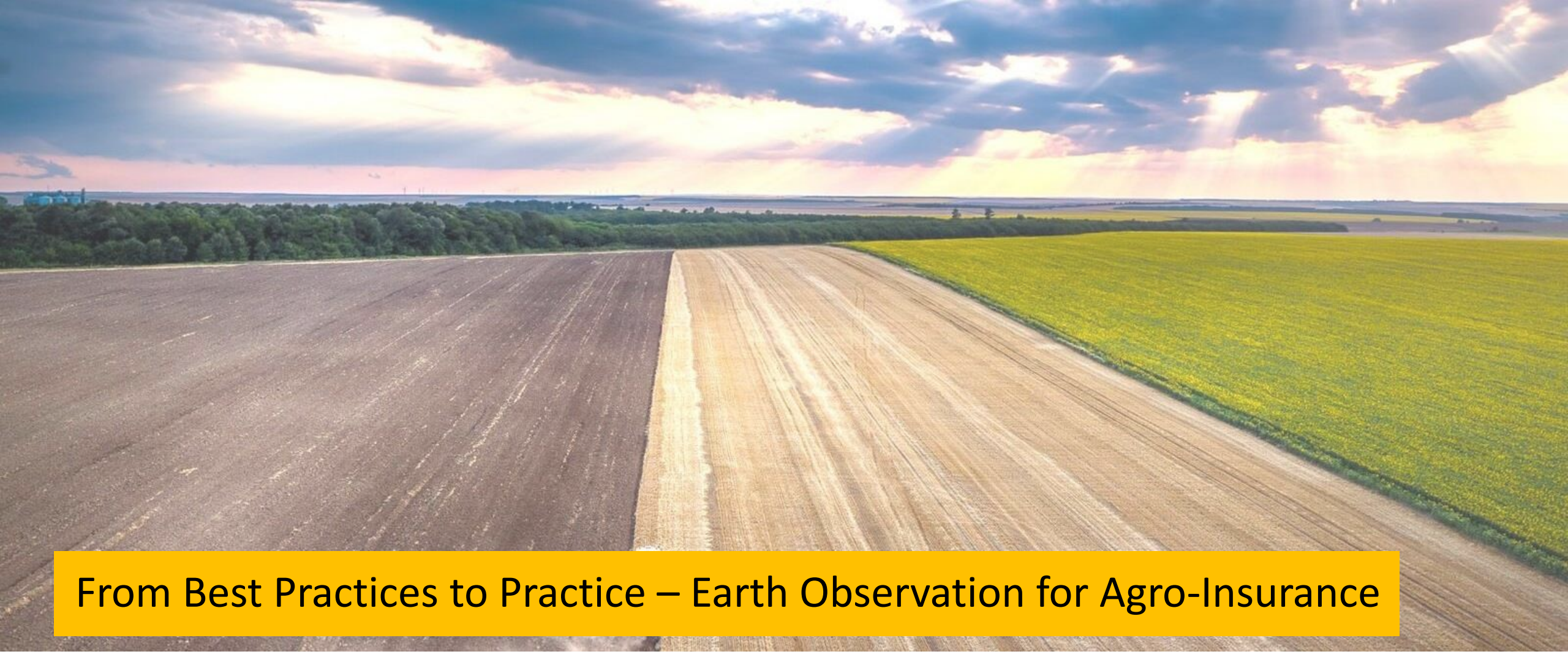

From Best Practices to Practice – Earth Observation for Agro-Insurance

EO4I
Earth Observation for Agro-Insurance

Connecting EO services and products to future insurance solutions

Online-Workshop, 28 April 2021

esa

vito remote sensing

GeoVille

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Welcome

Ralf Ryter

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Agenda (Day 1 - 28/04/2021)

09:00 – 09:20 Welcome & Short introduction to project (GeoVille)

<u>Session 1: EO capabilities (GeoVille/VITO)</u>

09:20 – 09:45 Current and future EO capabilities

09:45 – 09:50 Q&A

<u>Session 2: Requirements of the agro-insurance sector (VITO)</u>

09:50 – 10:15 Sector requirements overview & EO product usage considerations

10:15 – 10:20 Q&A

Agenda (Day 1 - 28/04/2021)

Session 3: Capabilities matching Requirements (GeoVille/VITO)

10:20 – 10:45 Use Cases of EO4I

10:45 – 10:50 Q&A

10:50 – 11:00 Break

11:00 – 11:30 Technological push by Covid-19 pandemic? (AgroInsurance International)

11:30 – 11:40 Q&A

11:40 – 12:00 Summary of the day and final Q&A (GeoVille)

Project Team

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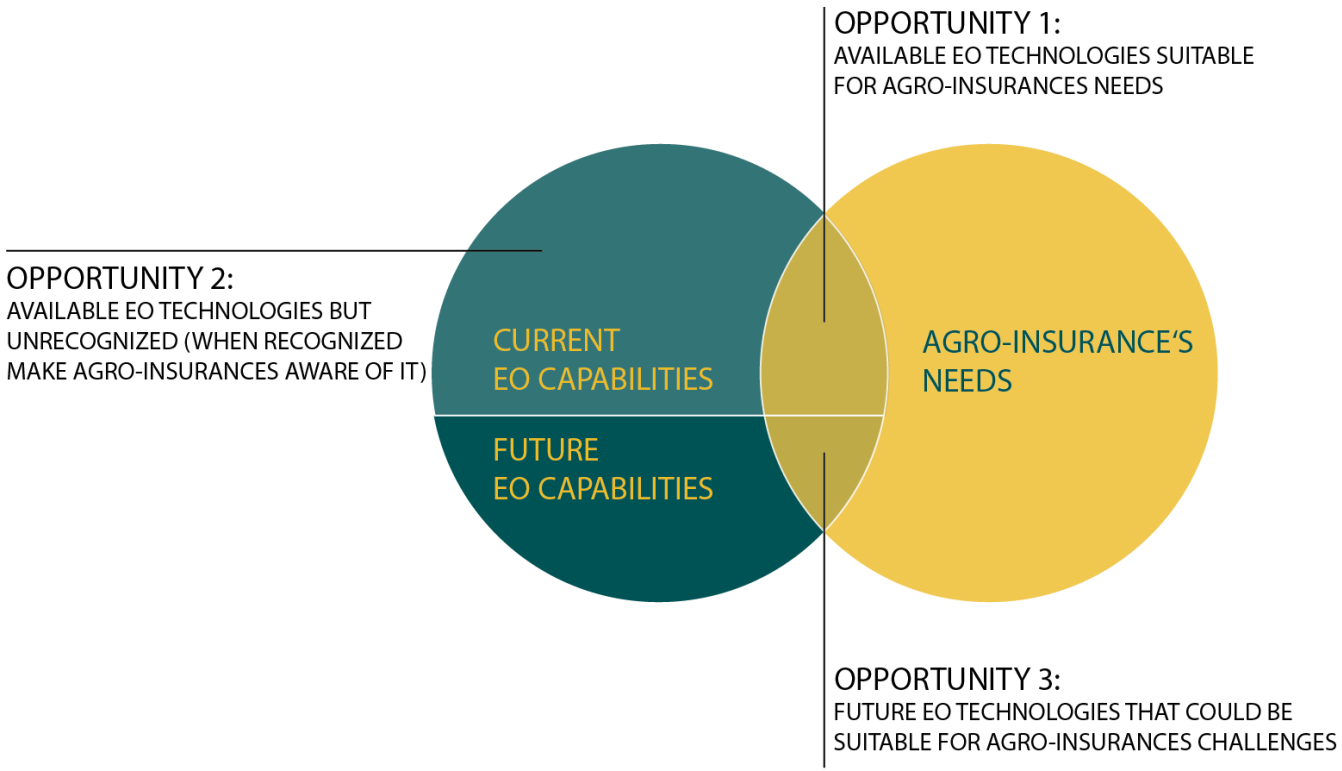
Schweizer Hagel
Suisse Grêle
Grandine Svizzera
VEREINIGTE HAGEL
Swiss Re
Munich RE

Project Objectives



ACTIVITIES

GEOINFORMATION NEEDS OF THE SECTOR

EO CAPABILITIES AND EXISTING GAPS

ROADMAP FOR FUTURE ACTIVITIES

Key Events

EARSC working area
2019-2020

USER WORKSHOP @LPS19
Milan, May 2019

EO4I @ ESA Φ-week
Frascati, September 2019

EO4I @ AIAG Congress
Bordeaux, October 2019

ONLINE USER SURVEY
2019

USER WORKSHOP @IBK
Innsbruck, November 2019

USER MEETINGS
2019-2021

Roadmap


DEMONSTRATE VALUE FOR A POTENTIAL UPTAKE OF EO WITHIN THE AGRO-INSURANCE SECTOR
ENABLE UTILISATION OF EO SOLUTIONS BY THE AGRO-INSURANCE SECTOR
COMMUNICATION TO INCREASE THE VISIBILITY OF EO WITHIN THE AGRO-INSURANCE SECTOR
IDENTIFY OPPORTUNITIES BEYOND THIS PROJECT'S FOCUS

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EO capabilities

Roel van Hoolst

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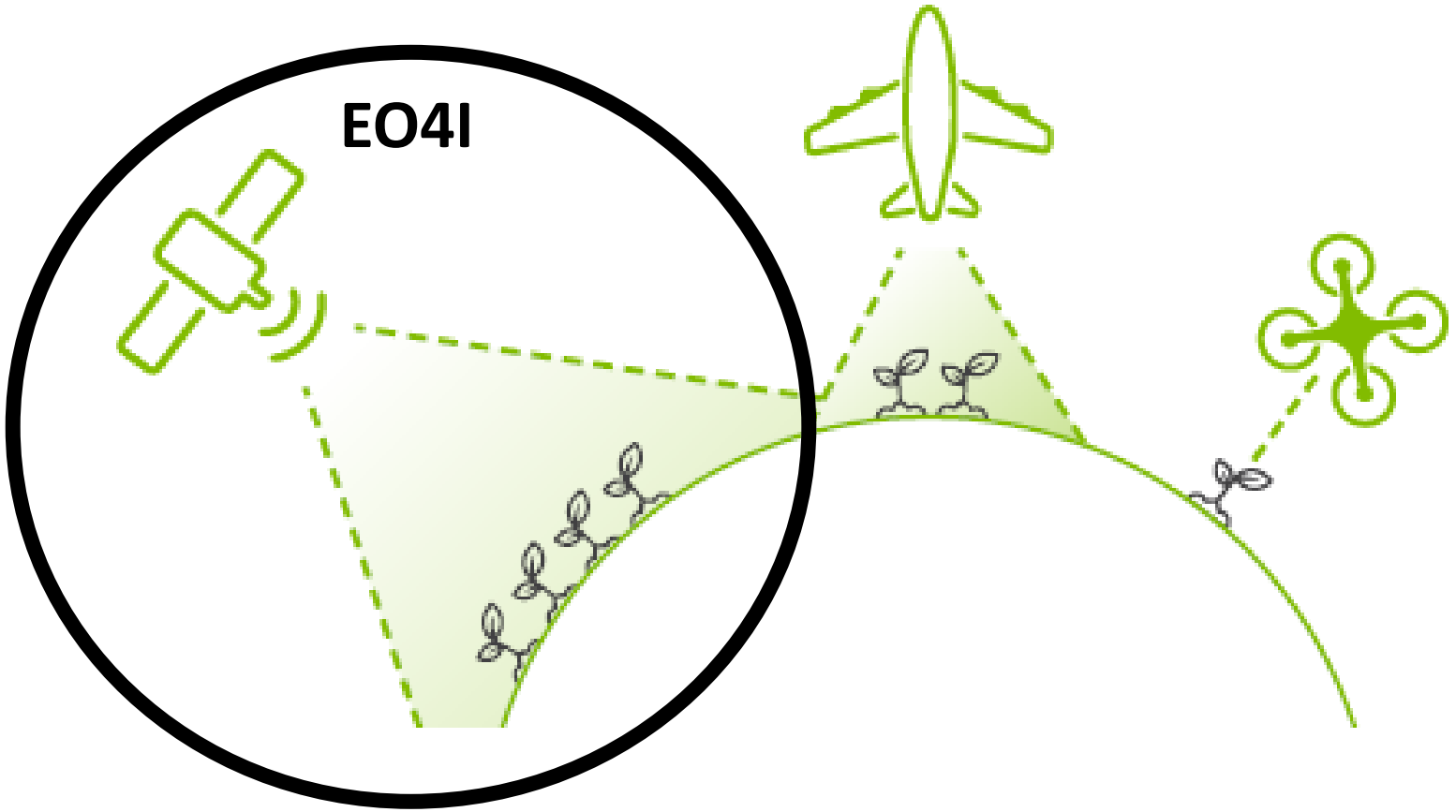
Remote sensing for agriculture



Products relevant for Agro-insurances

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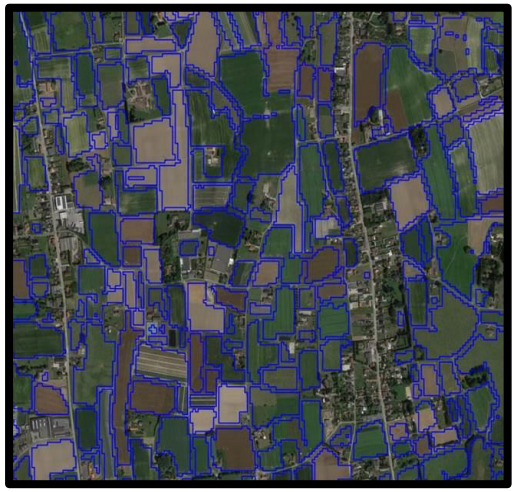
Parcel Detection



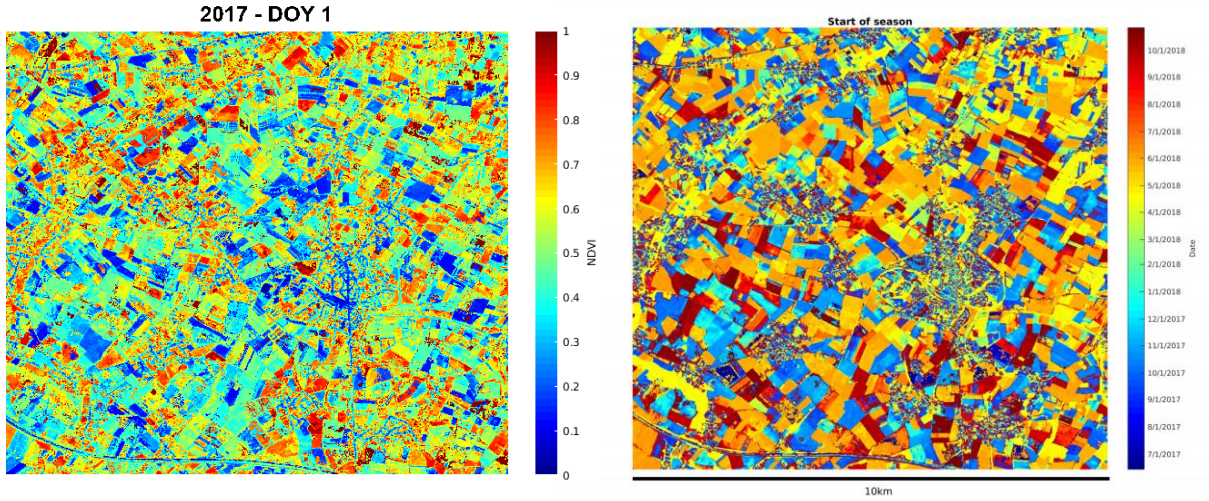
21 products identified in EO4I

Product information on EARSC platform

earsc-portal.eu/display/EO4I

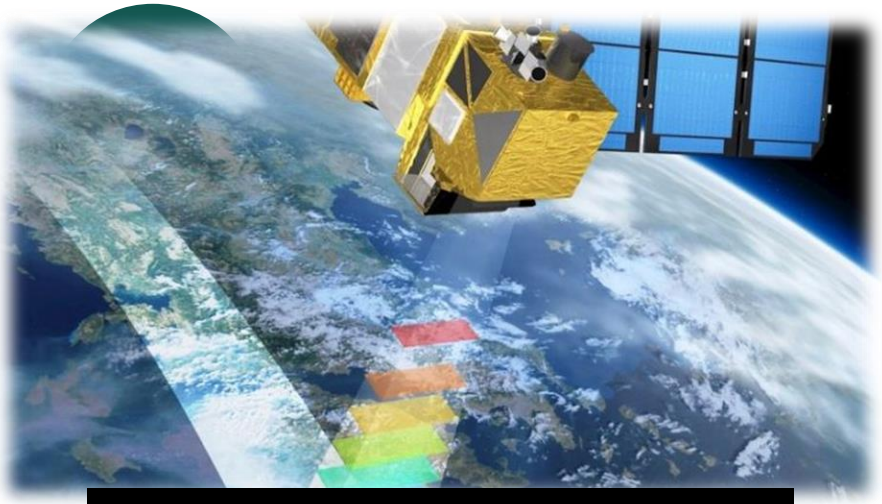
Biomass

Crop emergence



Crop type maps

Product categories



Satellite observations

Vegetation Indices

Crop Canopy Characteristics

Crop Growth Anomaly

Low level products

High level products

Biophysical Quantities

Environmental parameters

Agricultural Features

Agricultural information

EO product categories – low level

Vegetation Indices

Highlight particular property of crop canopy

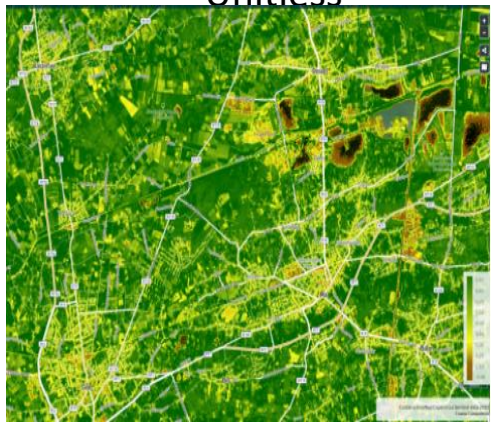
Mathematical calculations of crop canopy reflectance

