Satellite data in Agriculture

ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

DR. PANAGIOTIS (PANOS) ILIAS
IT BUSINESS ANALYST – FOOD & TECHNOLOGY DEPARTMENT
INSTITUUT VOOR LANDBOUW VISSERIJ EN VOEDINGSONDERZOEK

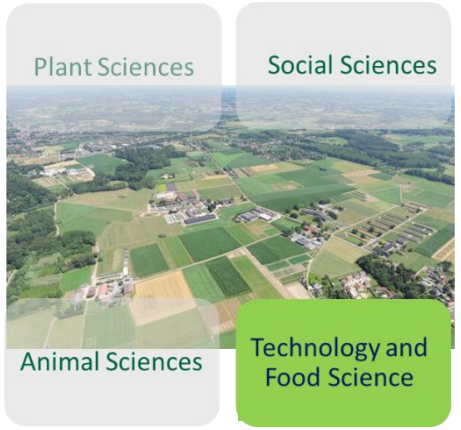
ABOUT ME:

- GeoAI Engineer: Enjoy to design and develop IT solutions by applying business analysis and architectural best practices.
- Experience in various domains including AgriFood.
- Support current ILVO digitalization activities like the DjustConnect Data Sharing Platform, AI-platform, the Development of EU Agricultural data space and the Food Waste Data Space.
- Responsible for the development of EO AI based services that can support the Topsoil Organic Carbon Estimation within the ENVISION, EJP-Soil Stereopes and ScaleAgData projects.
- I am leading the BDVA TF.AgriFood.

BDV BIG DATA VALUE ASSOCIATION

ABOUT ILVO:

- Flanders Research Institute for Agriculture, Fisheries and Food.
- Research Institute linked to the Flemish government.
- Created 85 years ago, 630 employees.
- One of ILVO mission is to support Flemish AgriFood community to its digitalization activities.
  - Data Sharing / API economy.
  - Digital Sovereignty.
  - Precision - Smart Farming.
  - AI, IoT, Big data & Robotics.



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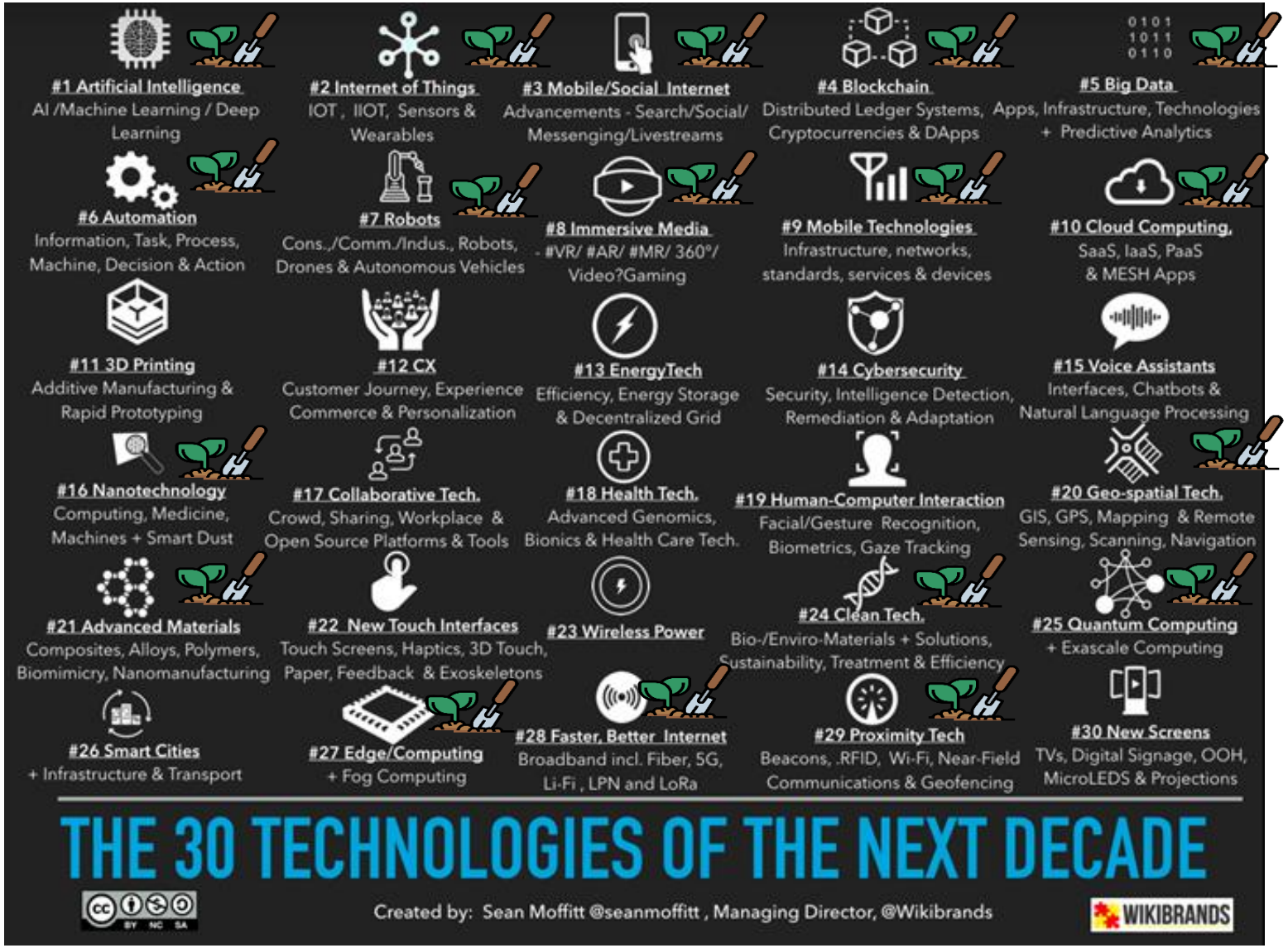
Part A: The Technology Industry, the Space Sector & the AgriFood industry.

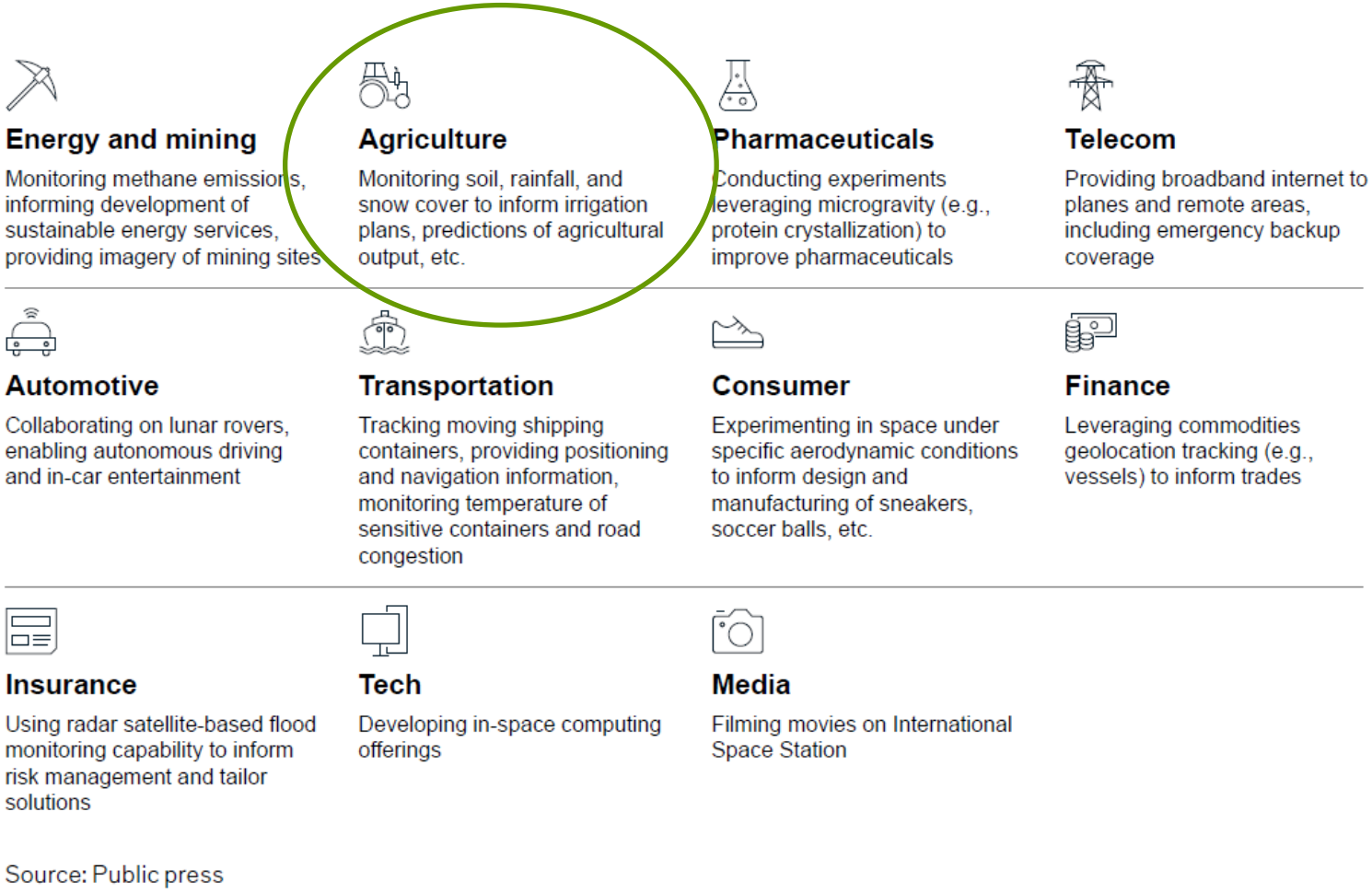
Source: https://business.esa.int/news/how-space-data-enabling-agritech-sector

The technological industry keeps up with high growth rates



Agricultural applications!!!

