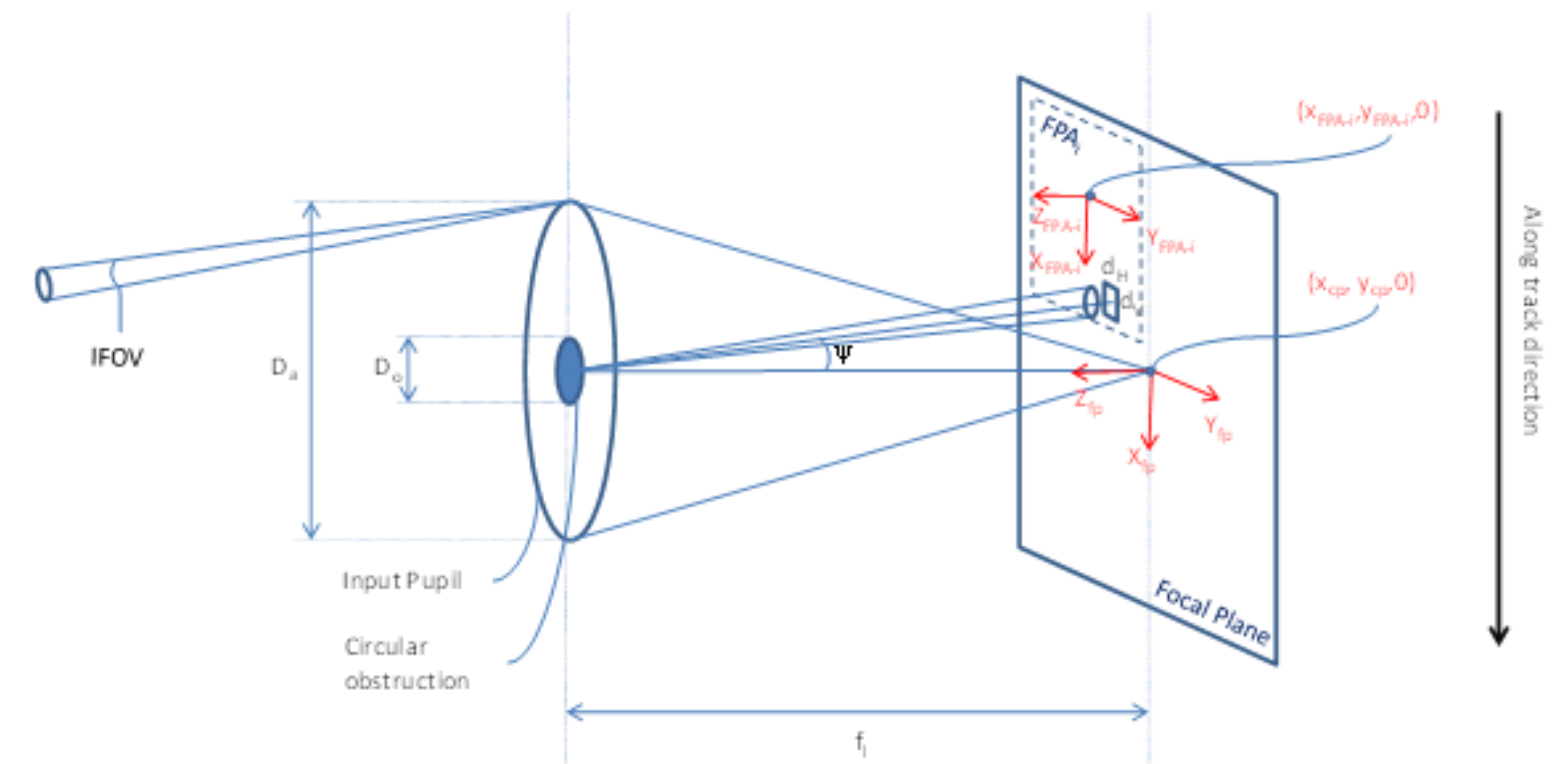
PAN/MS/HYP instrument Models (PRISMA/GOKTURK)
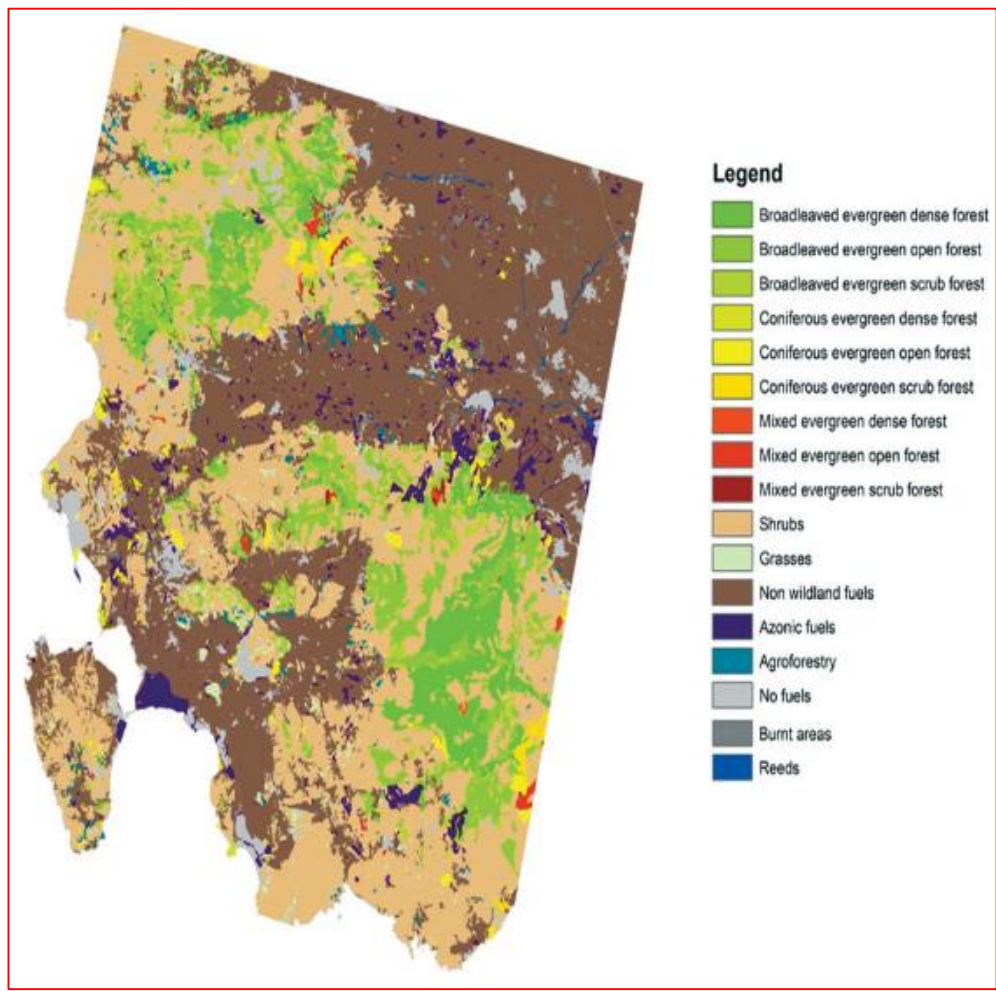
Water quality with CNR IREA