Very wide spectra of indices

Greenness: NDVI

Water content: (MSI)

Unitless



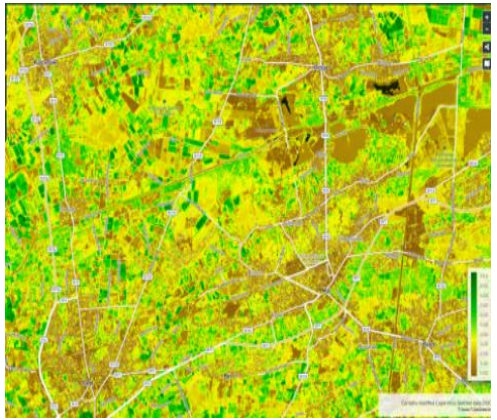
Crop Canopy Characteristic

Quantify crop canopy characteristic

Satellite based modelled value of crop canopy characteristic

Fractional Vegetation Cover [-]

Leaf Area Index [m2/m2]



Crop Growth Anomalies

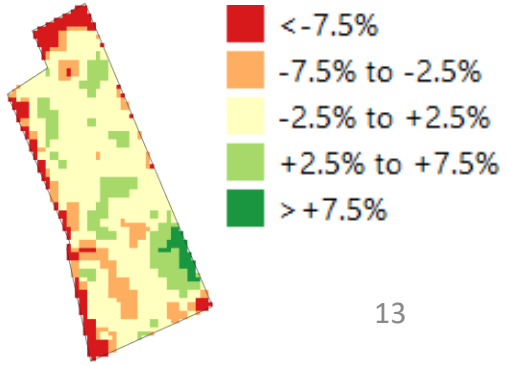
Detection of abnormal crop growth

Calculation of differences in space & time

Within field variability

Regional benchmark

% deviation



EO product categories – high level

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Biophysical quantities

Directly related to crop production

Modelled or machine learning

Biomass growth (kg/ha/day)

Yield (ton/ha)

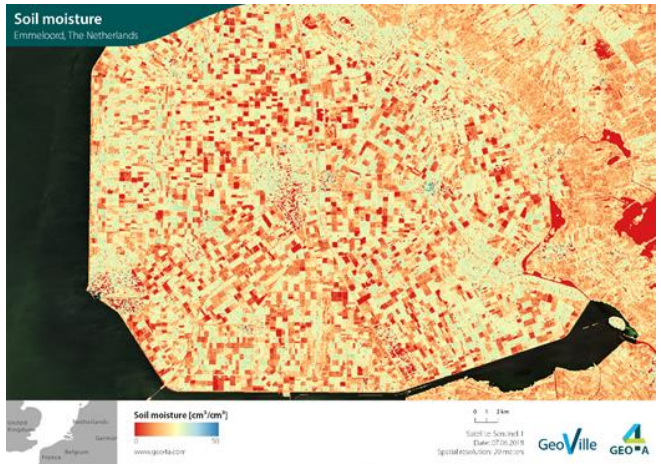
Environmental parameters

Environmental conditions related to crop production

Modelled or machine learning

Soil Moisture (m3/m3)

Evapotranspiration (ET)



Agricultural features

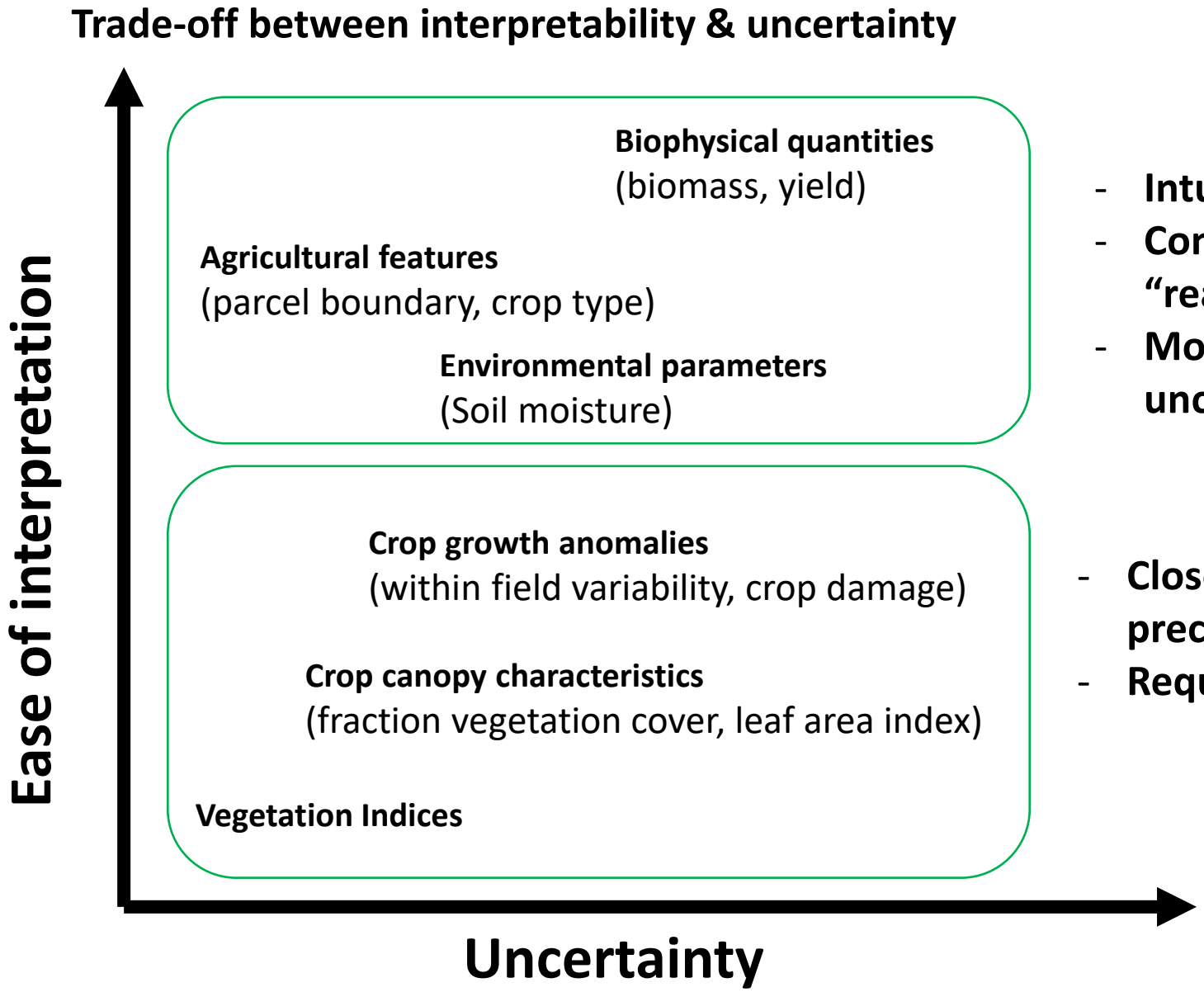
Detection of agriculture landscape elements

Machine learning

Field boundaries

Crop type

Considerations on EO products



High level products

- **Intuitive to use**
- **Contain information observed in "real life"**
- **Modelled & hence higher uncertainties**

Low level products

- **Close to the satellite observation & precise**
- **Require support for interpretation**

Considerations on EO product usage

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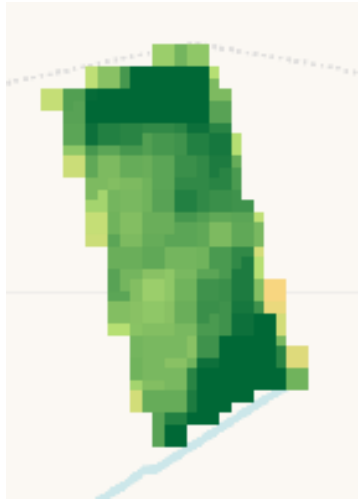
Earth Observation for Agro-Insurance

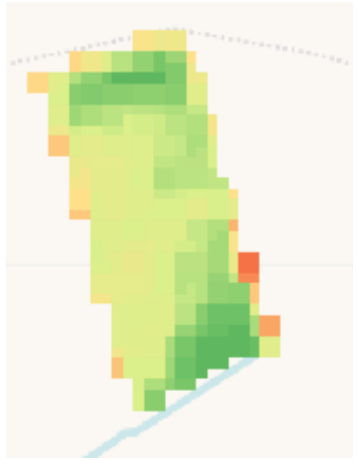
Example for crop damage assessment

Ease of interpretation



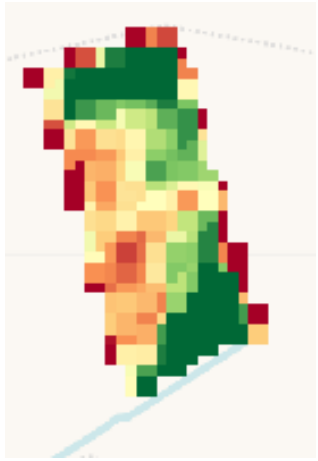
Vegetation Index

[-]
0 = low greenness
1 = high greeness



Leaf Area Index

= leaf area / ground area
[m2 / m2]



Within Field variability

% of deviation

Crop Growth Zones

XX%

% Crop Damage

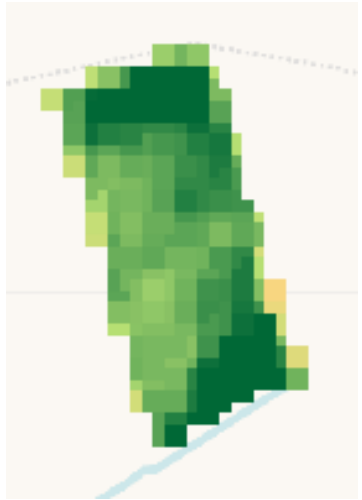
Uncertainty

Considerations on EO product usage

EO4I Earth Observation for Agro-Insurance

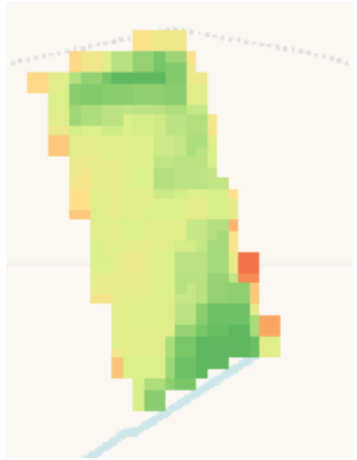
Example for crop damage assessment

Uncertainty



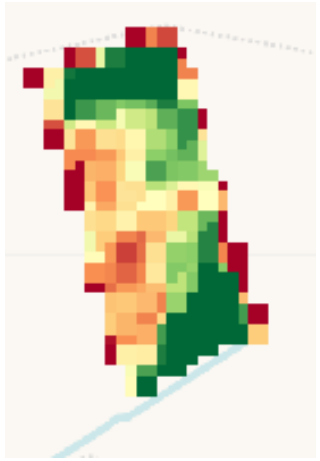
Vegetation Index

"Calculated from spectral signature"



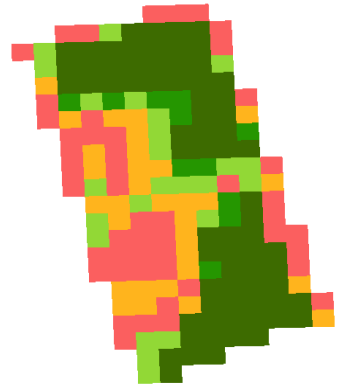
fraction Vegetation Cover

"Modelled from spectral signature"



Within field variability

"Statistical post-processing"



Crop Growth Zones

"Spatio-temporal processing. Categorization"

XX%

% crop damage

"Decision methodology on crop damage"

Considerations on EO product usage

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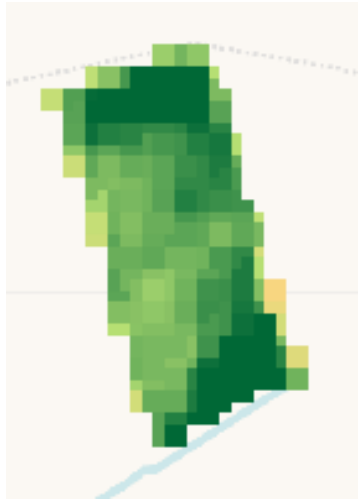
Earth Observation for Agro-Insurance