The Space industry



Energy and mining

Monitoring methane emissions, informing development of sustainable energy services, providing imagery of mining sites

Agriculture

Monitoring soil, rainfall, and snow cover to inform irrigation plans, predictions of agricultural output, etc.

Pharmaceuticals

Conducting experiments leveraging microgravity (e.g., protein crystallization) to improve pharmaceuticals

Telecom

Providing broadband internet to planes and remote areas, including emergency backup coverage

Automotive

Collaborating on lunar rovers, enabling autonomous driving and in-car entertainment

Transportation

Tracking moving shipping containers, providing positioning and navigation information, monitoring temperature of sensitive containers and road congestion

Consumer

Experimenting in space under specific aerodynamic conditions to inform design and manufacturing of sneakers, soccer balls, etc.

Finance

Leveraging commodities geolocation tracking (e.g., vessels) to inform trades

Insurance

Using radar satellite-based flood monitoring capability to inform risk management and tailor solutions

Tech

Developing in-space computing offerings

Media

Filming movies on International Space Station

Source: Public press

Source: https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/the-role-of-space-in-driving-sustainability-security-and-development-on-earth

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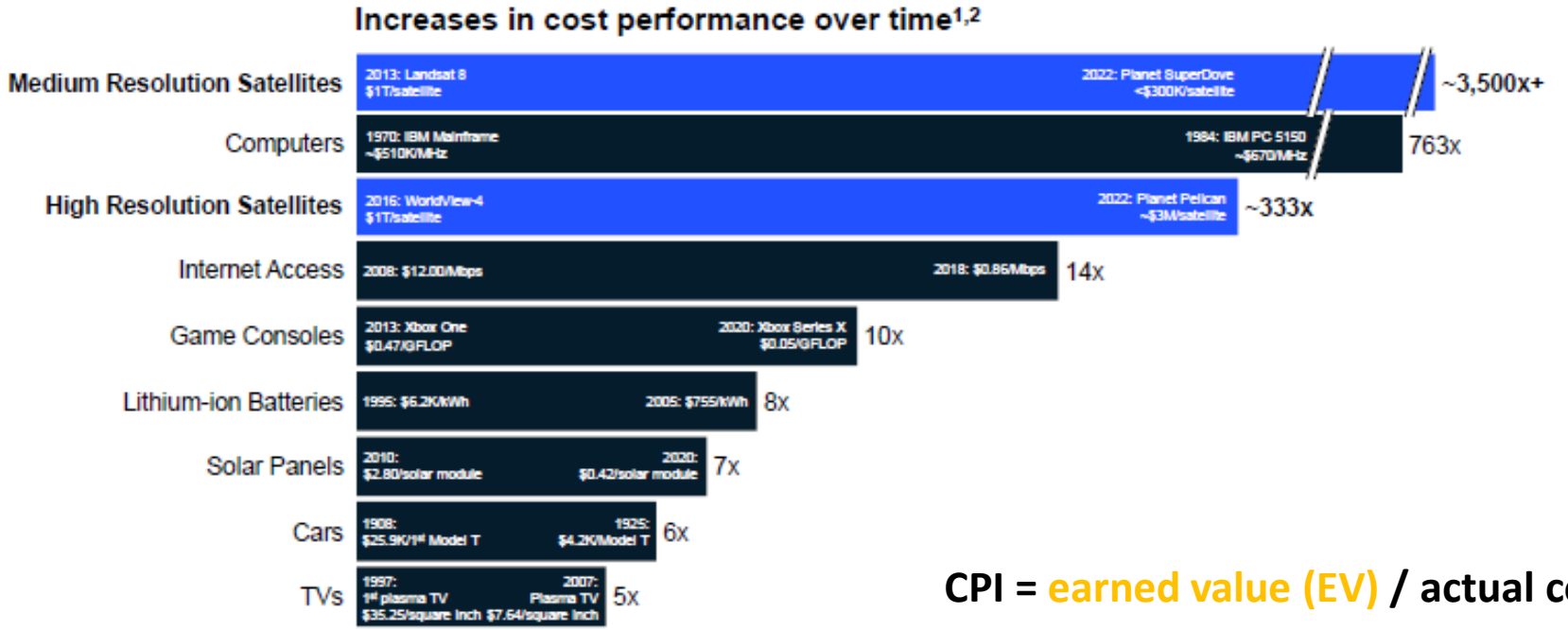
The Satellite cost performance index

Exhibit 2: Satellite cost performance improvements within a 15-year time horizon far surpass those seen in most other technologies.



1. Prices are converted to 2022 dollars
2. Comparisons reflect products with similar end-markets; however, they are not meant to construe perfect substitutes. Products may not be comparable on other factors (eg, satellites may not be comparable on data rates, signal to noise ratio, lifetime – however, increase is notable even on other measures such as dollar per bit)

Source: Public press; CPI Inflation Calculator; Center for Strategic and International Studies; National Renewable Energy Laboratory; NCTA; American Enterprise Institute; expert interviews; McKinsey analysis

CPI = earned value (EV) / actual cost (AC).

Source: https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/the-role-of-space-in-driving-sustainability-security-and-development-on-earth