Total Suspended Matter mg/l for three sea levels (Sterckx et al., 2007), with CNR.
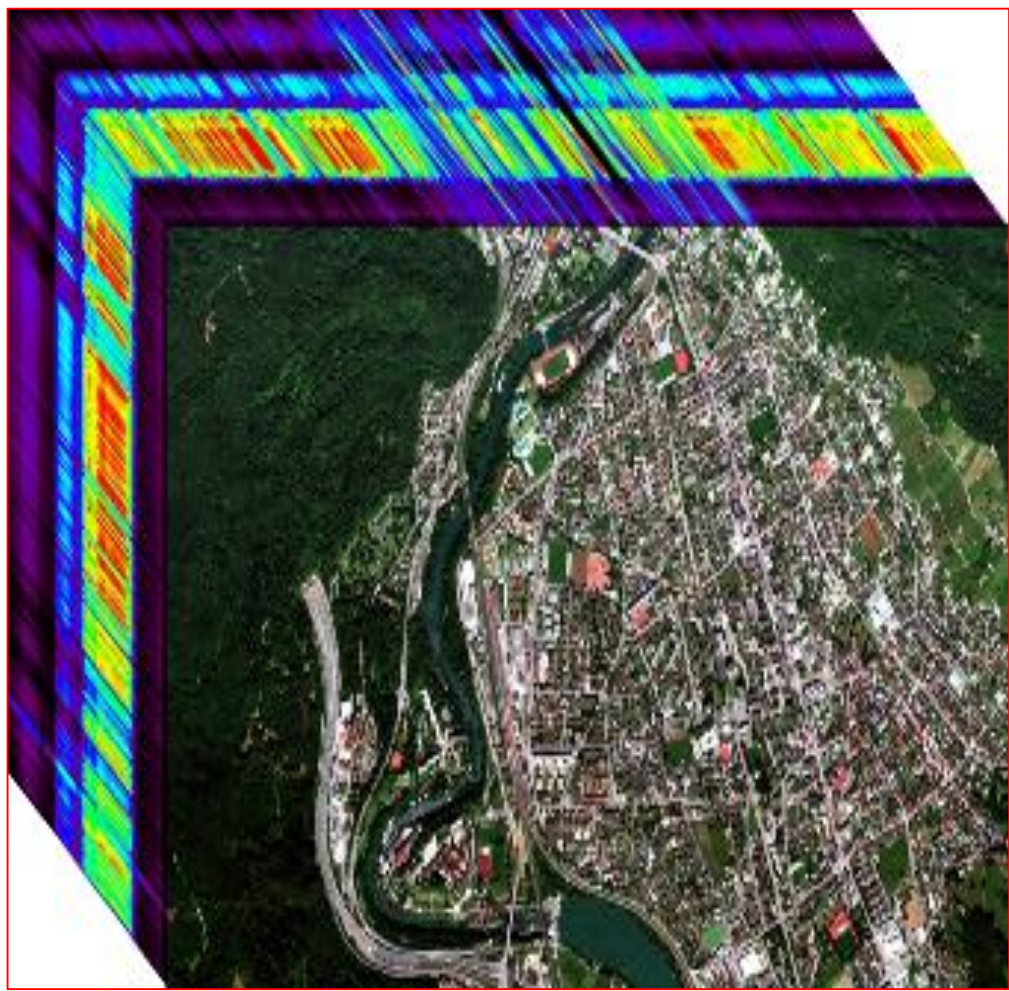
Vegetation indicators with CNR IMAA