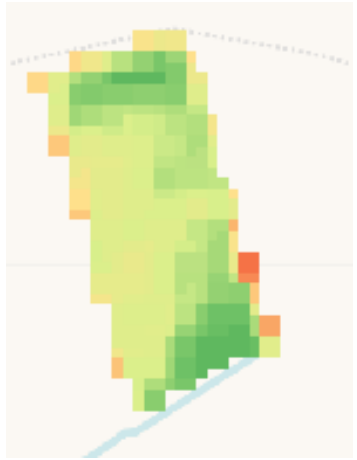
Example for crop damage assessment

Ease of interpretation



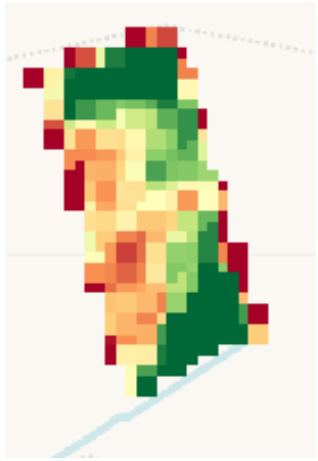
Vegetation Index

Intercompare fields & dates



fraction Vegetation Cover

Benchmark against observations



Within field variability

Guideline for in-situ sampling

Crop Growth zones

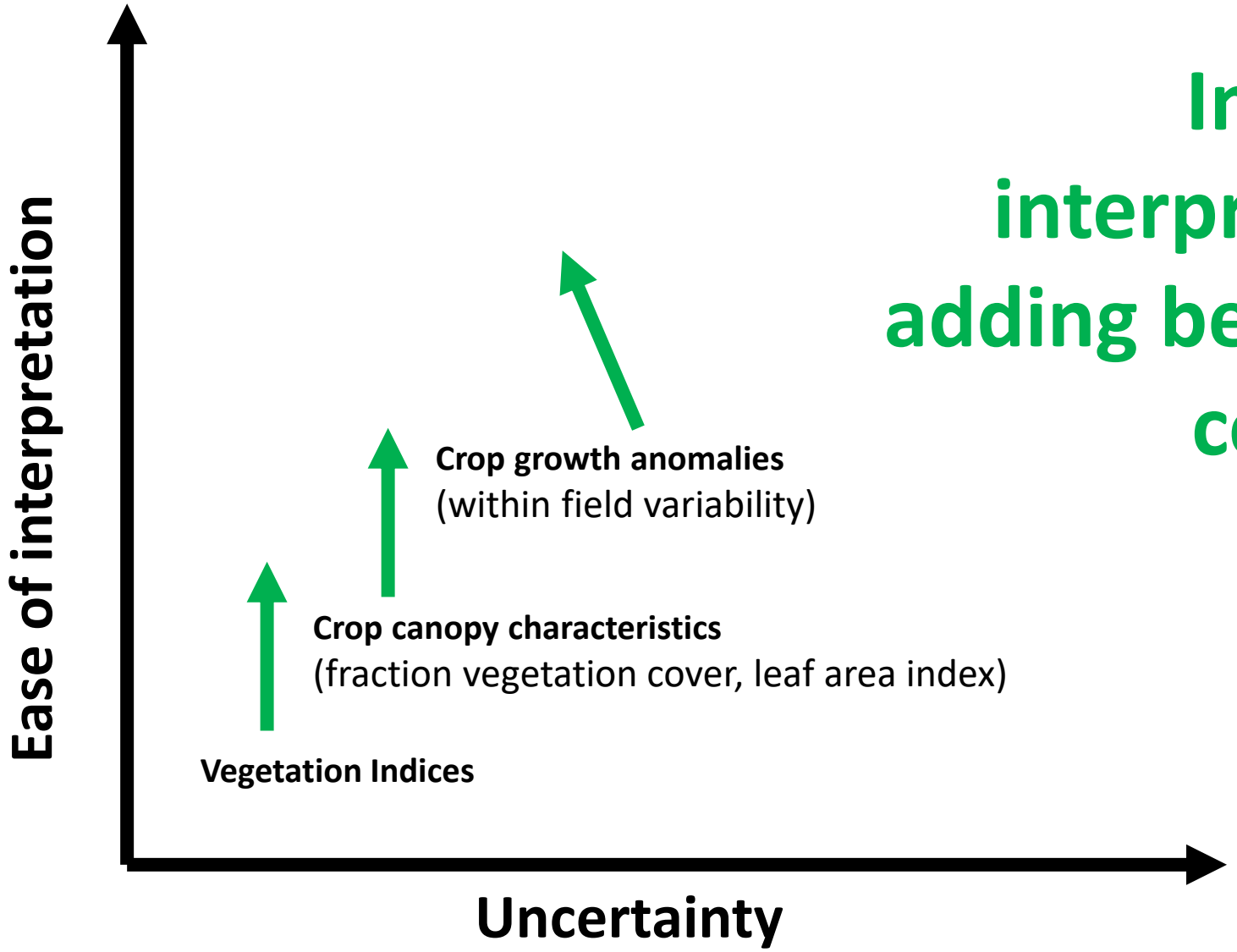
Indication on crop damage zones

XX%

% crop damage

Remote decision on crop damage

Low level products



Improve interpretability by adding benchmarking & context

Low level products

Examples from the WatchItGrow crop monitoring platform (watchitgrow.be)

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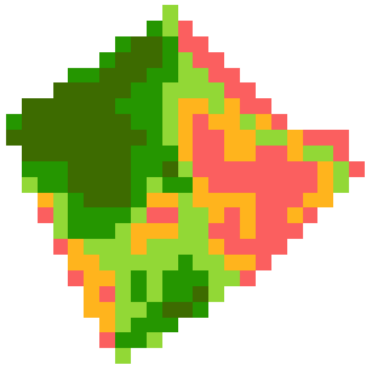
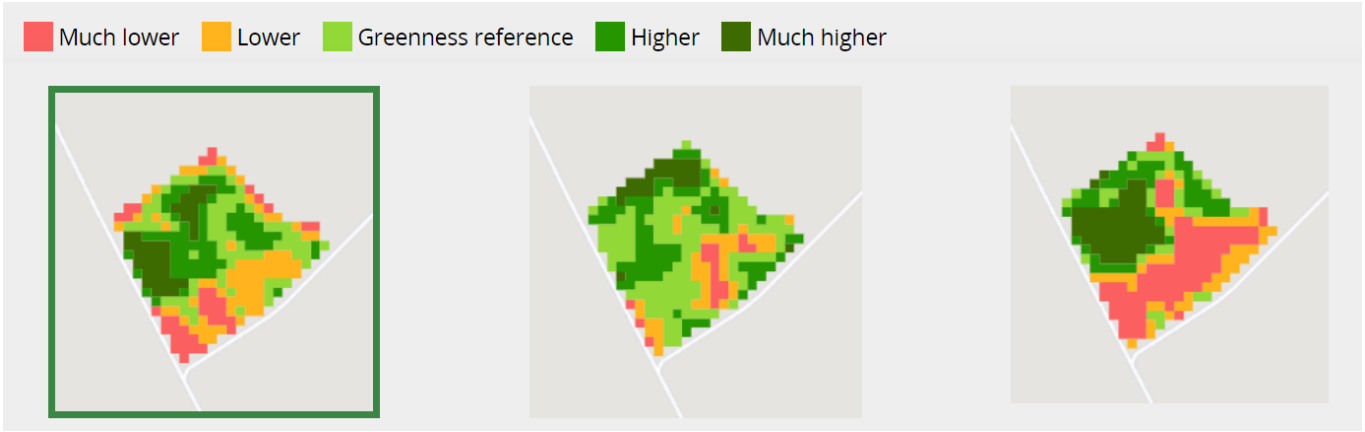
Situation summer 2020

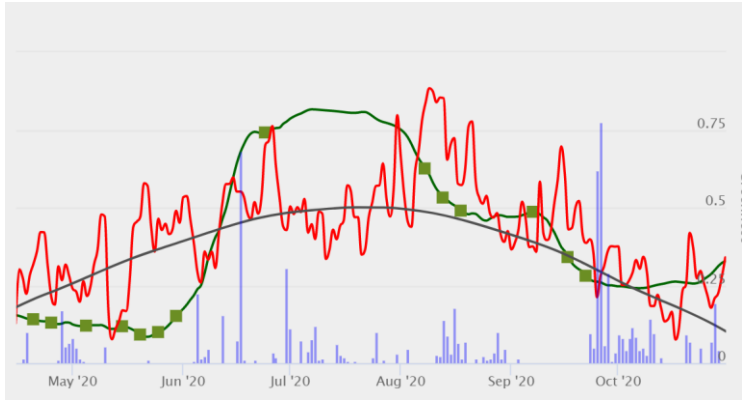


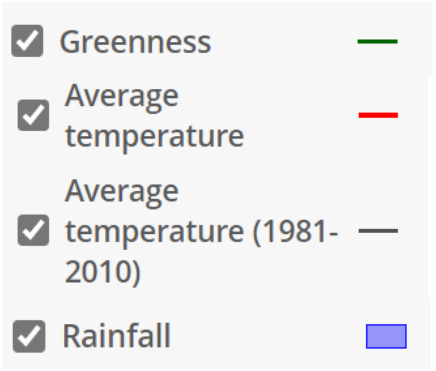
Seasonal variability in previous growing seasons



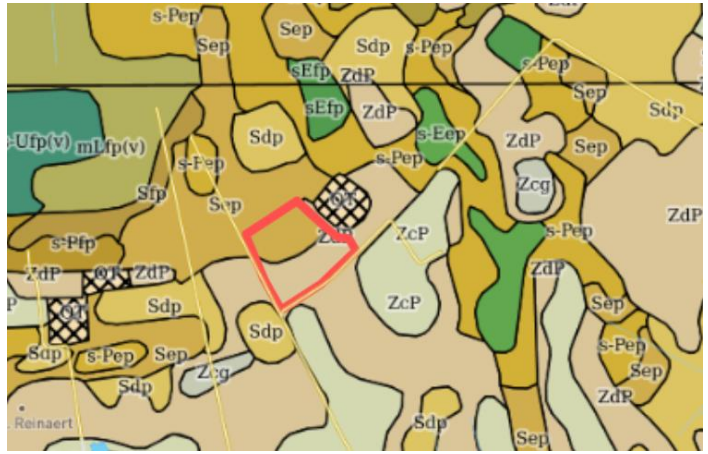
2017 Maize **2018 Beans** **2019 Maize**

Meteo data

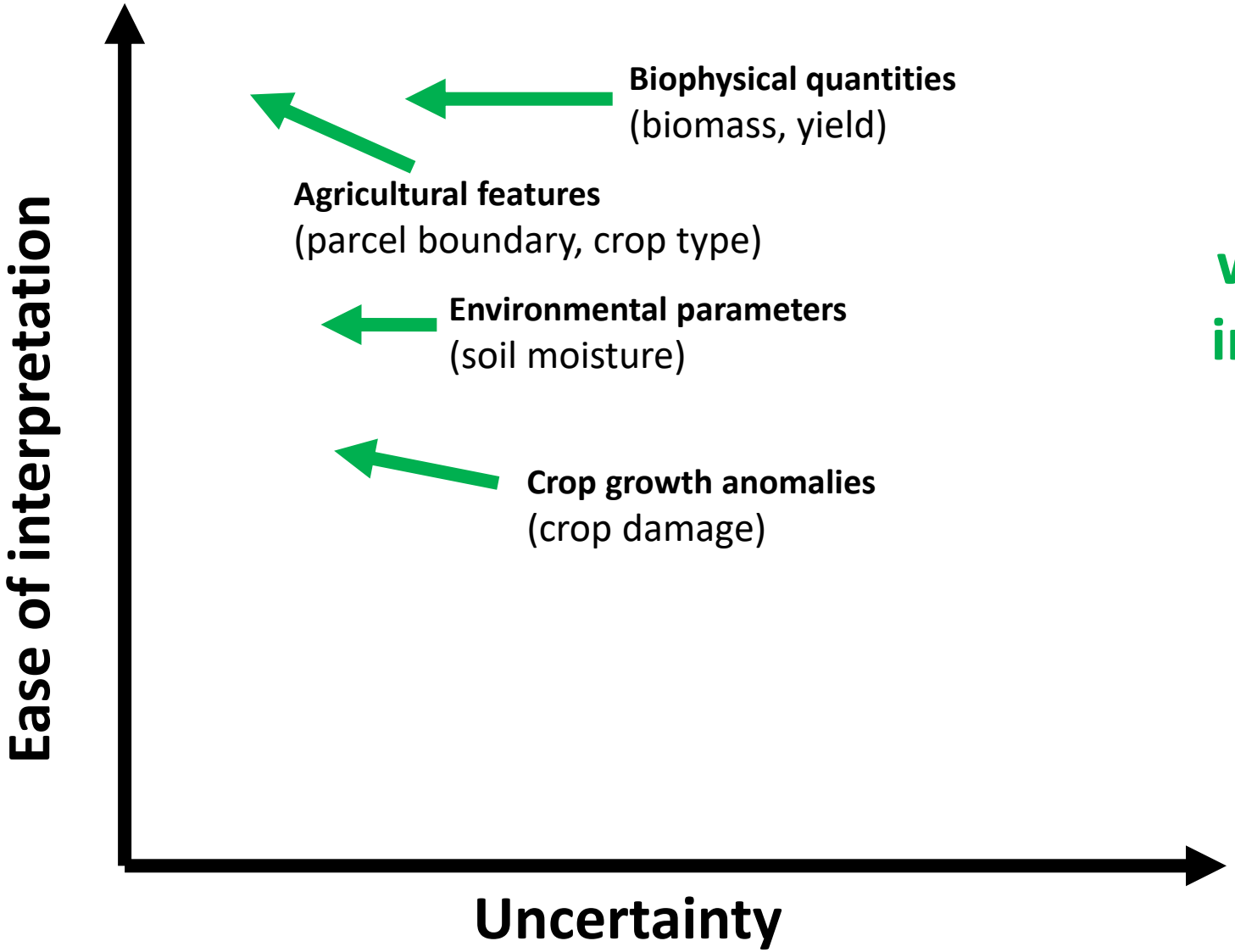




Ancillary information (e.g. soil type)



High Level Products



Reduce uncertainty of higher level products with new technologies, in-situ data & co-design

The way forward

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Earth Observation
for Agro-Insurance

Co-design & data sharing

New technologies

Research

New sensors

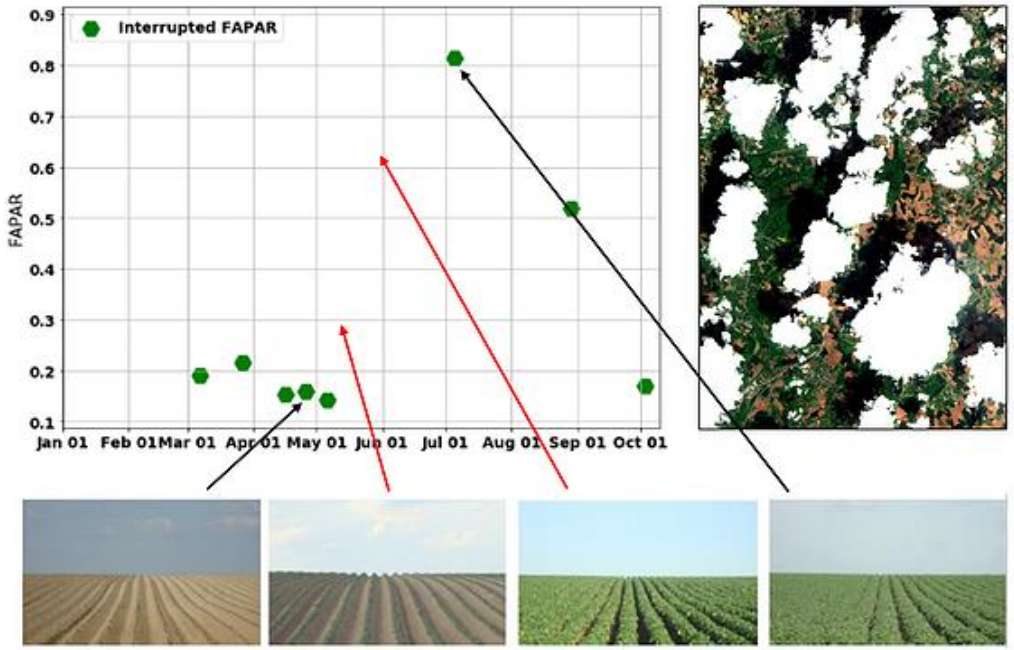
From R&D to automated services

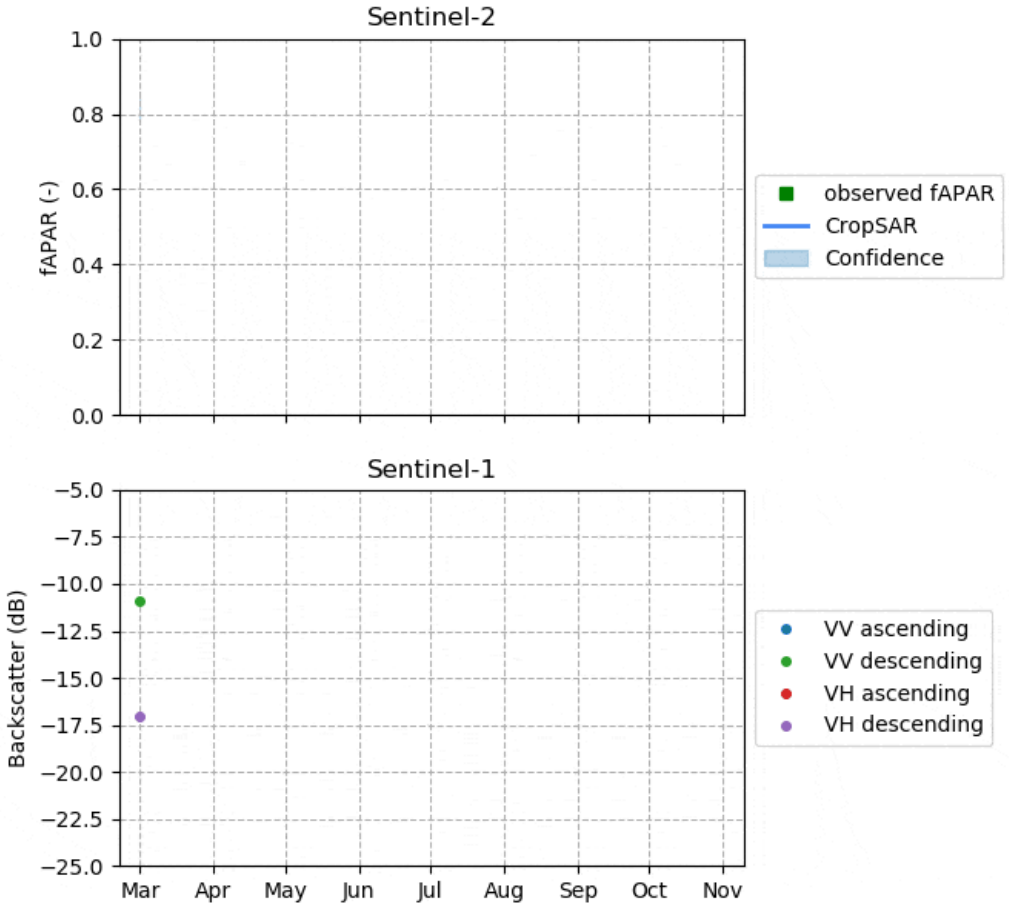

How to deal with clouds for operational crop monitoring?