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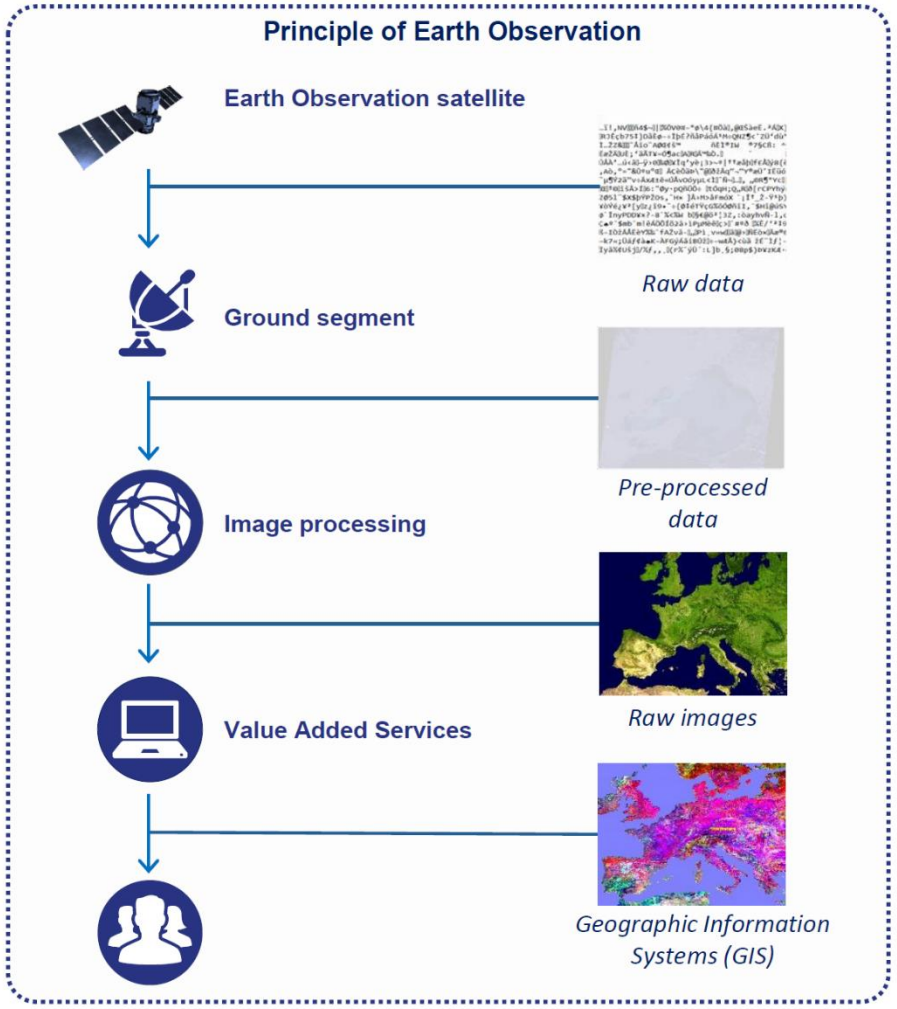
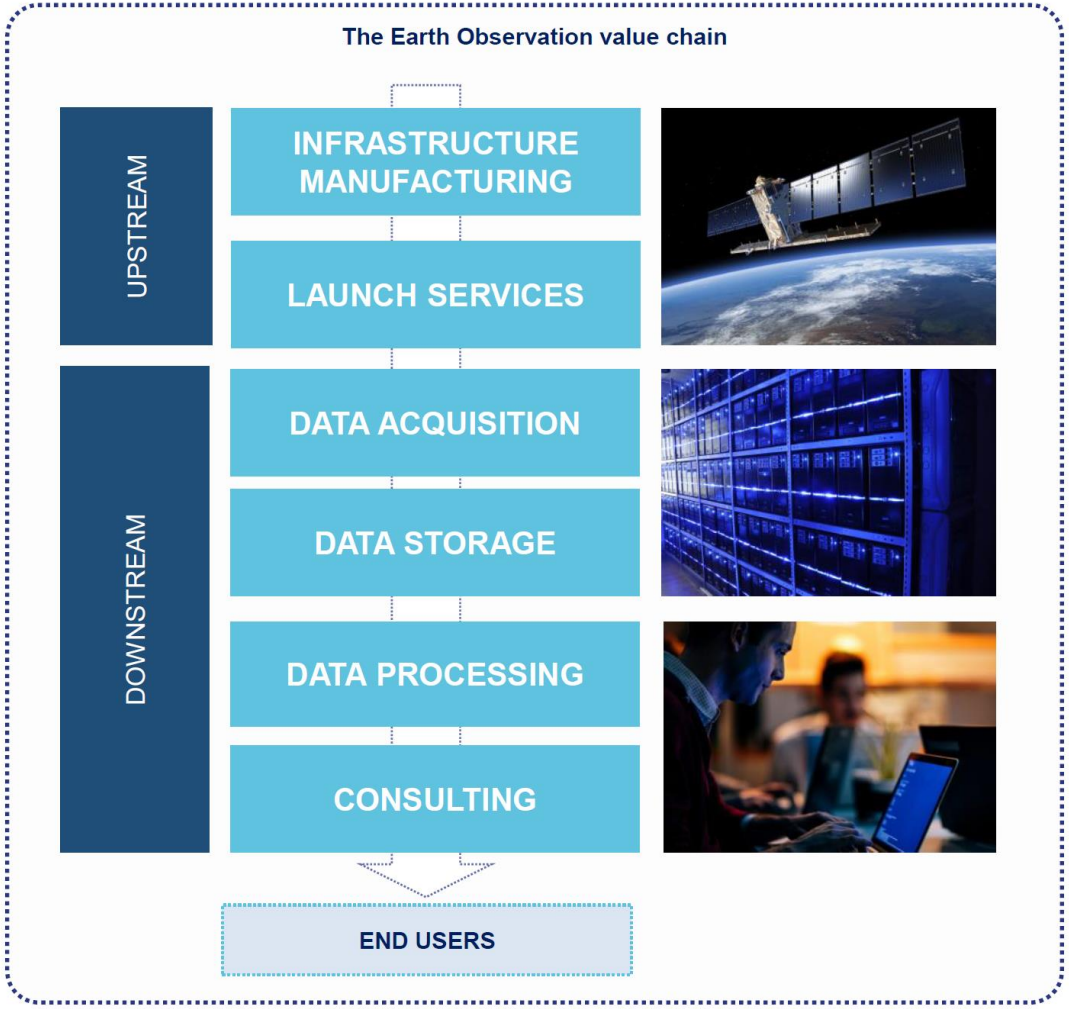
Satellite Earth observation* is one of the main domains

* Earth Observation (EO) refers to remote sensing and in-situ technologies used to capture the planet's physical, chemical, and biological systems and to monitor land, water (i.e. seas, rivers, lakes) and the atmosphere.

Satellite-based EO, by definition, relies on the use of satellite-mounted payloads to gather data about Earth's characteristics.





Source: https://op.europa.eu/en/publication-detail/-/publication/693988e9-574c-11e9-a8ed-01aa75ed71a1/language-en

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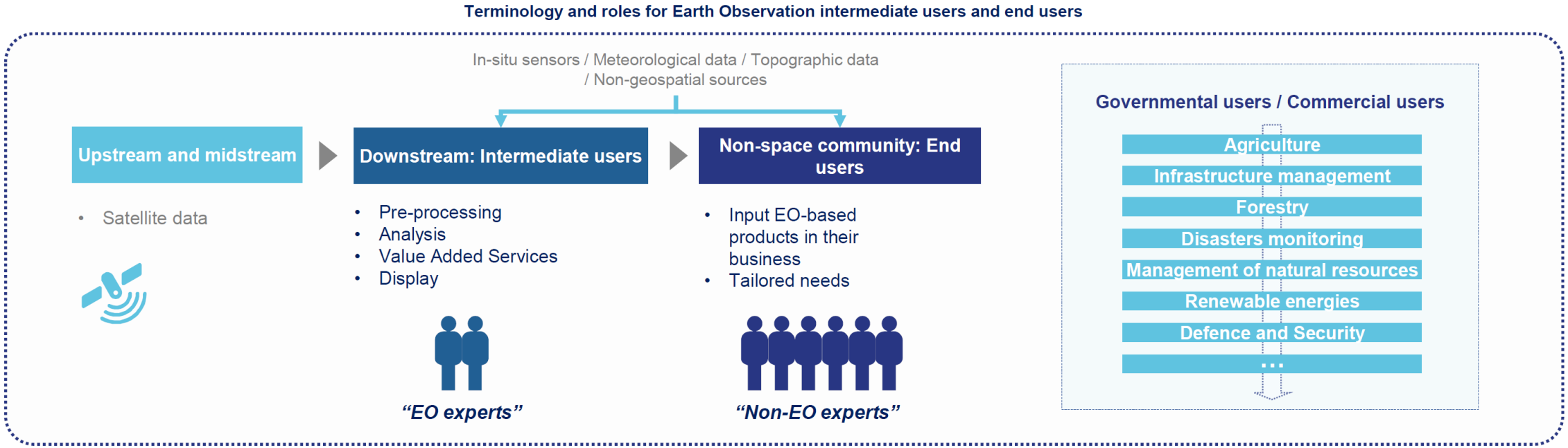
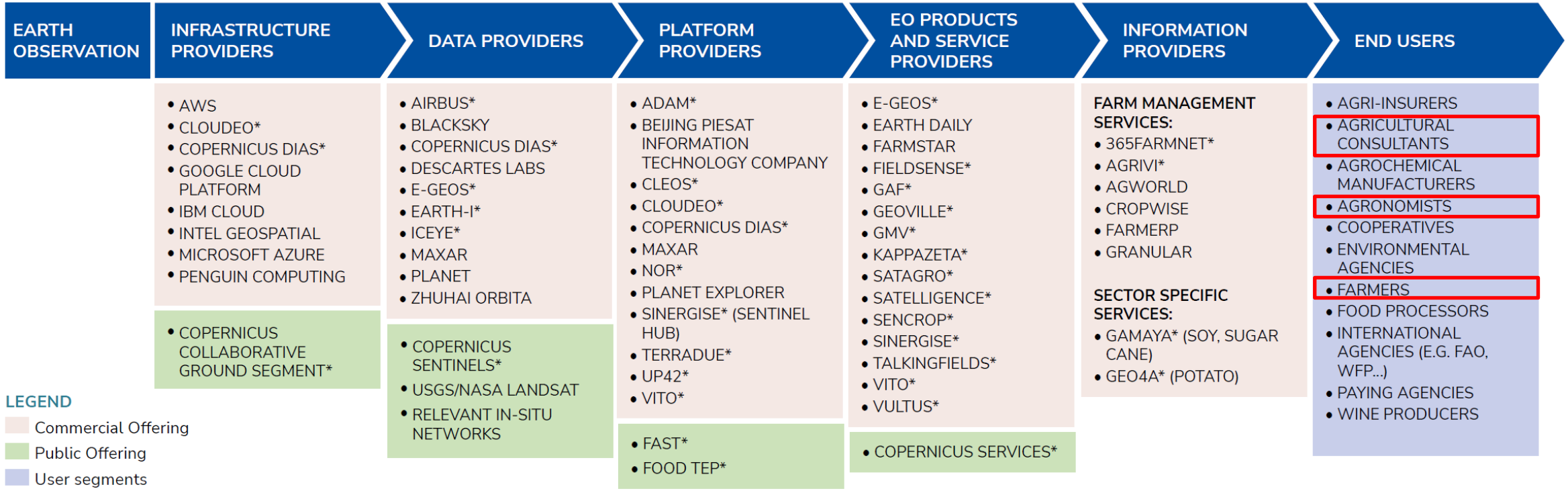
Roles for intermediate users and end users



Source: https://op.europa.eu/en/publication-detail/-/publication/693988e9-574c-11e9-a8ed-01aa75ed71a1/language-en