Vegetation indicators retrieval based on ML/DL inversion of models (with CNR)

Fire Fuel Map with UNIROMA1

Fire fuel map (with UNIROMA1)

Material detection with UNIPISA

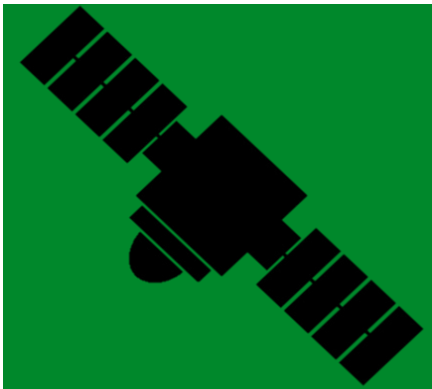Material Detection (with UNIPISA)

Digital Twin Earth Precursor

Climate Explorer

built on existing advanced
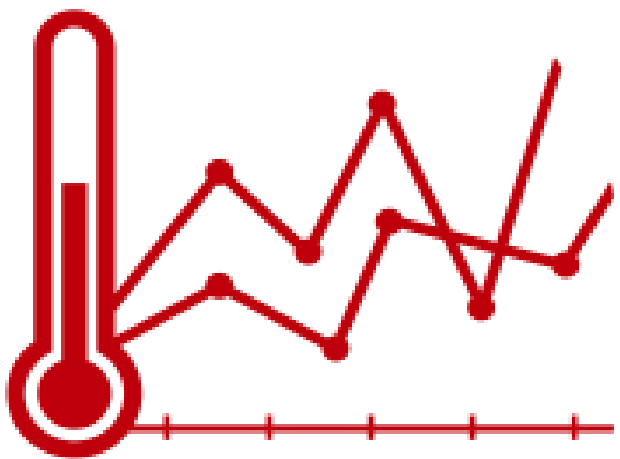**Earth System Model**
(land/atmosphere/ocean)

assimilating state-of-the-art
Earth Observation Data

delivered via
Machine Learning Emulation

through a cloud-based
Interactive Data Portal

Will enable **Decision Makers**
without expert technical knowledge
to generate and visualise
Decision Ready Information
related to

Regional Impacts of Climate Change

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