New technologies

Radar based gap filling of optical data

Operational available at parcel level



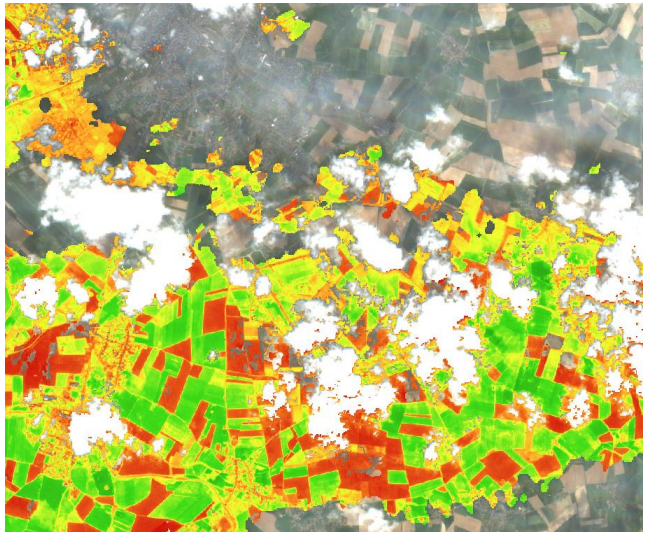


[Looking through the clouds to improve crop monitoring! (vito.be)]

New technologies

Radar based gap filling of optical data

Sentinel 1 & 2 fusion R&D at pixel level



Near future: Sensor Fusion for continuous monitoring

What is the role of radar, Very High Resolution (e.g. daily Planet data), medium resolution imagery?


Yield estimations

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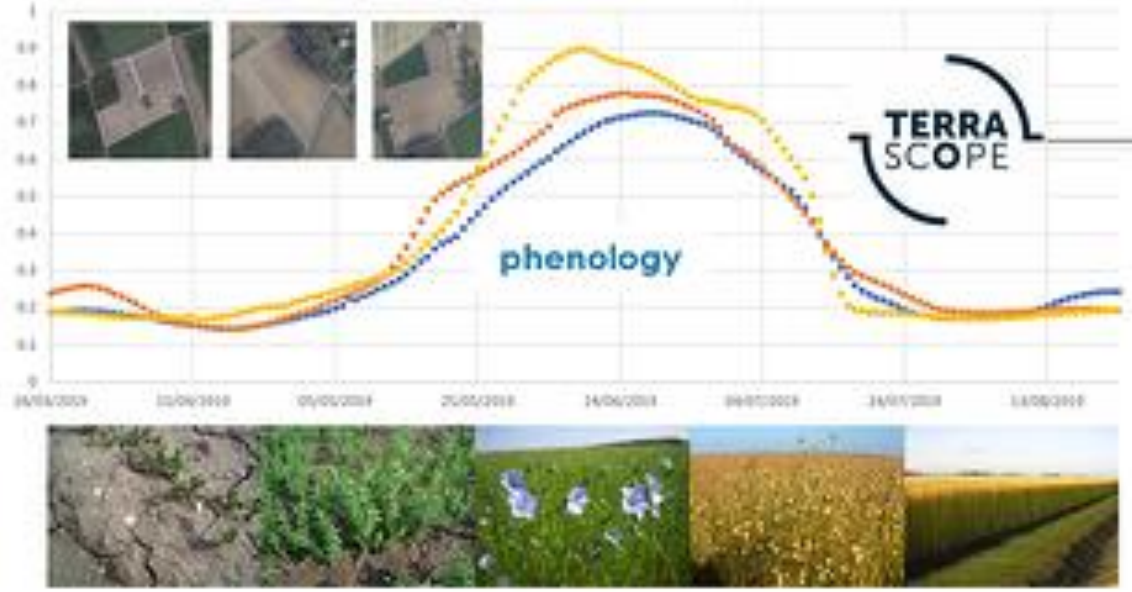
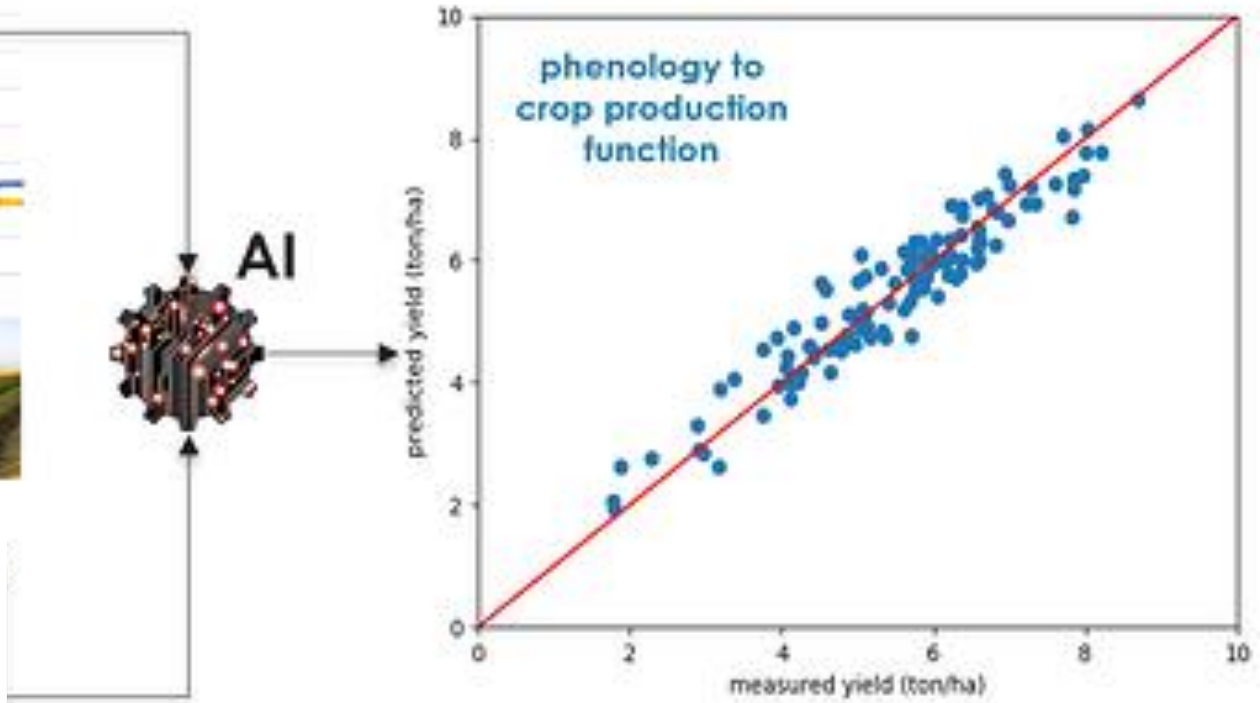
Crop yield forecasting using Artificial Intelligence



In-situ yield data




Crop damages

Crop damage assessment

Currently

Mostly operational products on general damages/anomalies

“There is a deviation in crop growth.”

Already useful to target field/areas/…

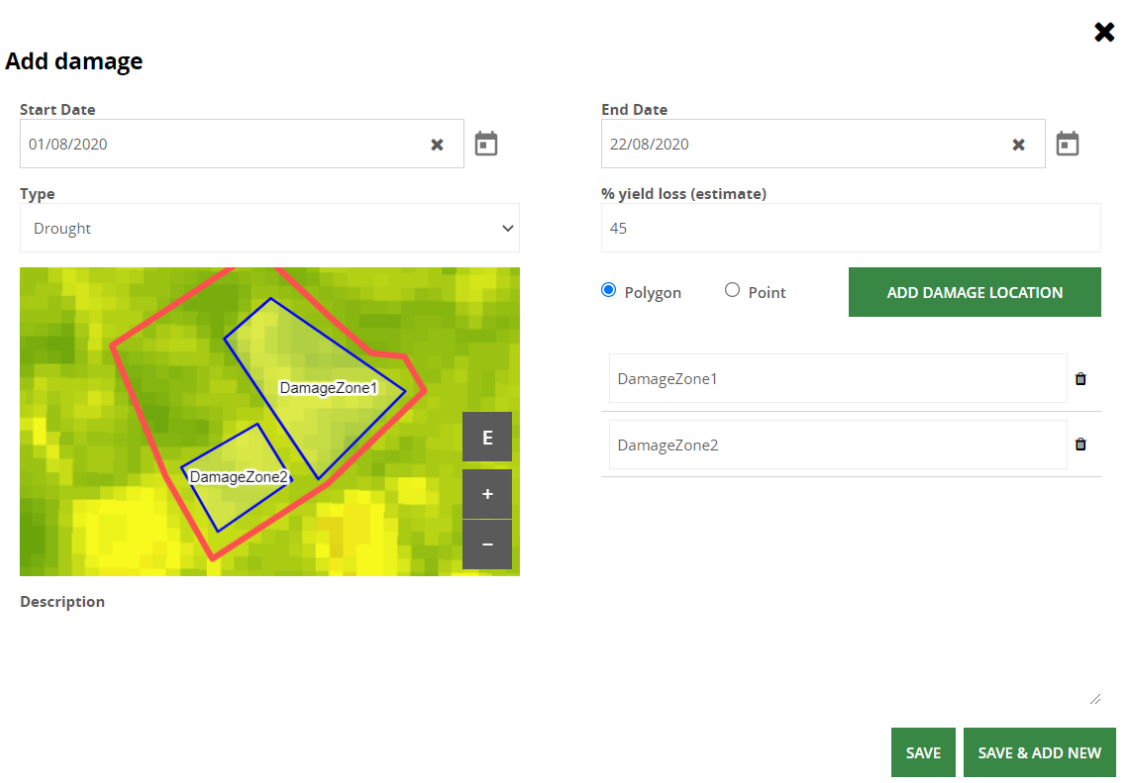
Crop damage assessment

Way forward

For specific crop damages

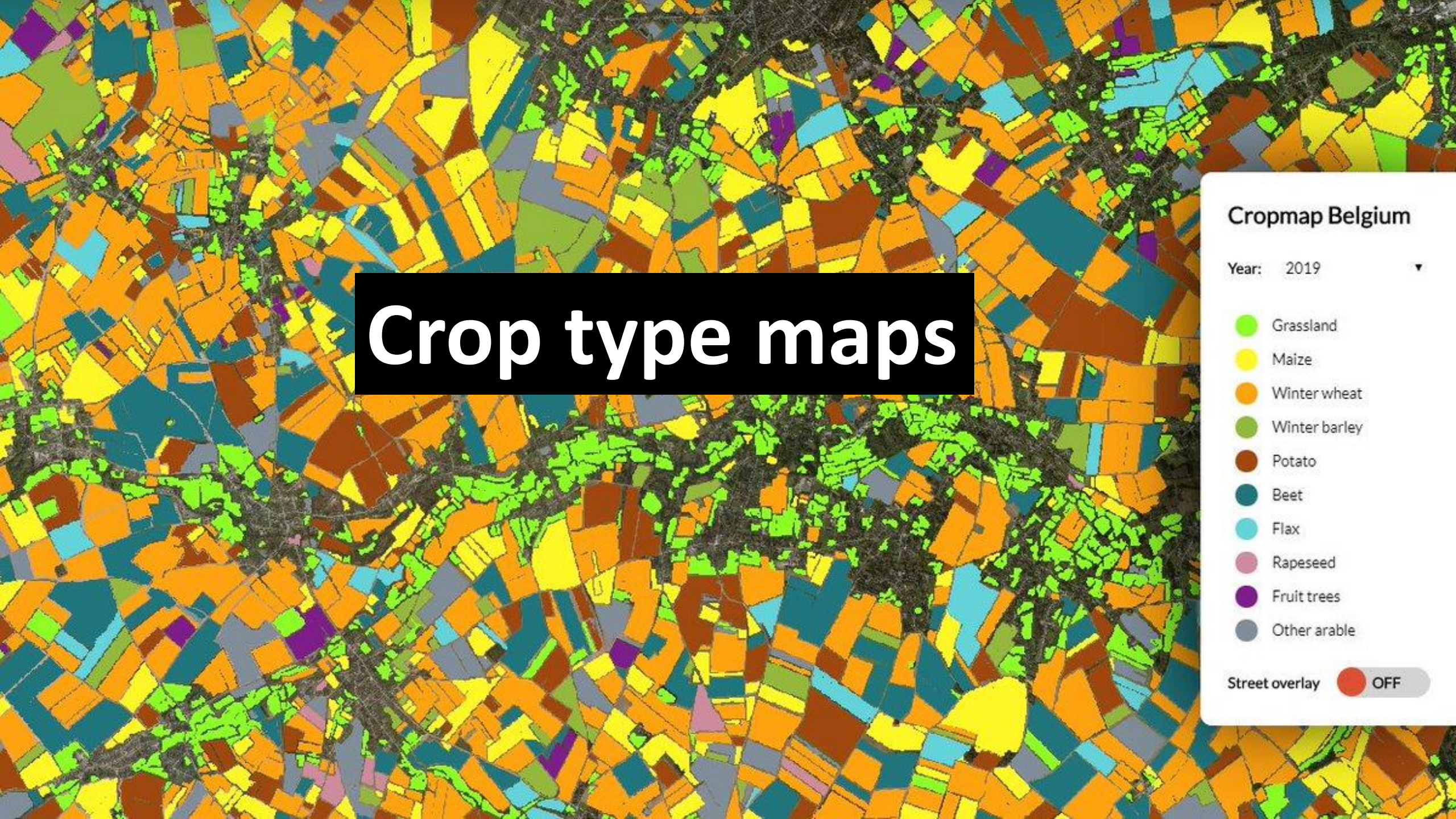
Study the relation between changes in structural and biochemical parameters & satellite indices*

Required: Spatially explicit in-situ data on specific damages



Where should these data come from?

*Chauhan et al. 2020. Understanding wheat lodging using multi-temporal Sentinel-1 and Sentinel-2 data. Remote Sensing of Environment. 243, 2020.