Agriculture Value Chains & Farmers



Source: https://www.euspa.europa.eu/2022-market-report

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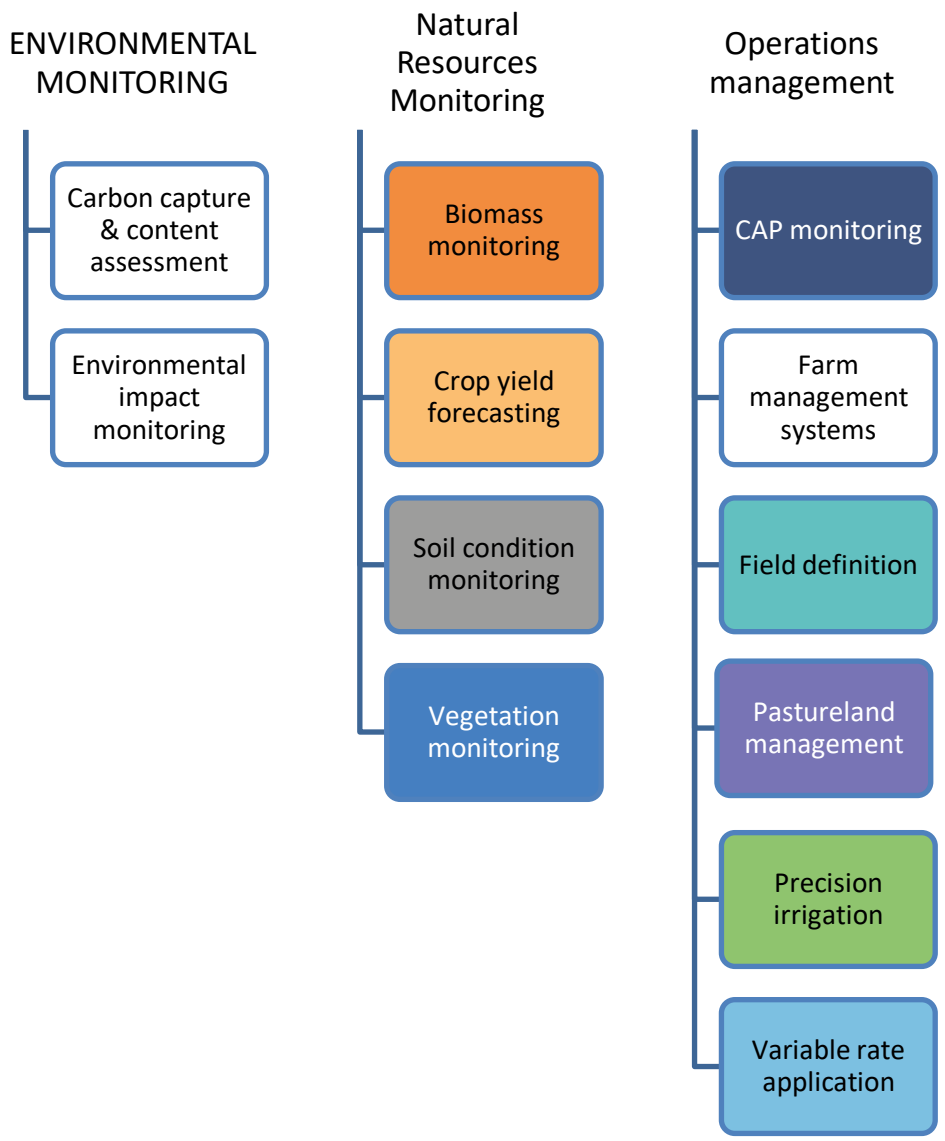
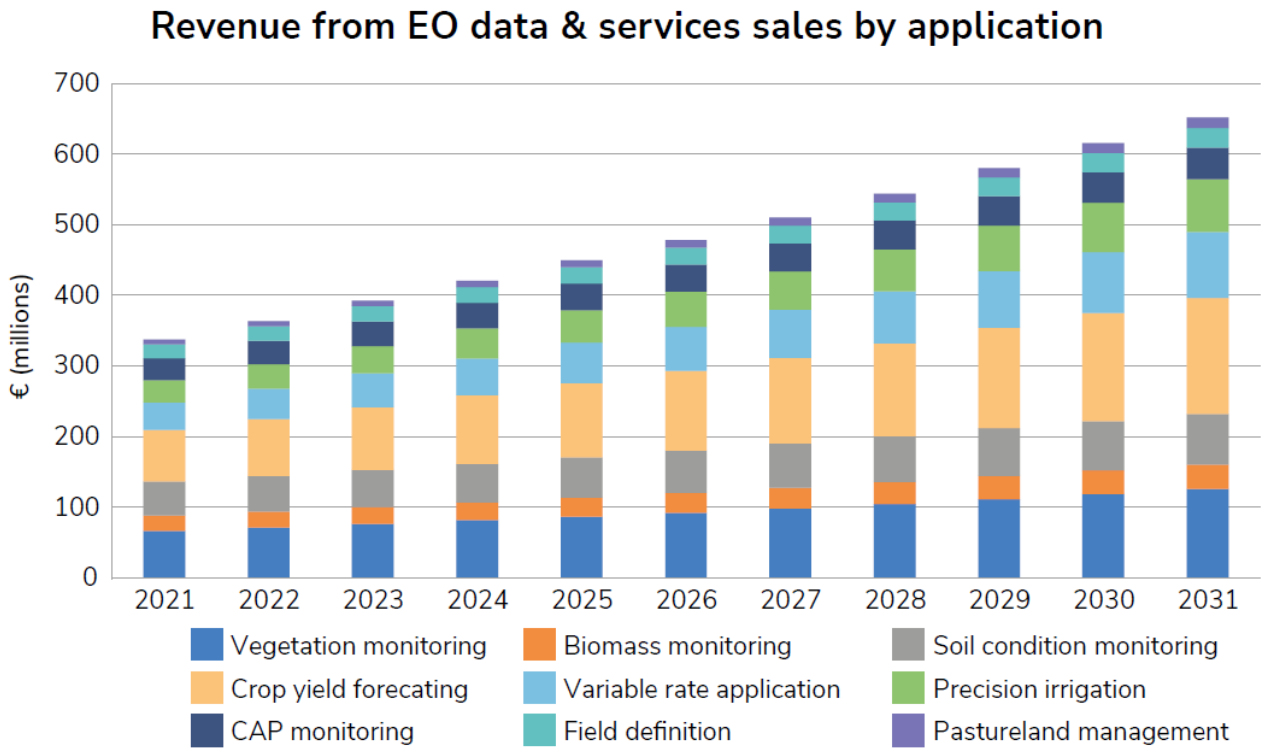
Agricultural applications & revenue



Global Navigation Satellite System (GNSS)



Source: https://www.euspa.europa.eu/2022-market-report

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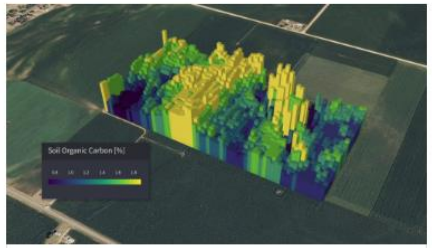
Earth observation a promising investment but..



Cloud Ag visualization showing variable soil carbon levels across a single field. Image credit: Cloud Ag

Startup Spotlight: Cloud Ag seeks to replace soil sampling by measuring carbon from the air

December 1, 2020 Jack Ellis

The agriculture industry is slowly but steadily switchin on to carbon sequestration, its potential environmenta impact, and the opportunity for it to provide additiona income streams for farmers.

PROJECT PLANET

Scientists say this new satellite is a game changer for tracking how our environment is changing

By Danya Gainor

Success Stories

Copernicus Sentinel-2 data to estimate soil organic carbon in croplands

03 May 2019

One of the main threats for soil degradation is the decline of soil organic carbon—the Copernicus Sentinel-2 satellites are currently being exploited to monitor soil conditions in croplands, in turn supporting the Common Agricultural Policy of the European Union.