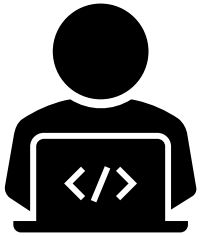
Crop type maps

Automated crop type detection

So far mainly ad-hoc crop type maps

Work in progress: fully automated crop detection

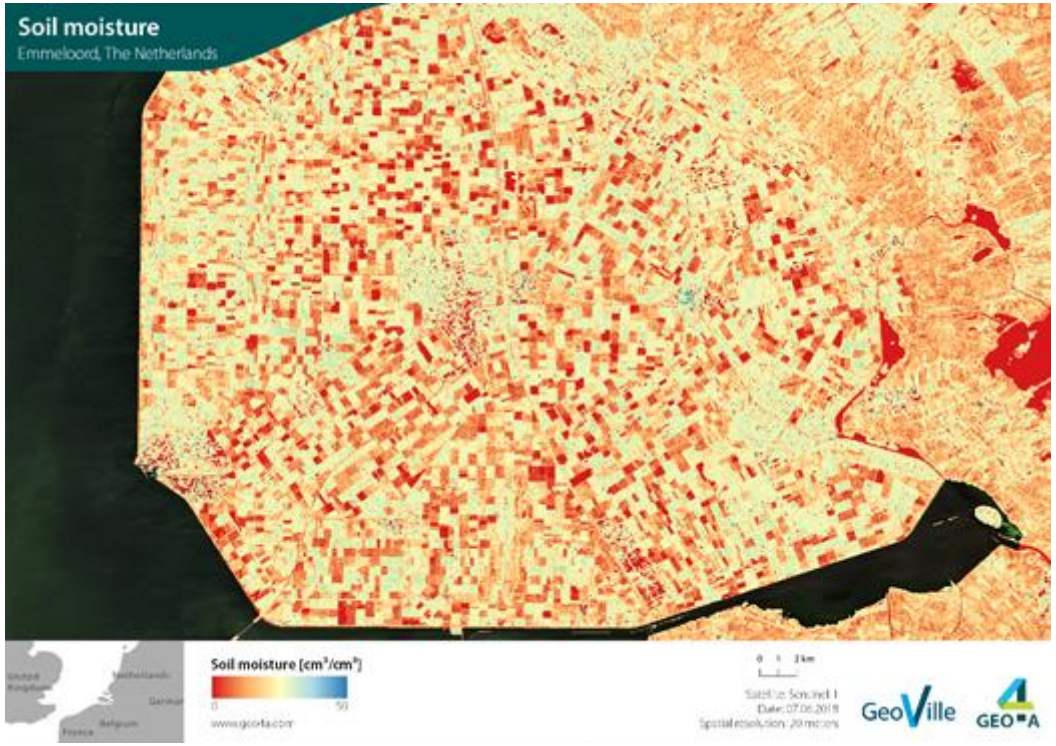
Here are my fields.
Show me which
crop type is being grown,



NextLand | nextland (ec-nextland.eu)

Soil moisture

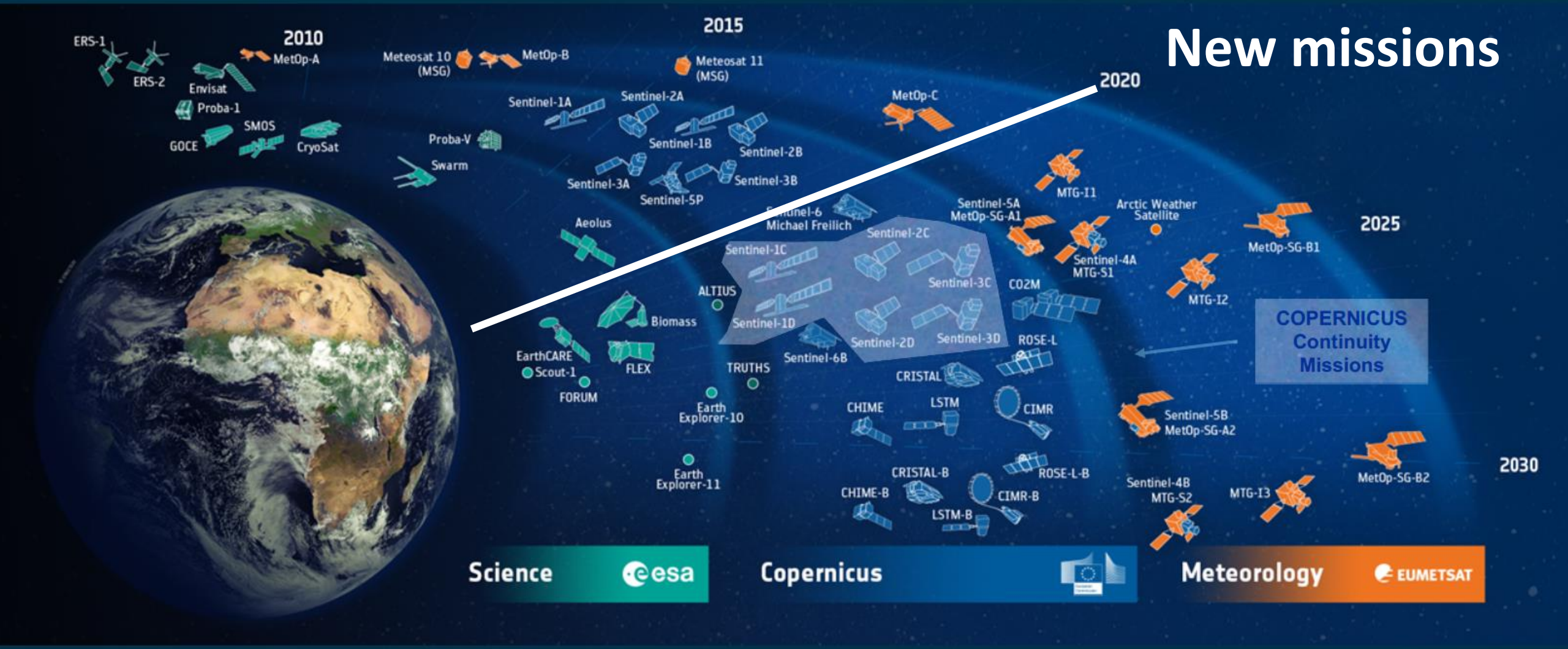
Parcel level soil moisture



- **Information about water/moisture content of the top few centimetres of soil**

- **Various sensors**
- Spatial resolution: **10 m** – 25 km
- Temp. resolution: Various time steps and historic archive

COPERNICUS Sentinels Continuity - Context



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Requirements of the agro-insurance sector

Michaela Seewald

esa

vito
remote sensing

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Understanding the Requirements

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EARSC working area
2019-2020

USER WORKSHOP @LPS19
Milan, May 2019

EO4I @ ESA Φ-week
Frascati, September 2019

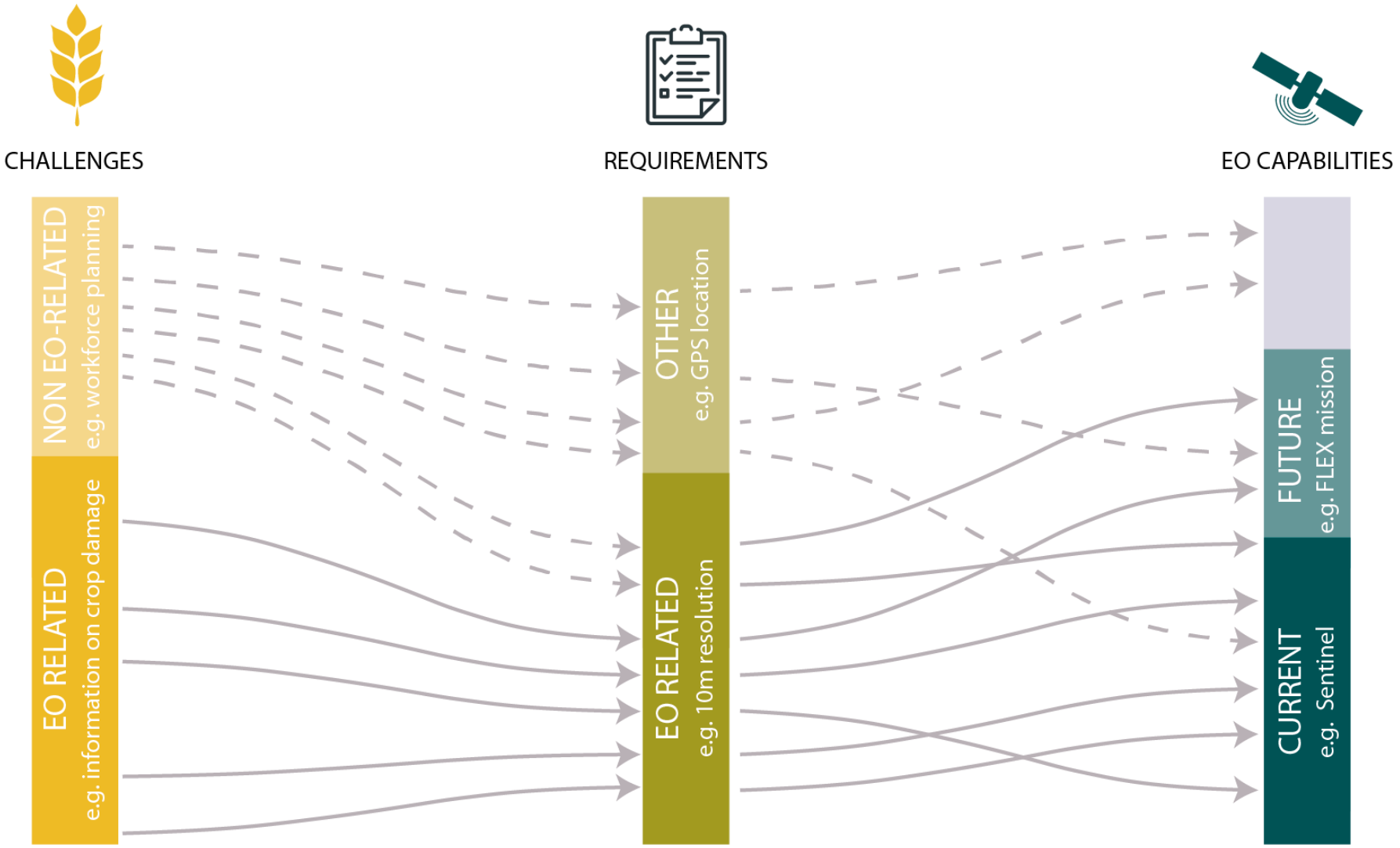
EO4I @ AIAG Congress
Bordeaux, October 2019

ONLINE USER SURVEY
2019

USER WORKSHOP @IBK
Innsbruck, November 2019

USER MEETINGS
2019-2021

From 61 Challenges to EO Capabilities

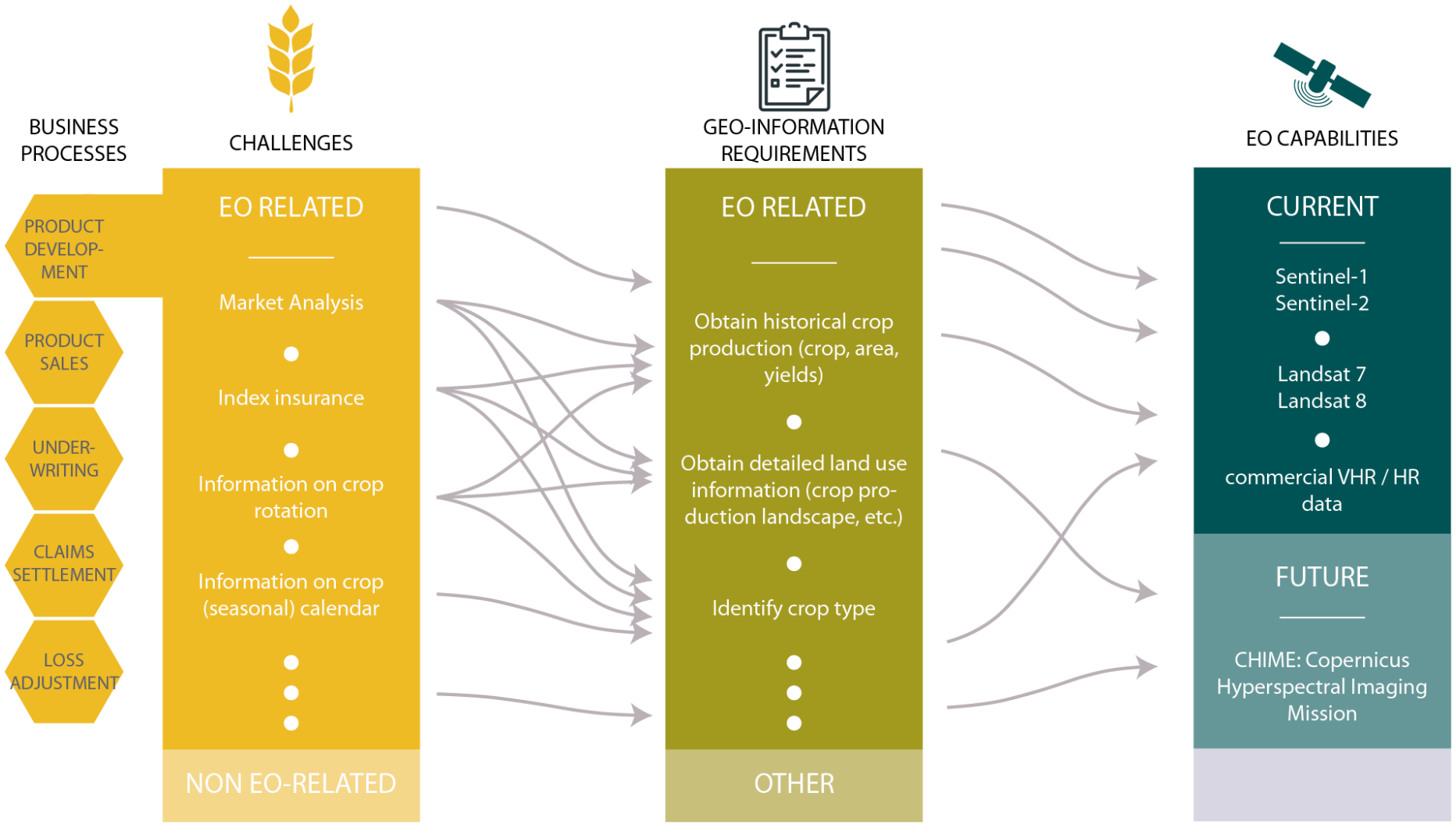


Geo-information requirements

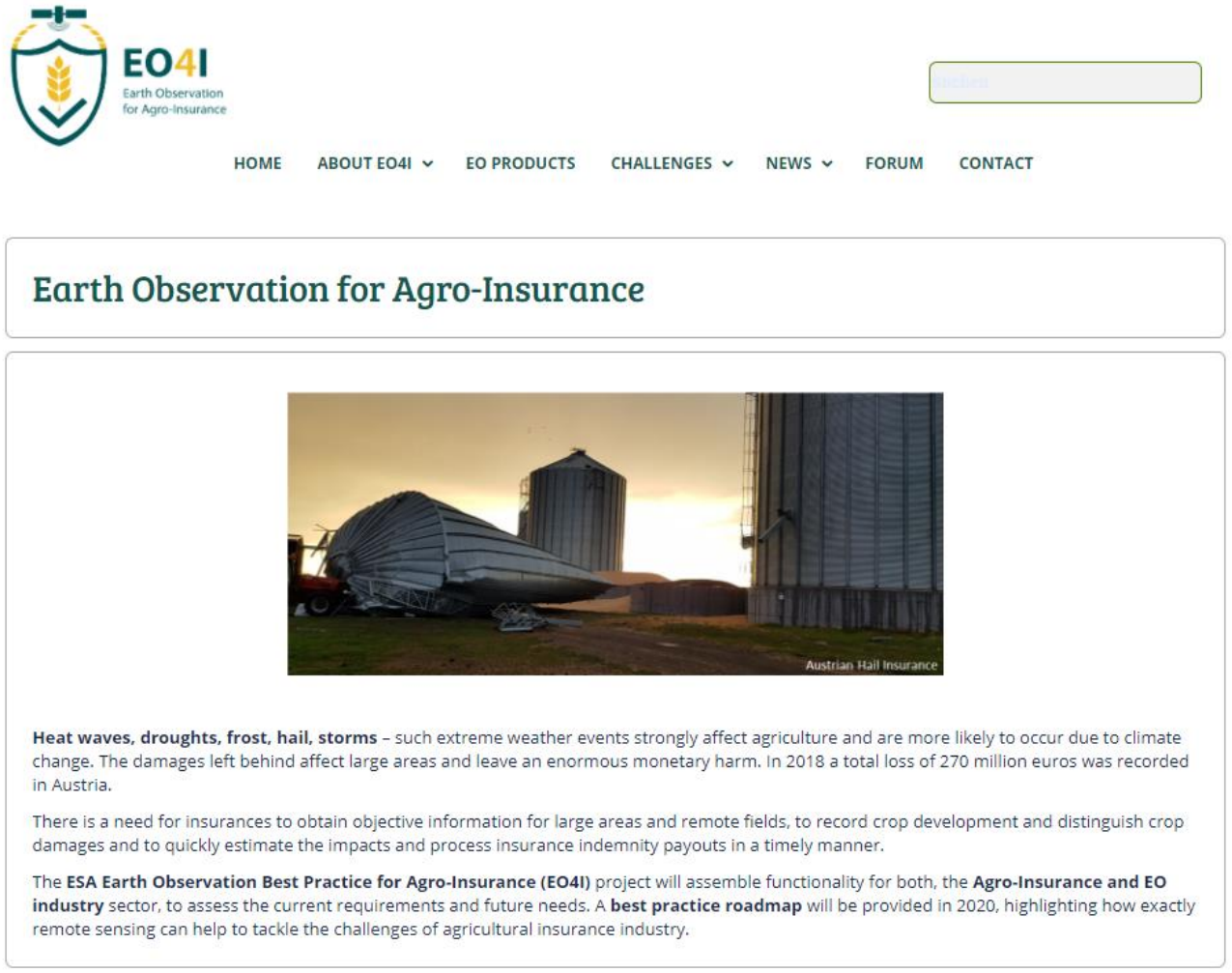
ID	Key Geo-Information Requirement
1	Obtain uninterrupted consistent long data series (high temporal/spatial resolution)
2	Obtain detailed topographic characteristics
3	Obtain detailed imagery of the surface
4	Identify soil types (mineralogy, structural properties of near surface)
5	Identify soil moisture contents
6	Obtaining information on parcel location and boundaries
7	Identify crop type
8	Obtain historical crop production (crop, area, yields)
9	Crop vegetation monitoring
10	Monitoring stress in vegetation
11	Identify the crop emergence and harvest date
12	Crop yield monitoring
13	Estimating yield losses
14	Identify crop damages
15	Identify effects of various risks (frequency, severity, area covered by each risk event)

ID	Key Geo-Information Requirement
16	Obtain detailed land use information (crop production landscape, etc.)
17	Identifying agricultural practices (irrigation, fertilisation)
18	Obtain detailed imagery of assets (property, machinery, other field infrastructure)
19	Identify location and condition of infrastructure objects (irrigation, greenhouses, water wells, etc.)
20	Identify water boundaries (flooded areas, etc.)
21	Identify livestock movements
22	Identify pastures biomass (yield potential)
23	Identify waves height, currents' energy and thermal data
24	Identify water flora/fauna (algae, etc.)
25	Identify forests characteristics (area, boundaries, timber type, etc.)
26	Monitor and forecast weather events
27	Assess the impact of drought events on crop production
28	Study the relation between climatological events and crop production proxies
29	Detection of vegetation growth anomalies
30	Parametric indicators for index insurance

From 61 Challenges to EO Capabilities



EARSC platform



https://earsc-portal.eu/display/EO4I/

OBJECTIVES FOR AGRO-INSURERS

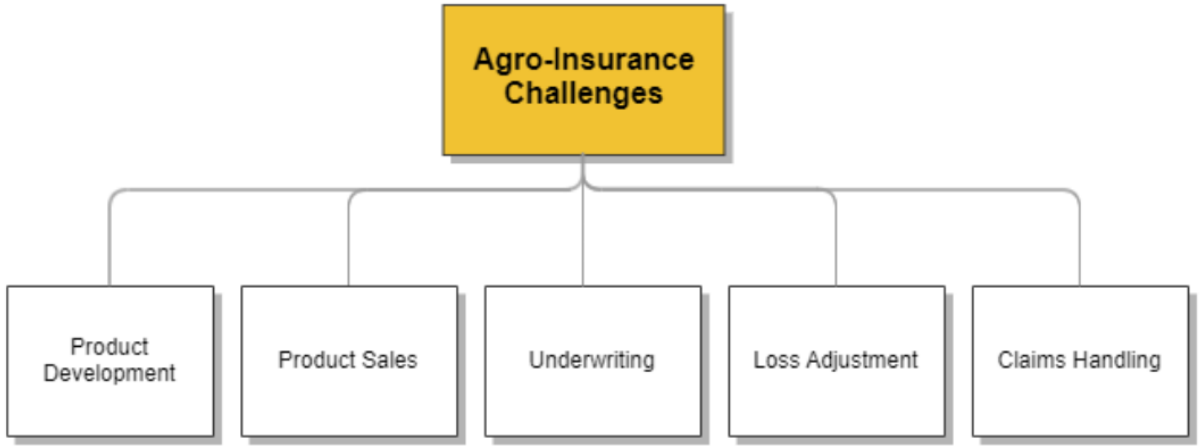
- First point of entry to all information gathered
- Relating operational challenges with existing EO products

OBJECTIVES FOR EO DEVELOPERS

- Background information on the sector‘s business processes and challenges

EARSC platform

- Structured according to business processes:



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BACKGROUND KNOWLEDGE ON INSURER‘S BUSINESS PROCESSES

Earth Observation for Agro-Insurance / Activities

Product Development

Description of business process

Product Development is a complex of activities that insurer undertake to develop and introduce a new insurance product on the market. Product development activities include:

Activities

Market analysis	Before actual product development, it is necessary t production, production area per each year of produ available. Market analysis also includes the producti focus, major producer groups (subsistent, small, cor change factors in production trends within a certain and possible risks for the future.
Identification of Risk Zones and crop production specifics	Crop production is not homogenous in most countr topographic and climatic conditions the crop's risk e practice in agricultural insurance to identify risk zon the actual risk level for the given area calculated by
Risk pricing / product rating / PML analysis for re/insurance	Product development includes analysis and estimati Agricultural insurance actuaries apply calculation m crop-related datasets available. Probable Maximum possible for a certain type of crop/risk in a defined r
Development of underwriting / loss adjustment guidelines	Each product should possess a set of required docu methodologies. Mostly those relate to program adm activities being among the key in the insurance proc guidelines specify the way risk-taking decisions shou crop/risk for insurance. Loss adjustment guidelines assessment process and calculation methodology fo indemnity sum.
Application of Policy wording / terms and conditions (general, crop-specific)	Terms and Conditions of insurance could be genera the product structure and special conditions applie

Earth Observation for Agro-Insurance / Activities

Loss Adjustment

Description of business process

Determination of the extent of damage resulting from occurrence of an insured peril. Loss Adjustment activities include (but not limited to):

Activities

Pre-insurance acceptance for insurance	Depending on the type of insurance product the pre-insurance crop inspection may be required to assure the presence of the crop and record its actual conditions at time of insurance application. Such crop survey is conducted by the trained crop surveyor or may be performed by the underwriter if the decision on insurability is made purely based on the EO services or data.
Initial crop inspection after risk event occurrence	It is important to record the crop condition after the risk event occurrence. Physically inspection is conducted by the trained crop surveyor/loss adjuster indicating the scale and the character of damage caused to the crop insured. Among the surveyor's tasks are to identify the effect of insured and non-insured perils. In most cases such an inspection should be conducted within a limited period of time after actual crop damage (e.g. within 10 days). This period may be specified for each crops/risk insurance product or applied as a standard period for all agricultural products within the insurance company.
Loss adjustment crop survey (pre-harvest)	Final loss adjustment survey report is regularly required for further indemnification of the insurance claim. Physical pre-harvest crop survey allows the surveyor to identify the regeneration or degradation of the crop and estimating of the final damage extent and/or potential yield loss.
Reporting on actual extent of damage subject for further indemnification	The final loss adjustment survey report with an indication of the defined extent of crop damage is provided to the underwriter for calculation and approval of the final indemnity sum with further claim transfer to the insurer's claims handling department for further pay-out.

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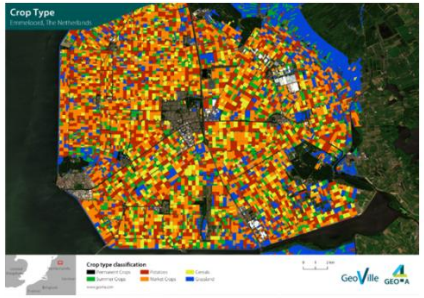
BACKGROUND KNOWLEDGE ON EO PRODUCTS

Crop Type Detection

Download Product Sheet



Crop types in a selected area of interest (Emmeloord, The Netherlands) (Source: GeoVille/Geo4A)

Category

☑ Product Development	☑ Product Sales	☑ Underwriting	☑ Loss Adjustment	☑ Claims Handling

PRODUCT DESCRIPTION

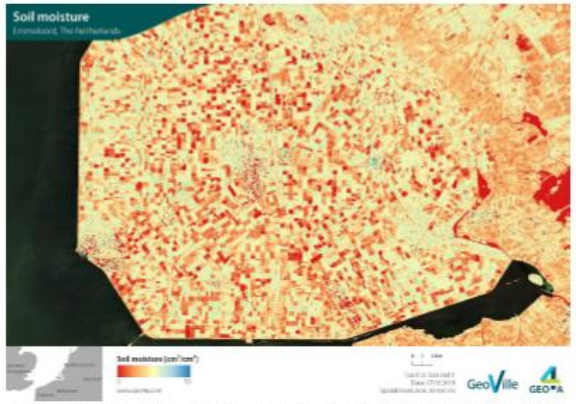
The crop type detection service provides information on types and location of crops grown with different levels of detail. Besides summer and winter crops, various types such as potatoes, maize, cereals, and others field crops can be detected using Earth observation techniques.

The classification of crop types is performed by using spectral information and temporal information about crop development. With this information it is possible to separate accurately different crop classes over large areas. To identify the different crop types a long and consistent time series of satellite imagery is needed. Taking a close look on the fields over a growing season is important as the differences between the crops become apparent based on their phenological development over the season. The later in the season, the more accurate the identification of crops gets, as there is more information available and the vegetation differences are more clearly recognisable.

Optical as well as radar satellites are used for this service. Radar imagery such as Sentinel-1 provide information on structural properties of crops and therefore optimise the results. Furthermore, the limitation of optical data due to cloud coverage can be overcome using radar data. Different levels of detail are possible: analysis may be performed on pixel or parcel level; also, generic grouped classes as well as specific crop types are feasible.
The service is applied within a specified area of interest. Analysis is possible in different regions with some region-specific adjustments. To distinguish the different crop types more accurately, training data from regions and within the season is needed.

PRODUCT SPECIFICATIONS

SOIL MOISTURE



High resolution soil moisture based on Sentinel-1 (Emmeloord, The Netherlands) (Source: GeoVille/Geo4A)

CATEGORY

☒ Product Development	☒ Product Sales	☒ Underwriting	☒ Loss Adjustment	☒ Claims Handling

DESCRIPTION

Soil moisture plays an important role for the environment and the climate system. Affected by precipitation, temperature, soil characteristics and more factors, soil moisture refers to water stored in the soil. It influences hydrological and agricultural processes as well as runoff generation and many other processes. Earth observation provides global, seamless surface soil moisture information, measuring the moisture content of the top five centimetres of soil. Based on this, root zone soil moisture can be modelled. This seamless observation is a clear advantage compared to point based in-situ measurements, and recent developments allow to obtain also high-resolution satellite soil moisture observations.

The ESA Climate Change Initiative (CCI) Soil Moisture provides a +40-year dataset of daily soil moisture [m^3/m^3] at 25 km, updated yearly. Based on active and passive sensors this consistent global dataset provides valuable information at larger scales but does not meet the need for real time soil moisture information at field level. The Copernicus Global Land Service provides Surface Soil Moisture (SSM) and the Soil Water Index (SWI) with a resolution of 1 km for the layer over Europe and 12,5 km at global scale, every day. Recently, also higher resolution (e.g. 100 m as well as 10 m) near real time soil moisture products are being made available using the Copernicus Sentinel Constellation and offered by commercial Earth observation companies.

The data may be used as an indicator for insurance portfolio's drought/flood monitoring and loss adjustment procedures to benchmark the areas affected/unaffected by risk event. A more accurate and robust underwriting with additional rating instruments to be applied based on the soil moisture data.

PRODUCT SPECIFICATIONS

Main processing steps	High resolution soil moisture is estimated by a multi-sensor, time-series data-based approach. Data from various satellites with different spatial resolutions is combined.

- Greater acceptance of index covers by farmers
- Regular market penetration review

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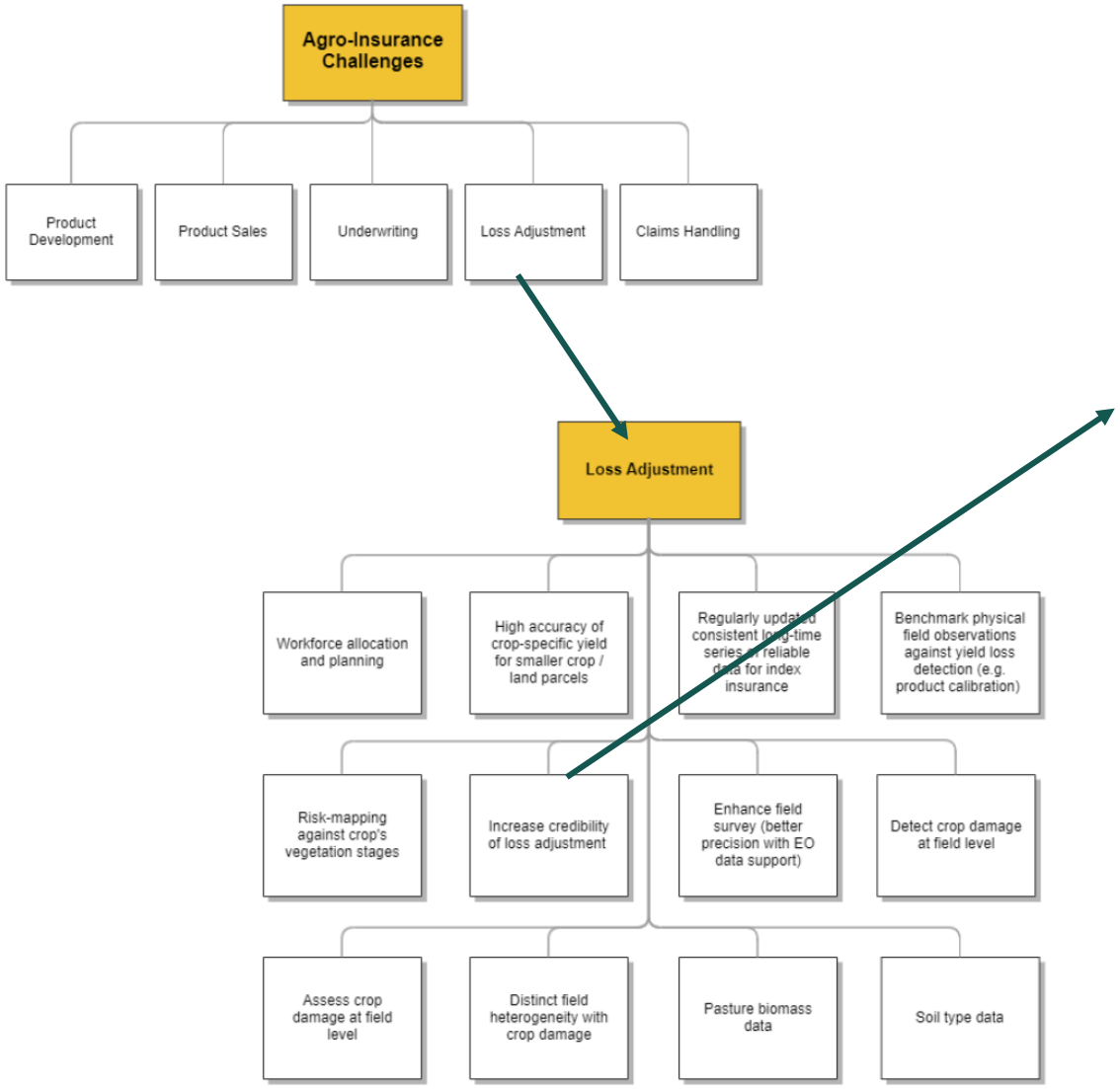
CONNECTING REQUIREMENTS WITH PRODUCTS



LA-6 Increase Credibility of Loss Adjustment (e.g. show EO data/visualization to support loss adjustment communication to farmer)

An index structure/product has to provide a range of reliable information that could be used by the loss adjuster while communicating with the farmer on estimating the final extent of the damage.