GNSS- and EO-enabled revenues crossed €200 billion in 2021, set to reach almost €500 billion over the next decade

EUROPEAN UNION

EU MISSIONS SOIL DEAL FOR EUROPE

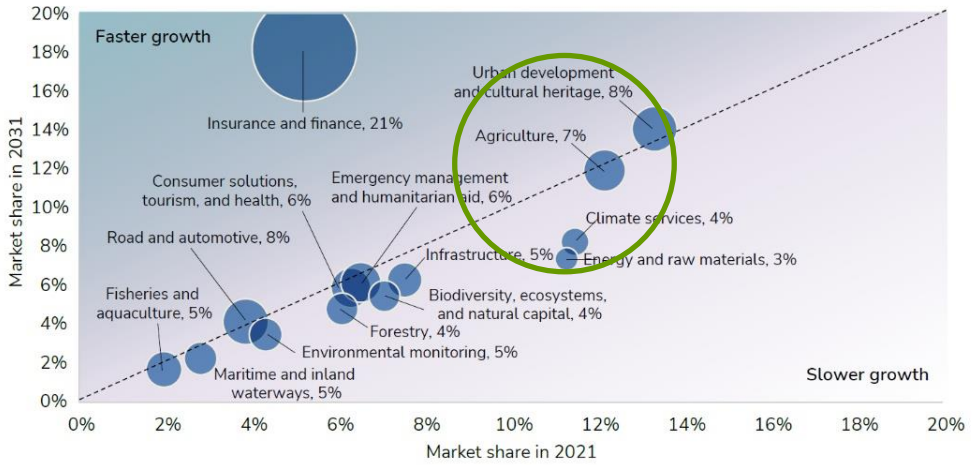
Soils in the new CAP

- Soil management is recognised in the new CAP as an important element to improve farm sustainability in economic and environmental terms:
  - Specific objective 5: **"Foster sustainable development and efficient management of natural resources such as water, soil and air".**
- Higher environmental ambition of the new CAP is channelled e.g. via
  - stronger requirements for conditionality
  - new GAEC 2: preservation of carbon rich soils such as peatlands and wetlands
  - eco-schemes
  - agri-environment-climate measures
  - farm investments
  - Farm Sustainability Tool for Nutrient Management (FaST)

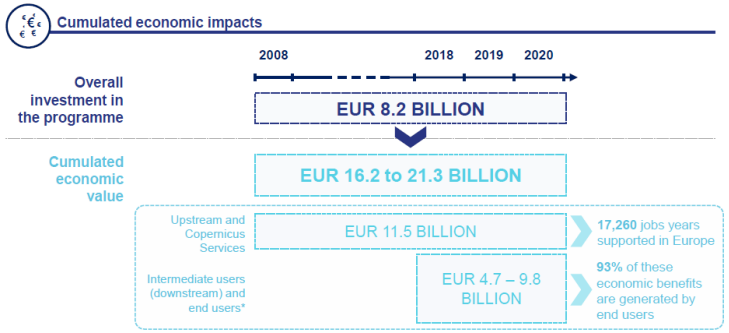
Research and innovation recognised as an enabler for achieving CAP objectives

7

Segment's market share in 2021 and 2031



Note: The size of the bubbles represent the CAGR of each segment between 2021 and 2031.



Copernicus Europe's eyes on Earth

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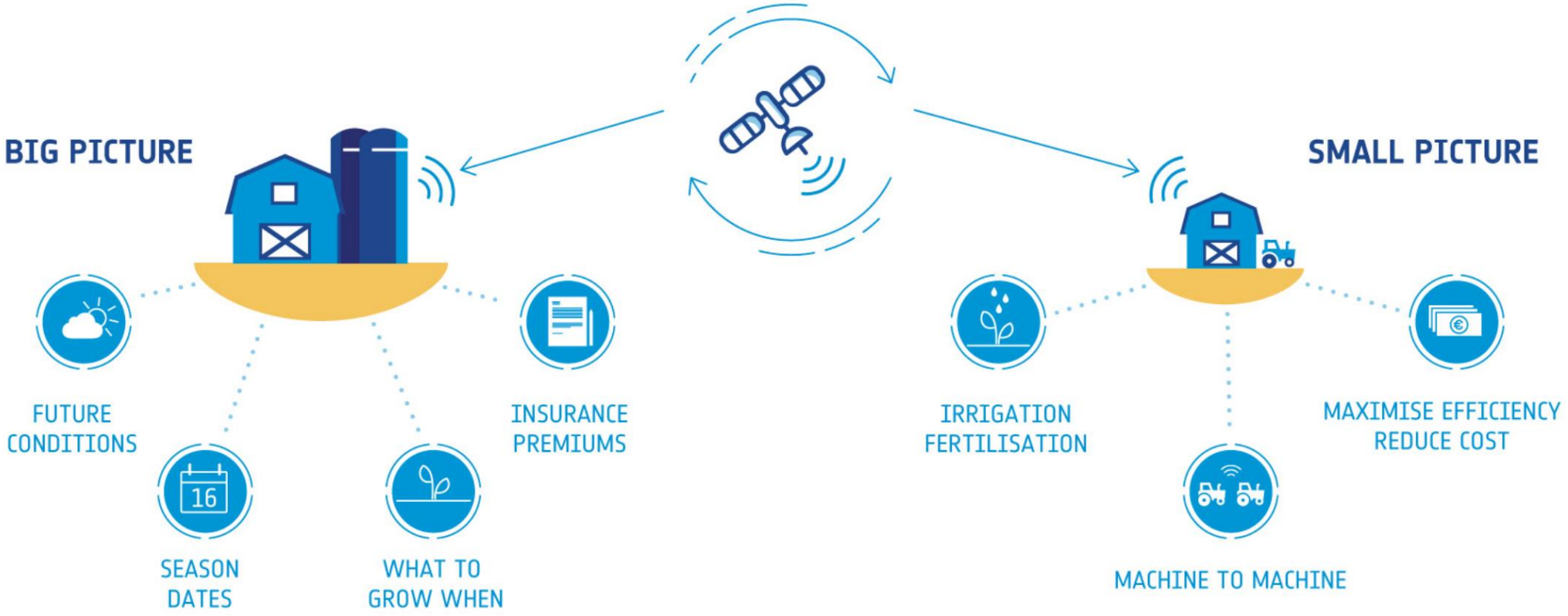
Part B:
Adoption of EO-based innovations



https://business.esa.int/news/how-space-data-enabling-agritech-sector

The end-user(s) has questions …

How can we integrate this service? Another APP?
Accuracy issues? Technological problems?
Are there independent reviews? Will it work in practice?

How to get started? Solution for my specific problem?
Is it applicable for me?

What about my data? Are others happy with the change?

Payback time? How will this improve my life?
Added value? High investment costs!
Reduce of cost and when?

Studie Departement Landbouw en Visserij: "Toepassing van precisielandbouwtechnieken"
VIS studie: "Digitale transformatie in de voedingsindustrie, wat is een ideaal concept voor living labs?"

Clear need for (real-life) end-user involvement

Top 10 companies across the value chain based on 2019 revenues

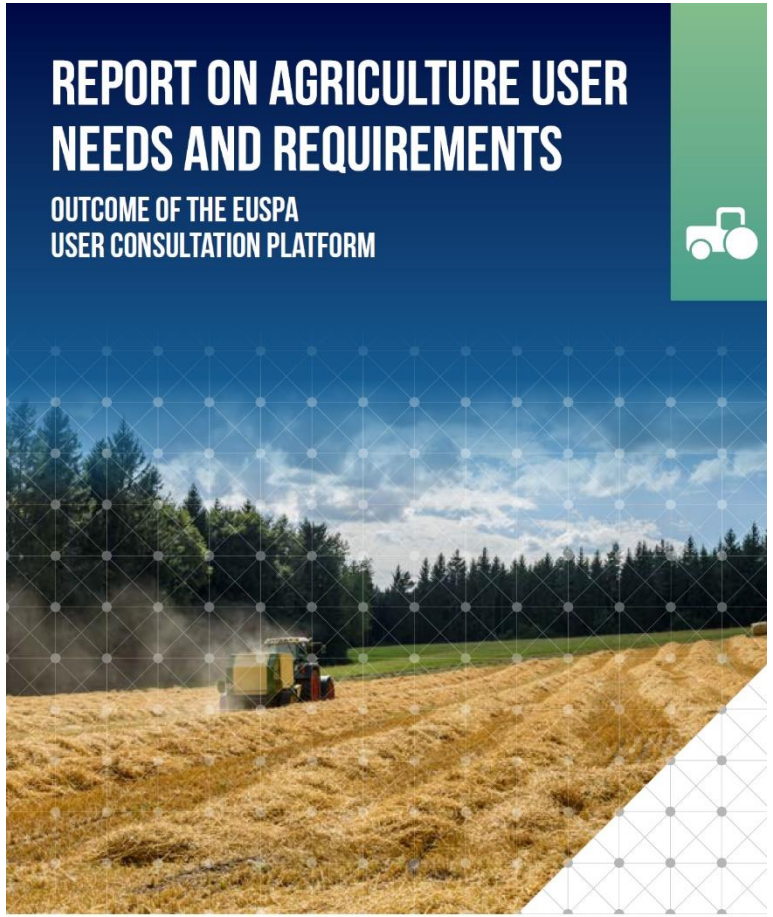
Data acquisition and distribution		Data processing		Analysis, insights & decision support		Users
Maxar	US	Maxar	US	Airbus	NL	
Airbus	NL	Airbus	NL	Leonardo	IT	
Thales	FR	Alphabet Inc. (Google)	US	Verisk	US	
Planet	US	Leonardo	IT	Trimble Inc.	US	Users of EO products and services across the different market segments
Leonardo	IT	Oracle Corp	US	NEC Corporation	JP	
Amazon	US	Amazon	US	CGI Inc.	CA	
Space Imaging Middle East	AE	CGI Inc.	CA	Maxar	US	
21AT	CN	ESRI	US	VITO	BE	
KSAT	NO	Trimble	US	21AT	CN	
Science and Technology Holding B.V.	NL	Cyient Limited	IN	Beijing Piesat	CN	

the niche EO market of Road and Automotive (led by US companies with 77 %).

Based on the latest European Association of Remote Sensing Companies (EARSC) Industry Survey, SMEs and start-ups account for more than 93% of European EO companies, showcasing the **importance of small companies** for the European EO economy.