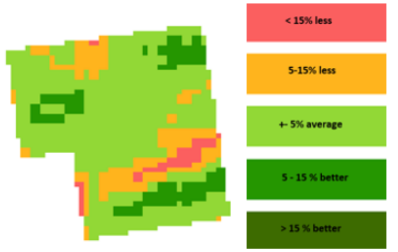
Relevant EO Products

- Monitor and Forecast Weather Events
- Early Vegetation Stress
- Yield Estimation
- Drought Indicators
- Grassland Mowing Cycle
- Evapotranspiration
- Near Real Time (NRT) Service
- Crop Growth Zone Detection
- Crop Type Detection
- Date of Emergence
- Field Boundaries
- Soil Moisture
- Vegetation Growth Monitoring
- Crop Damage Zones Detection
- Vegetation Indices: LAI, NDVI

Earth Observation for Agro-Insurance / EO Products & Services for Agro-Insurance

Crop Growth Zone Detection

Download Product Sheet



Historical crop growth zone detection based on 5 years of Sentinel-2 data for a parcel in Belgium (Source: VITO, watchitgrow.be)

Category

Product Development | Product Sales | Underwriting | Loss Adjustment | Claims Handli

PRODUCT DESCRIPTION

A crop parcel is mostly uniformly treated by farmers and local weather conditions. Many fields however show a spatial variability in cro performance in the course of the growing season. Such variability is caused by a variety of natural and technology factors.

Where a multiyear recurrent variability is caused by differences in soil types, topography, weather micro-zones, crop growing technolo

Conclusions

SECTOR OVERVIEW OF THEMATIC BUILDING BLOCKS
LINKED TO BUSINESS PROCESSES

IMPORTANCE OF TIMELINESS AND RESOLUTION

IN-HOUSE CAPABILITIES

PRIMARY INSURERS – REINSURERS

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for Agro-Insurance

Capabilities matching Requirements

Ralf Ryter

esa

vito
remote sensing

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Use Cases of EO4I

- Use Case I: Local Benchmarking & Crop Damage
- Use Case II: Drought Monitoring
- (Use Case III: Yield Volatility)

- Goal: Demonstrating EO capabilities within a proof of concept

EO4I
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Technology Push by COVID-19

Ian Shynkarenko,
CEO, AgroInsurance International

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PURPOSE OF COVID-19 RESEARCH

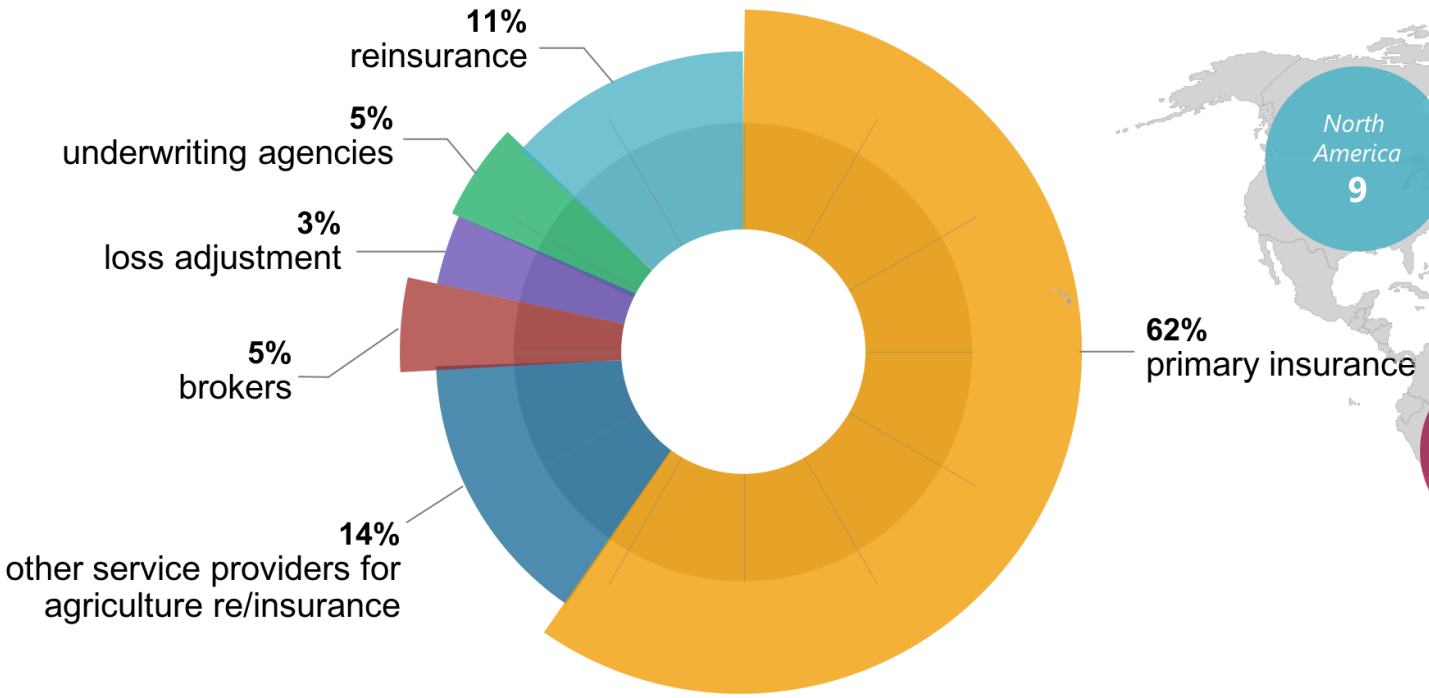
Key Focus:

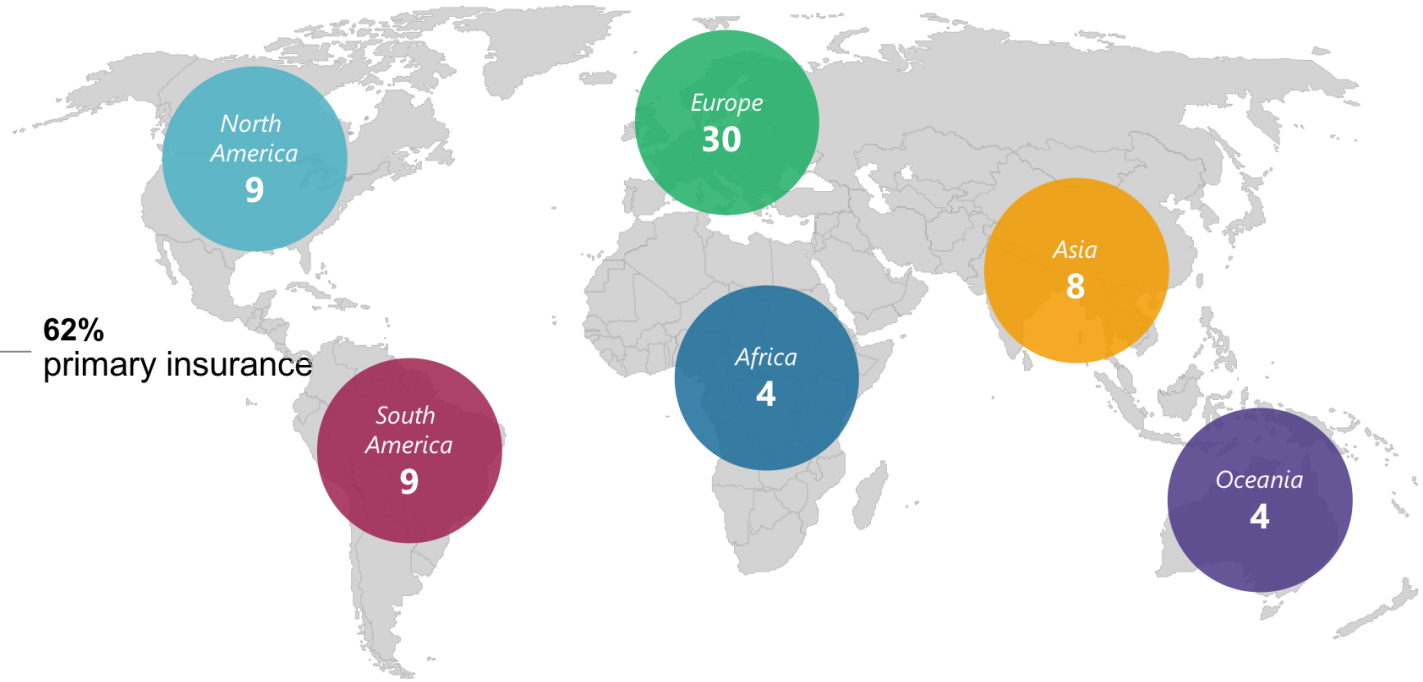
underwriting of existing / new business, processing renewals and assessing losses.

- Understand if agricultural re/insurers experienced any difficulties in 2020 due to COVID-19.
- If new procedures, protocols or technologies were introduced to support operation under challenging circumstances of 2020.
- Focus exclusively on agricultural insurance (field crops, horticulture, forestry, pasture crops, livestock, aquaculture, greenhouse, weather, yield and other types of index insurance for agriculture).*

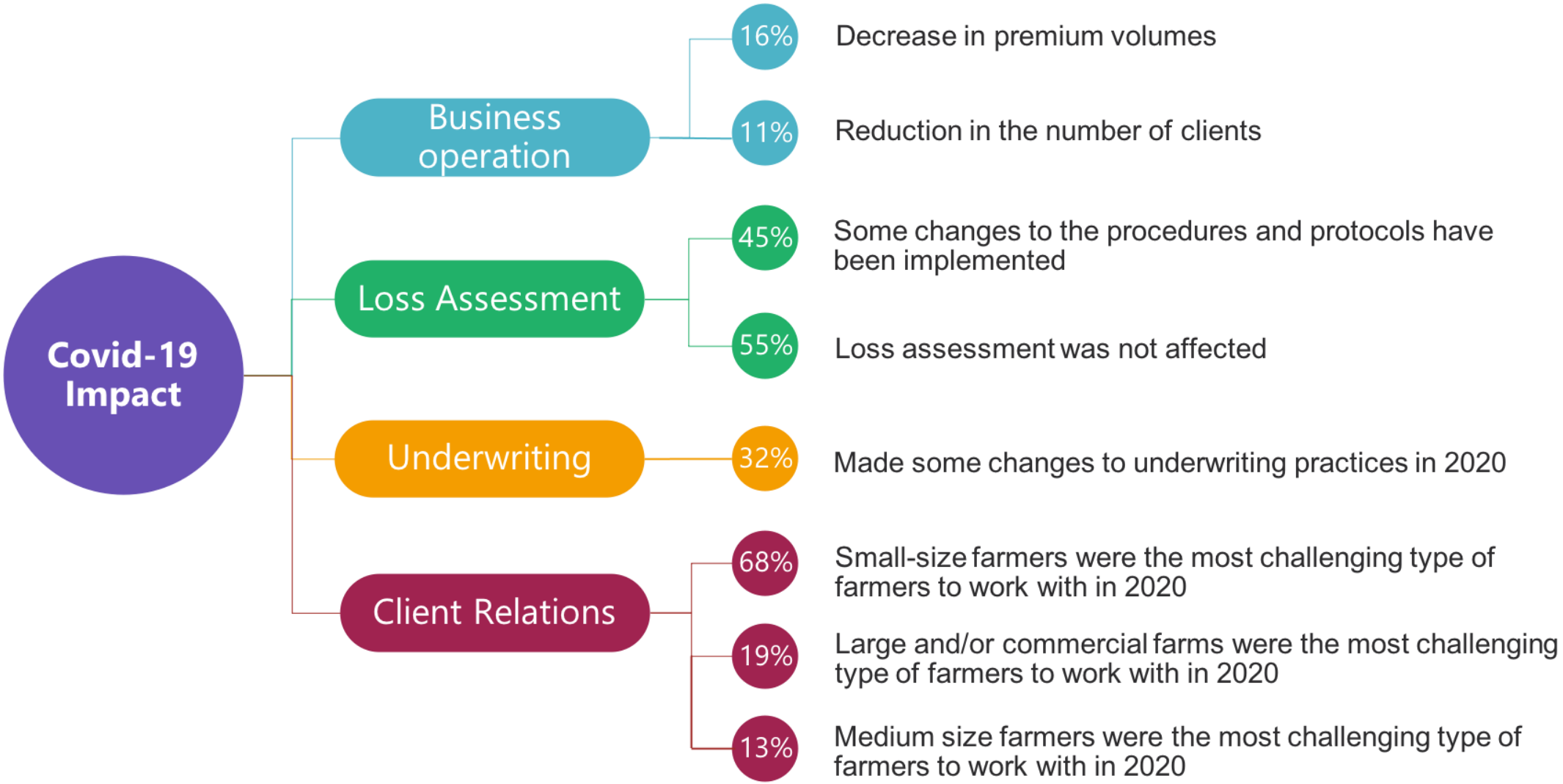
** AgroInsurance did not collect information on farm property or liability insurance business lines.*