The European EO industry is dominated by SMEs and start-ups

As presented throughout this report, **the flagship EU Space Programme** – driven in tandem by Galileo



GALILEO EGNOS Copernicus

EUSPA European Union Agency for the Space Programme

https://www.euspa.europa.eu/euspace-applications/euspace-users/user-needs-and-requirements

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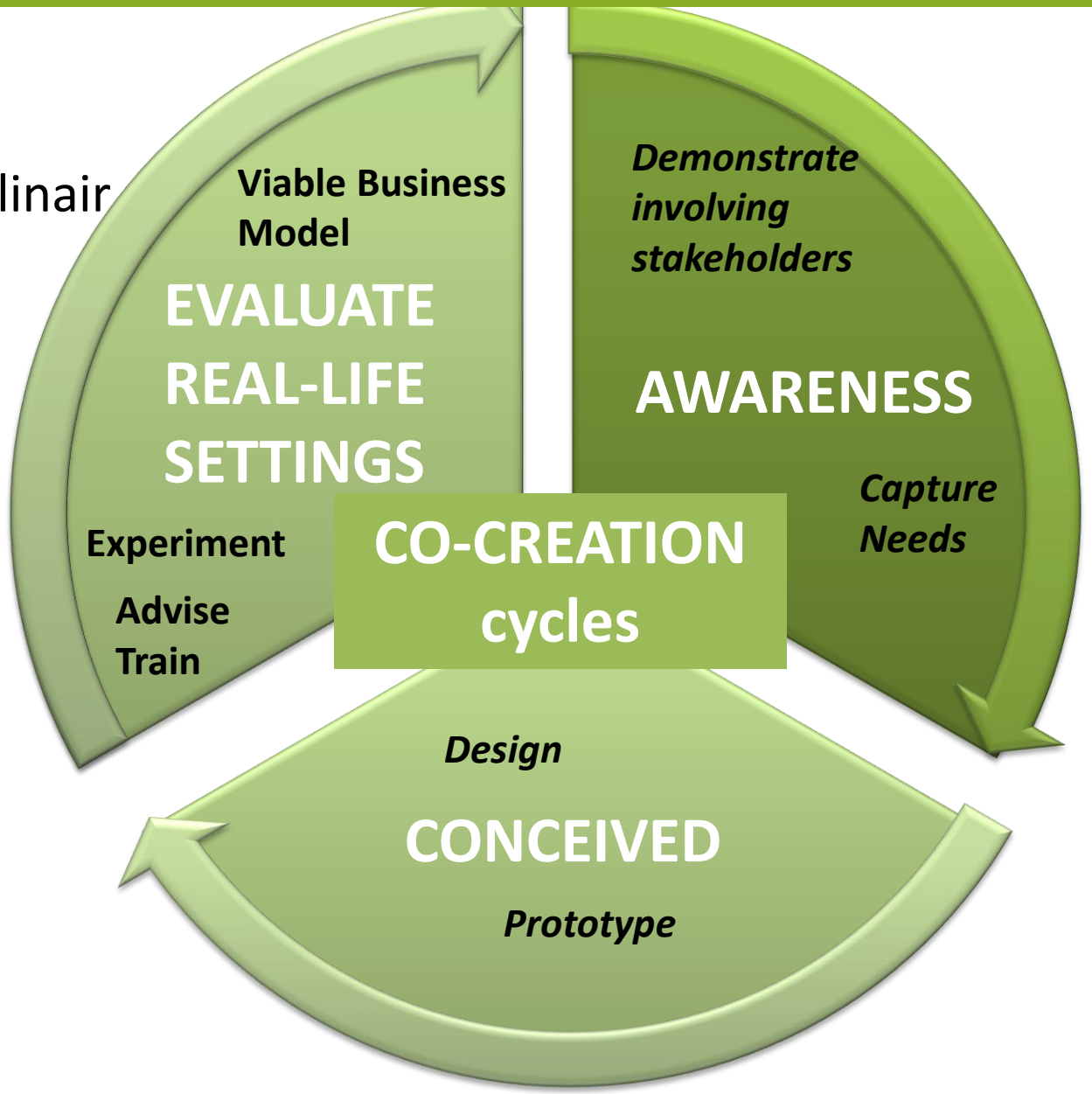
HOW? Living Lab x DIH

✓ Multidisciplinair **expertise**



FARMERS, CONTRACTORS, TECHNOLOGY COMPANIES, SOIL LABS, RESEARCH INSTITUTIONS, GOVERNMENT, CITIZENS, …

An Innovation Road Map for our community

SCALEAGDATA
MAKING DATA COUNT

Emerging technologies to indirect measure and model soil health parameters
EO Hyperspectral, Drones, Robotics

MRV system 'Carbon farming action platform'
EO-based Copernicus data - DjustConnect

Carbon Counts

Emerging technologies to indirect measure and model soil health parameters
Robotics

Emerging technologies to indirect measure and model SOC for CAP needs
EO-based Copernicus data

envision

EJP SOIL
STEROPES

DJUST CONNECT

Soil services relay on data sharing
DjustConnect – Soil Passport

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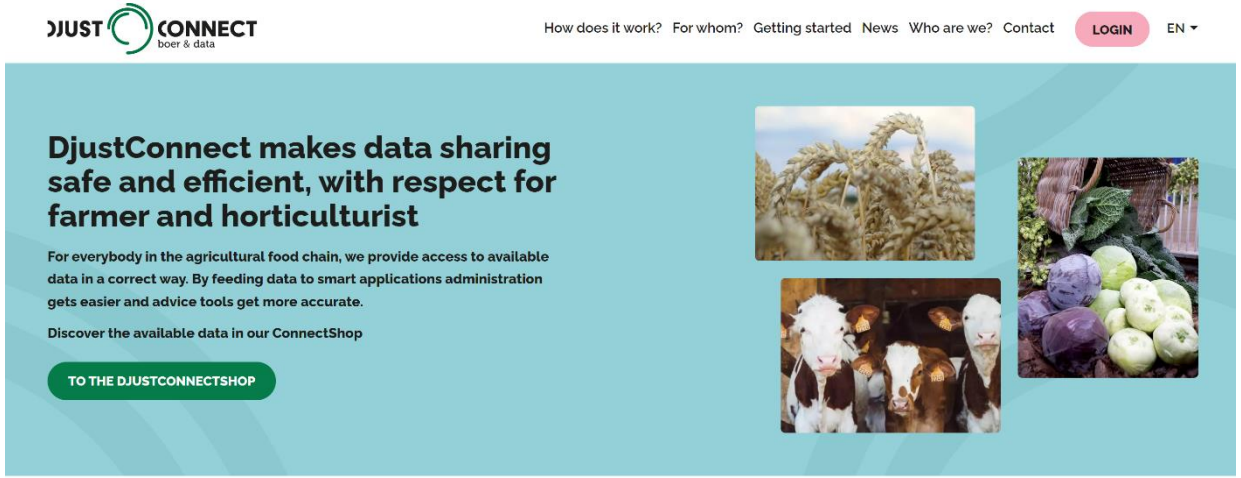

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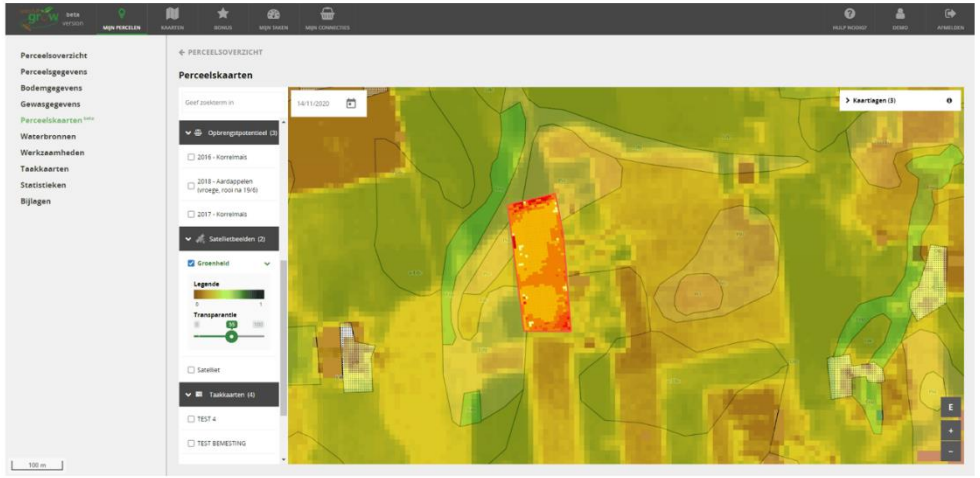
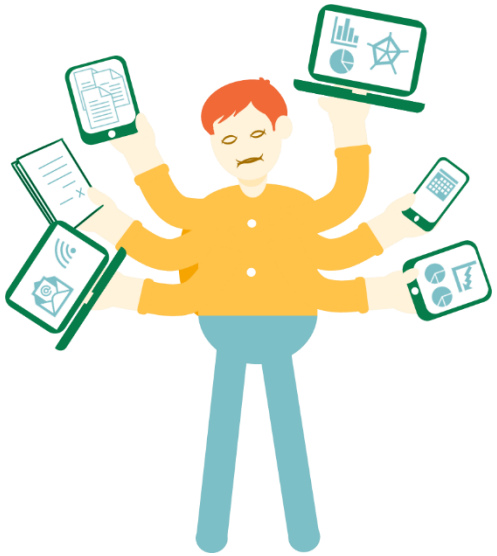


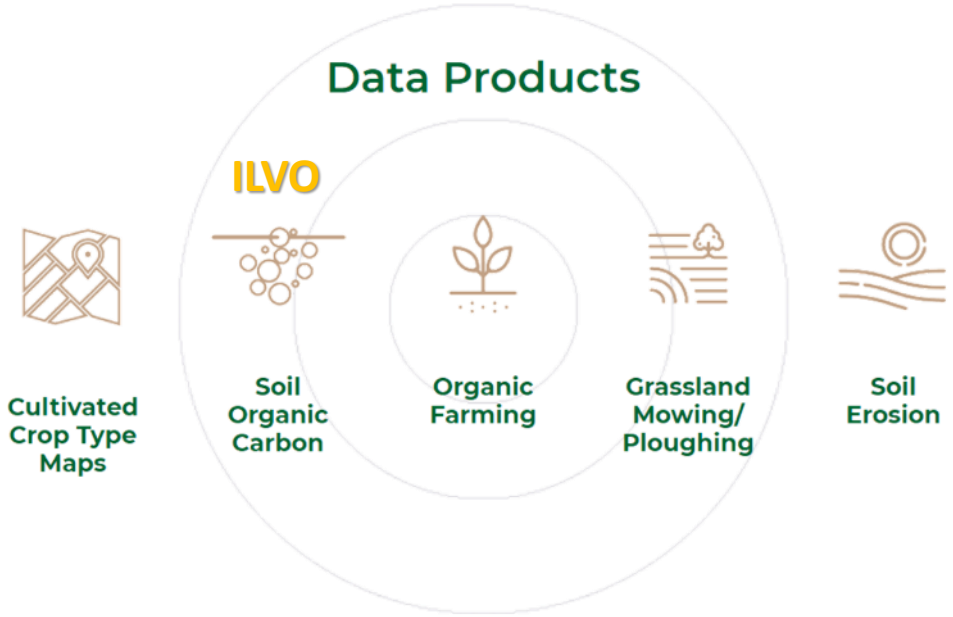
Vito



Farmer

What about my data?

Part C:
Develop EO data and products with Projects



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869366.

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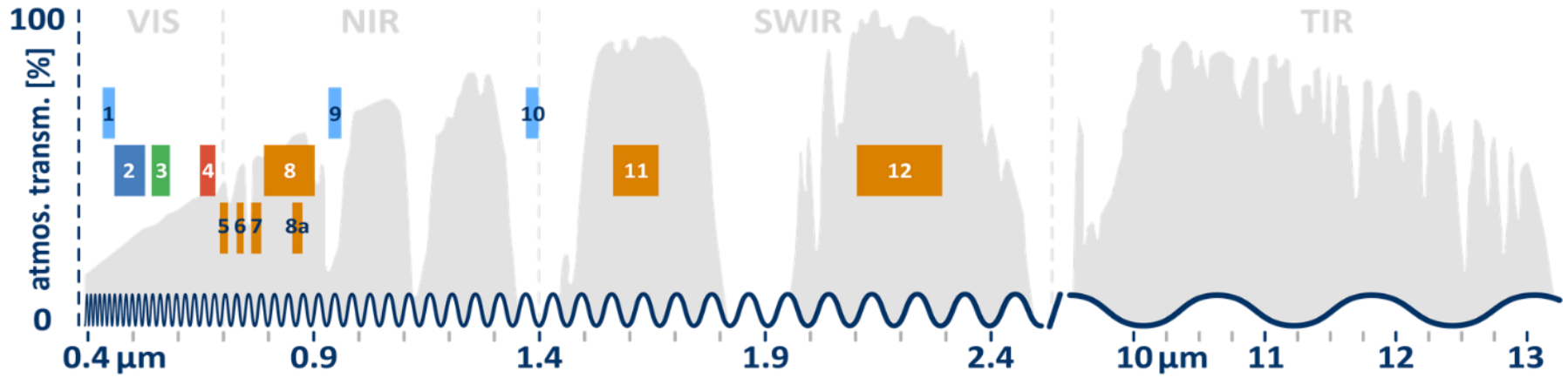
EU Project 101086355
Period: 2023-2026

ILVO goal (in short) within ENVISION?

- Develop a service that delivers top-soil qualitative Soil Organic Carbon estimations at a parcel level, covering the CAP needs for soil organic carbon monitoring in cropland.
- The service will adjust to provide estimations for the whole Flemish region (large scale).
- We are working together with the **Flemish Paying Agency (LV)** and **Flemish Farmers.**

How?

- By using Sentinel 2 data (time-series), together with SOC lab measurements of collected soil samples (soil campaign).
- Using indicators for the assessment of bare soil.



A development methodology supporting co-development

Phase 2: Modeling

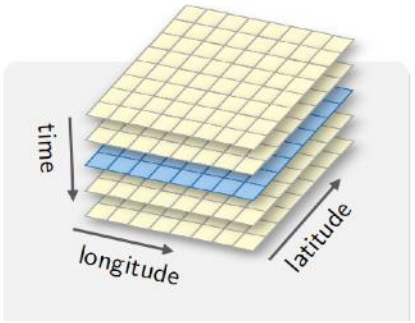
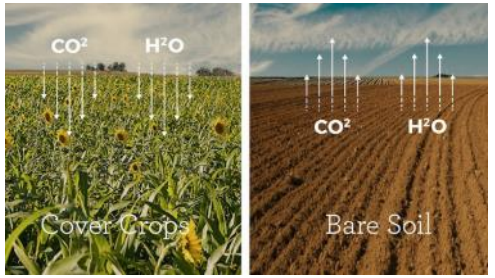
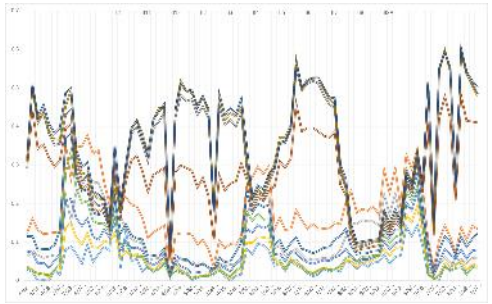
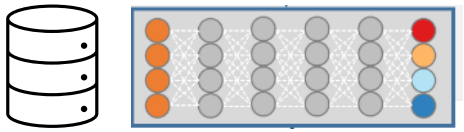


Image collection

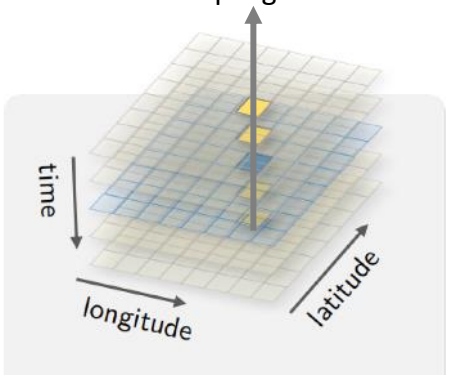
Identify Bare Soil Pixels







SOC Sampling Points



Cloudless Bare Soil Collection
(yellow pixels=bare soil)

Business Logic

Parcel Level

Regional Mapping

Parcel Level

SOC Maps (West Flanders)

Phase 1: Bare Soil (Crop Land)