INDUSTRIES CONTRIBUTING TO SURVEY

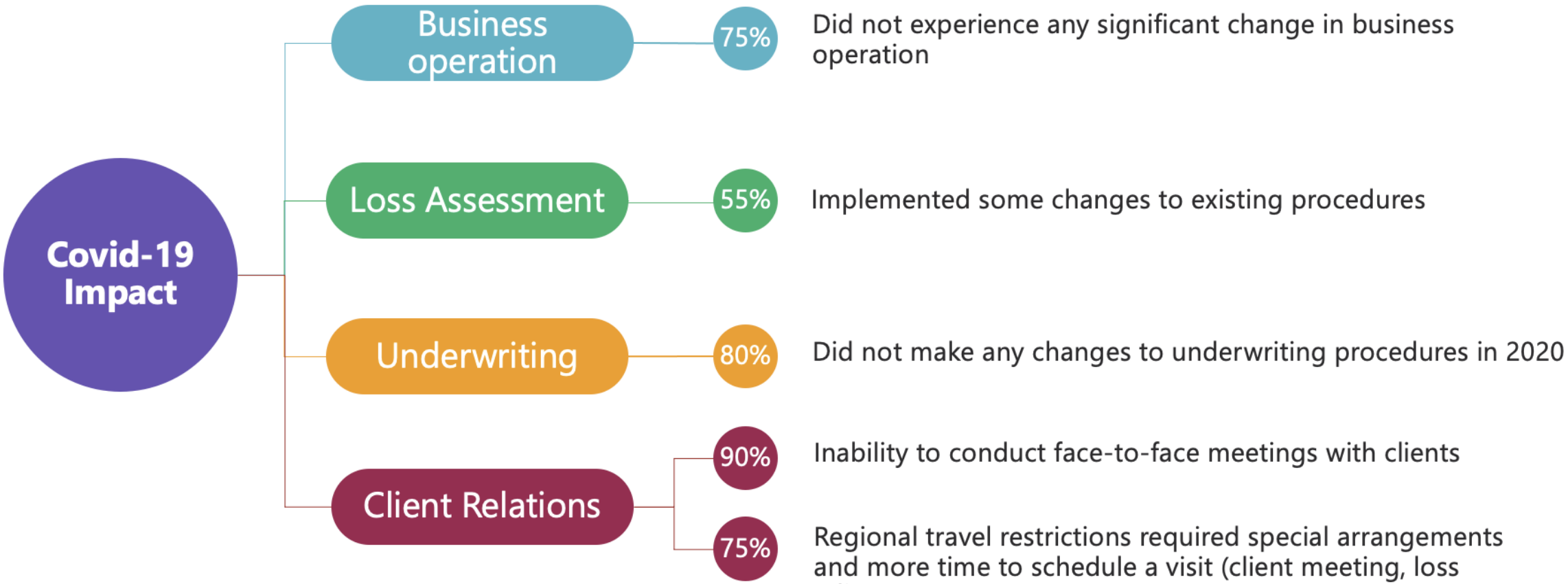




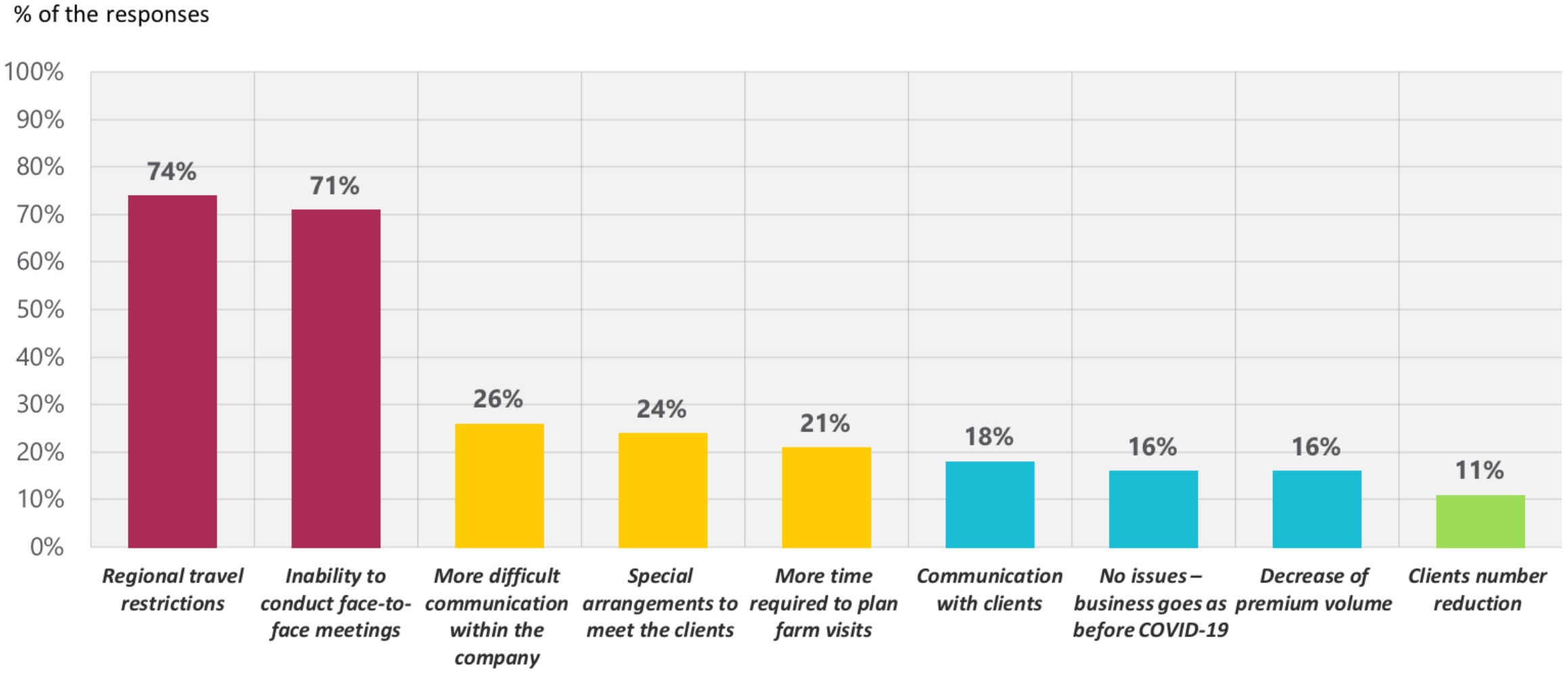
KEY FINDINGS – GLOBAL



KEY FINDINGS - EUROPE



2020 CHALLENGES - GLOBAL



FEEDBACK ON TECHNOLOGY AND DATA

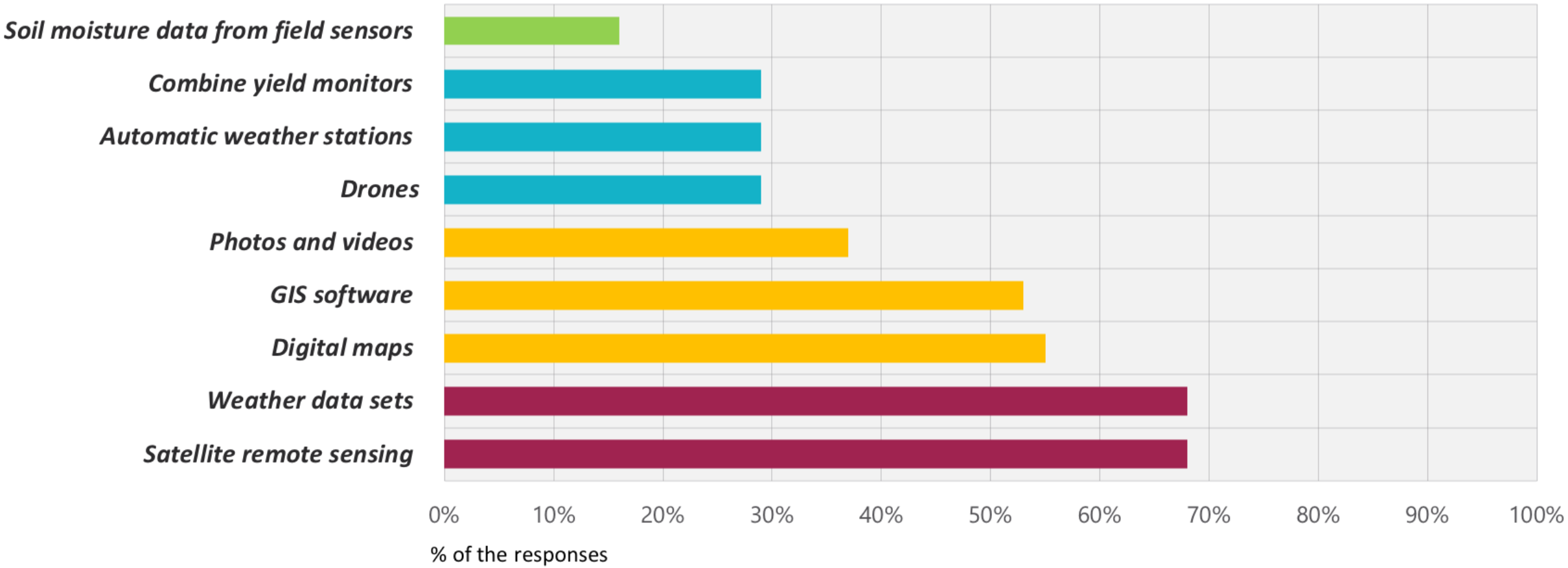
Key Message:

70% of respondents noted on the importance of further digitalization of agricultural insurance: introduction of new technologies and enhancement of data

Technology and Data Challenges:

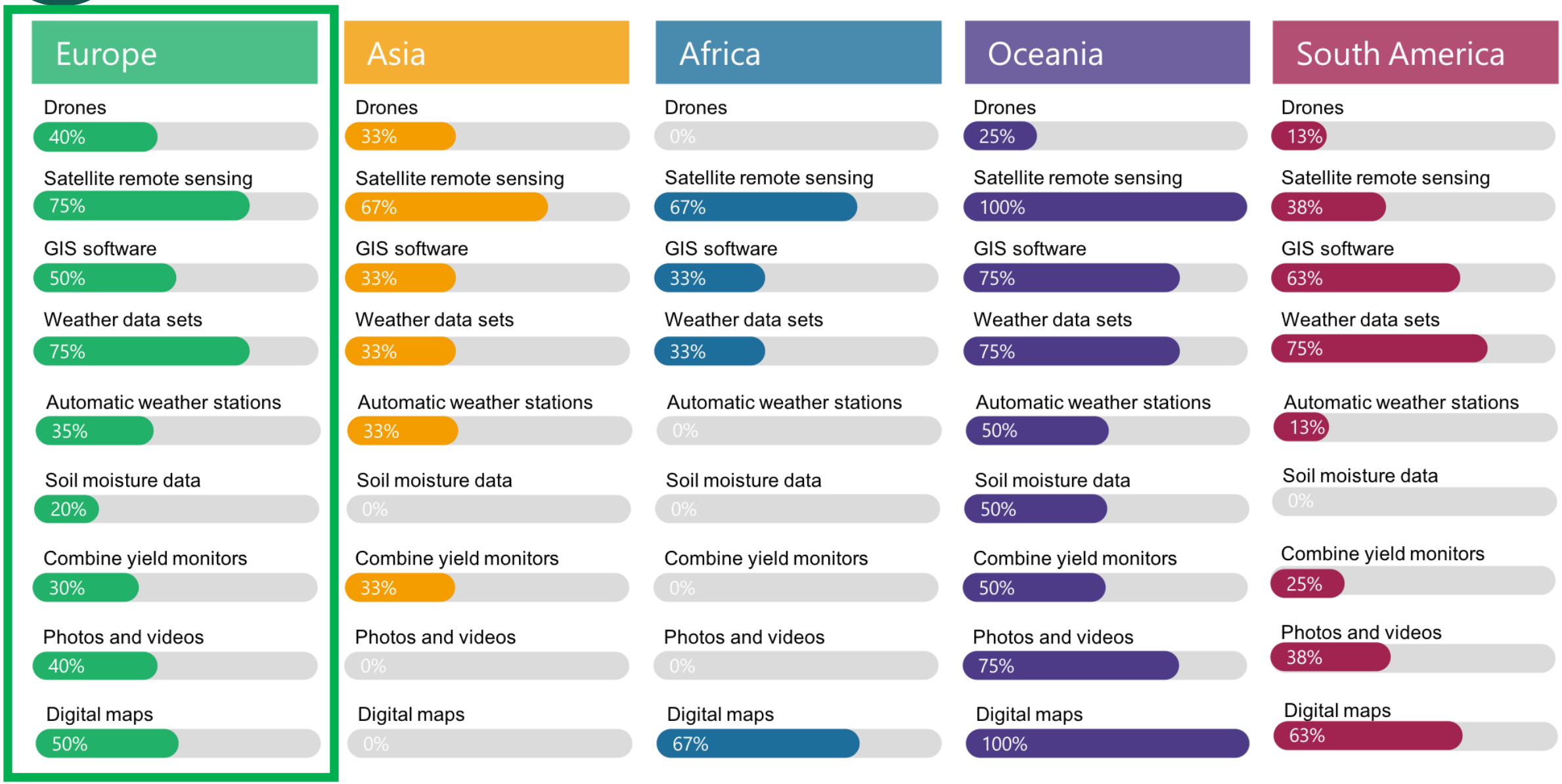
1. **Satellite data is still "*not good enough*" - data quality**
2. ***"Data required specific technical skills to interpret it properly" - capacity***
3. ***"Lack of understanding how the available satellite instruments could be better used for the purposes of agricultural insurance" - awareness***

TECHNOLOGY APPLICATION IN 2020 - GLOBAL

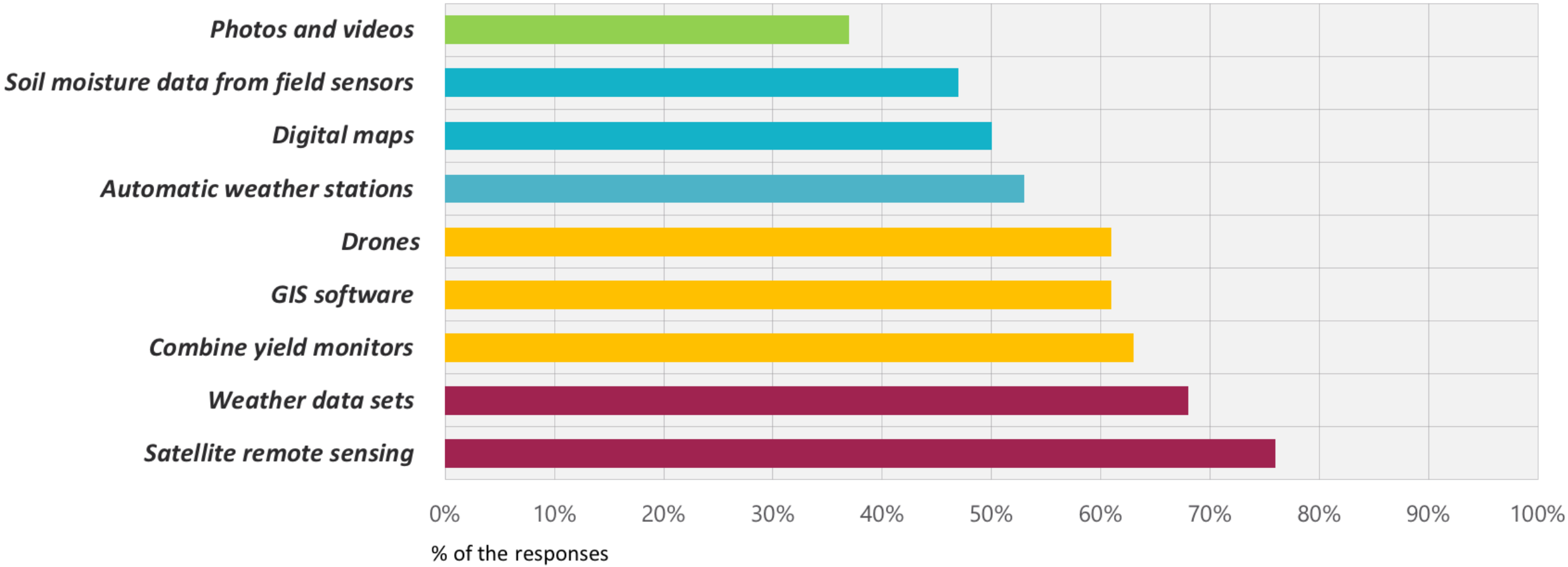


TECHNOLOGY APPLICATION IN 2020

EO4I Earth Observation for Agro-Insurance



FUTURE TECHNOLOGIES FEEDBACK - GLOBAL



FUTURE TECHNOLOGIES FEEDBACK - EUROPE

EO4I Earth Observation for Agro-Insurance

Europe

"Information about hails and other natural events is not collected centrally by any authorities. Thus we don't have clear picture of highly exposed zones and get bad portfolio concentration due to anti selection."		"The main challenges are the availability and quality, the integration (interfaces) and the interpretation of data"	""IoT", AI, (block chain), data fusion, Remote sensing, Augmented Reality, chat bots"
"Better granular, geo-referenced and calibrated (e.g. combine) data, AI and ML, all information available in one platform"	"GIS systems processing data on concluded insurance contracts"	"Farm data transparency and availability. Instruments that enable easy access to raw farm data, weather data, loss history, etc. (structured/semi-structured)"	
"Third party independent yield verification data. Adjusted historical yield data sets"	"It is all about data and the handling of large amount of data. The more granular and the more frequent data you have the better. Best would be if farmers would share their individual data from precision farming equipment"		"Mobile applications supporting damage estimation"

FEEDBACK – KEY REQUIREMENTS (survey responses)

- Increased **re-visit time** for new satellites and satellite constellations
- Higher **numbers of satellites** on orbit including **specialized agricultural** satellites (large and micro)
- Further development of **equipment with enhanced resolution** and more specific **data delivered quickly** to end users
- Adjustable platforms with **specialized solutions** for agricultural insurers (underwriting, loss adjustment, claims handling), integrated with the insurers' management information systems (MIS)
- Significantly **enhanced capabilities** for crop identification, yield assessment, livestock tracking, property inspection, etc.

THANK YOU!

AgroInsurance at Your Service:

- Research, analysis and program audit
- Product design and technical assistance
- Capacity building / training underwriters and loss adjusters
- Agricultural risk management consulting
- Customized underwriting solutions
- Loss adjustment services
- Technology introduction and support

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EO4I
Earth Observation
for Agro-Insurance

Summary & Q&A

Ralf Ryter, Roel van Hoolst, Ian Shynkarenko, Roman Shynkarenko

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remote sensing

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Summary

Presented and discussed topics:

- Short introduction to project
- Current and future EO capabilities
- Sector requirements overview & EO product usage considerations
- Use Cases of EO4I
- Technological push by Covid-19 pandemic

Summary

Most interesting discussion outcomes:

- Basically technological questions regarding EO
- (Near) real time monitoring in many business processes important
- Long-term data of importance
- New / more sensors / satellites needed to fulfill needs
- Combination of EO with other data necessary (n.b. accuracy)

Summary

Most interesting discussion outcomes:

- Covid: Business didn‘t suffer that much as expected
- Trusted data
- Tailored solutions
- Colaboration and close contact between both industries needed
- Historical data + new technology can give good results
- remote sensing can help recalculate pricing of insurance products

Agricultural area in central Spain (Albacete); Global Landcover Dynamics on landmonitoring.earth (GeoVille)

EO4I
Earth Observation for Agro-Insurance

Thank you!

For further information please contact:
Ralf Ryter (ryter@geoville.com)
GeoVille

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