Phase 3: Model Deployment

Phase 4: Validation - Evaluation

Phase 5: Improvements

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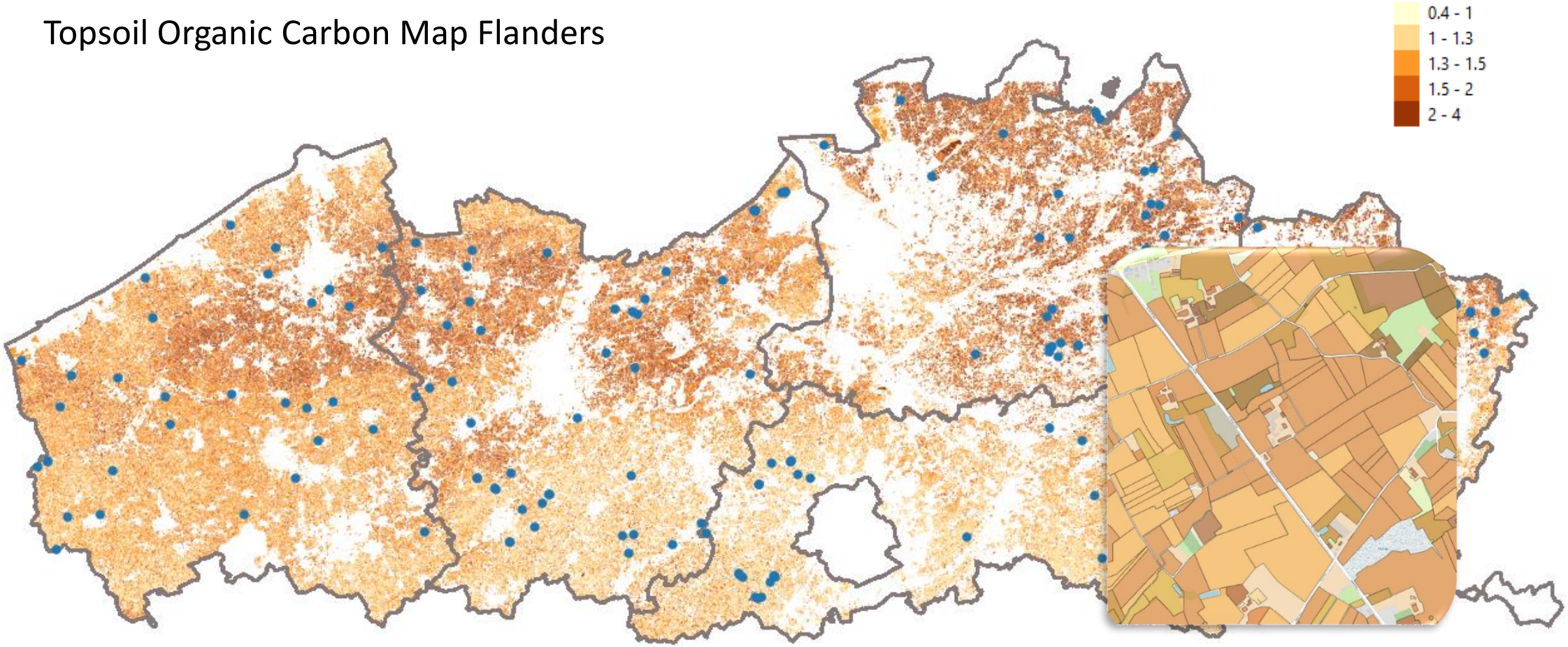
Soil condition monitoring data products

Topsoil Organic Carbon Map Flanders



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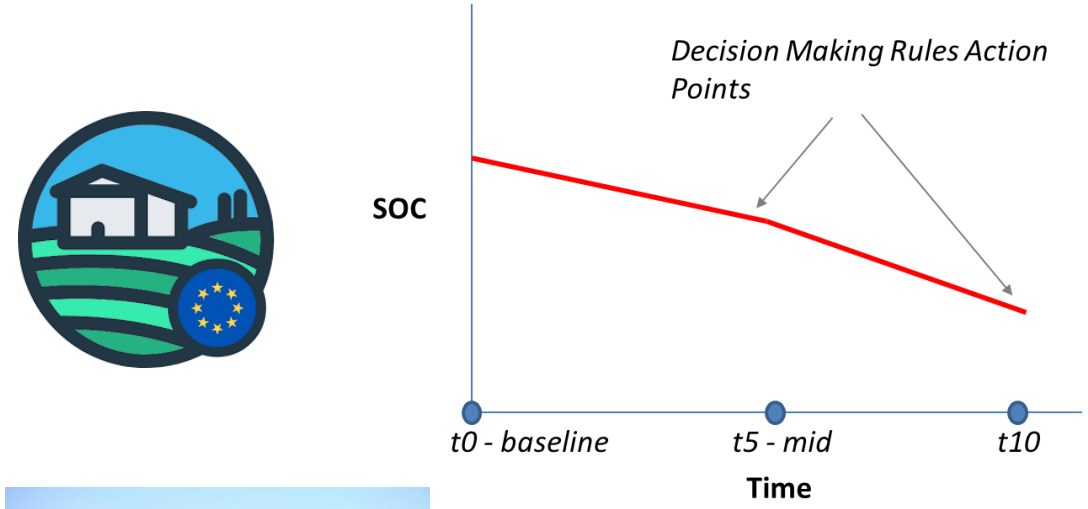
Main Co-Development Challenges

Co-Define a Meaningful Service business logic and a Sustainable Service Business Model

- Different options to deal with accuracy and error transferring => Which one to select?
- A decision make challenge => How can we support better the decision-making process? What is needed?
  - ✓ Different options to present SOC change over time.
  - ✓ Different options to present the modeling results (PAs – Farmers – Service Providers).
- The goal is to support CAP Strategic plans=> Any Reusable components?
- Alignment of CAP SOC monitoring with Monitoring Report Verification systems? Do we need to bring together different communities?
- Ground truth data are needed in Model building and Data sharing can support it. Which are the options for viable Business Models? What can be the benefit for the actors? Trusted partner? Governance?
- When do we have to stop? What is the common accepted optimum cost-accuracy level? What controls it? Can technology further support this by automating soil sampling activity?
- Part of the equation is the Environmental, Societal and Economic Impact. How to assess? Improve?



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Scale up the data products

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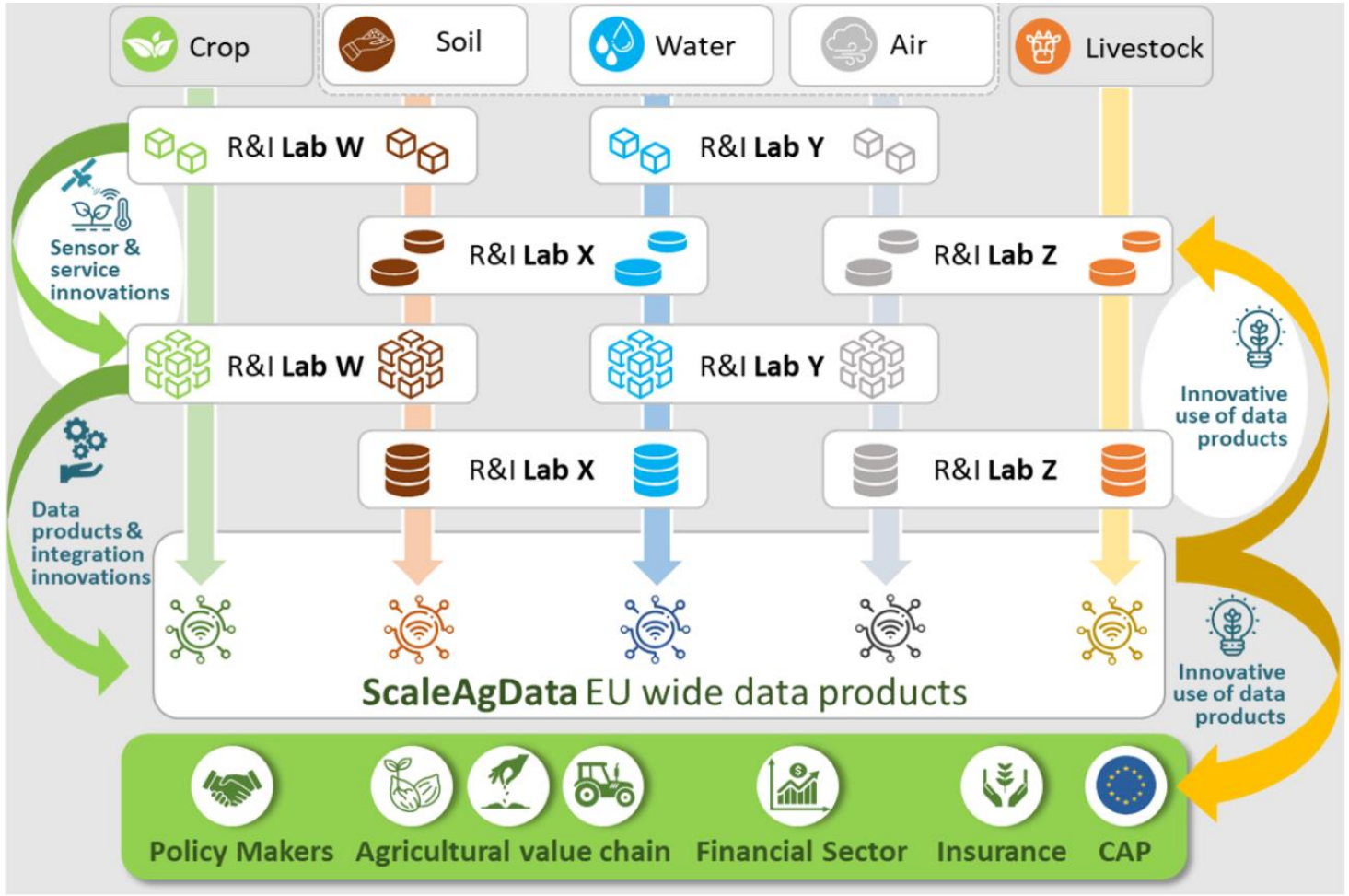

SCALEAGDATA
MAKING DATA COUNT

EU Project 101086355 — Name: ScaleAgData – Period: 2023-2026

Thank you

Institute for Agricultural and Fisheries Research
Technology and Food Science Unit
Living Lab
AgriFood Technology
www.ilvo.vlaanderen.be

Dr. Panagiotis (Panos) Ilias
panos.ilias@ilvo.vlaanderen.be
https://www.linkedin.com/in/drpanoselias/

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