Lessons learnt from SEN4CAP: Applying Sentinel data for agricultural applications

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SINERGISE

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CAP monitoring approach – Technology meets Policy

Sen4CAP Objectives

- **Provide evidence** how Sentinel derived information can support the modernization and simplification of the CAP **in the post 2020 timeframe**
- Provide **validated algorithms**, **products**, **workflows** and **best practices** for agriculture monitoring relevant for the management of the CAP

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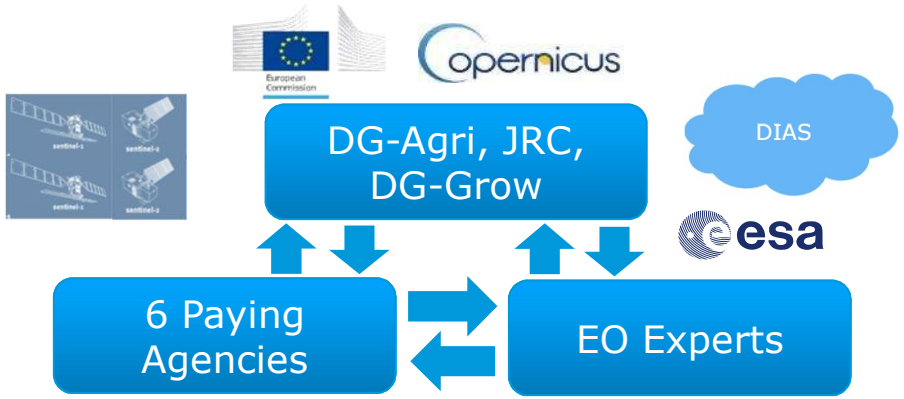
CAP monitoring approach – Technology meets Policy

- Focus on generating **markers** (products) that are used to support **compliance decision** within various **use cases** (subsidy schemes)
- Demonstration on **national scale** in 2018 and 2019
- Continuous **monitoring** within the crop growing season
- Implemented and operated on **cloud** (DIAS)



2017 ag. season – local sites *2018 ag. season – 6 national cases* *2019 ag. season – 6 NRT national demo*

Use cases & Algo development | Bench-marking | Valida tion | Use case demo & training | Validation & Assessment

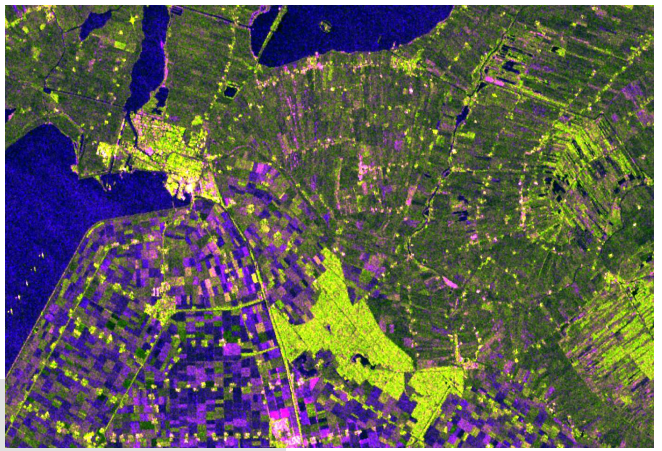
Users requirements in terms of use cases

Use cases
Crop diversification
Permanent grassland monitoring
EFA-Land lying fallow
EFA-Catch crops
EFA-Nitrogen-fixing crops
Land abandonment
Interactive visualization
LPIS update
Claimless system

Use Cases
w/ Paying
Agencies

Input Earth Observation (EO) datasets

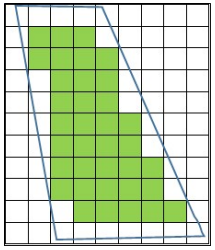
- **Automated EO data pre-processing**
  - Validated and operational
- **Optical imagery: Sentinel 2, Landsat 8**
  - Reflectance bands + Derived indices
  - 22 object-based metrics every 10 days
- **SAR imagery: Sentinel 1**
  - Backscatter + Coherence
  - 10 object-based metrics every 10 days + temporal features



Agricultural parcel

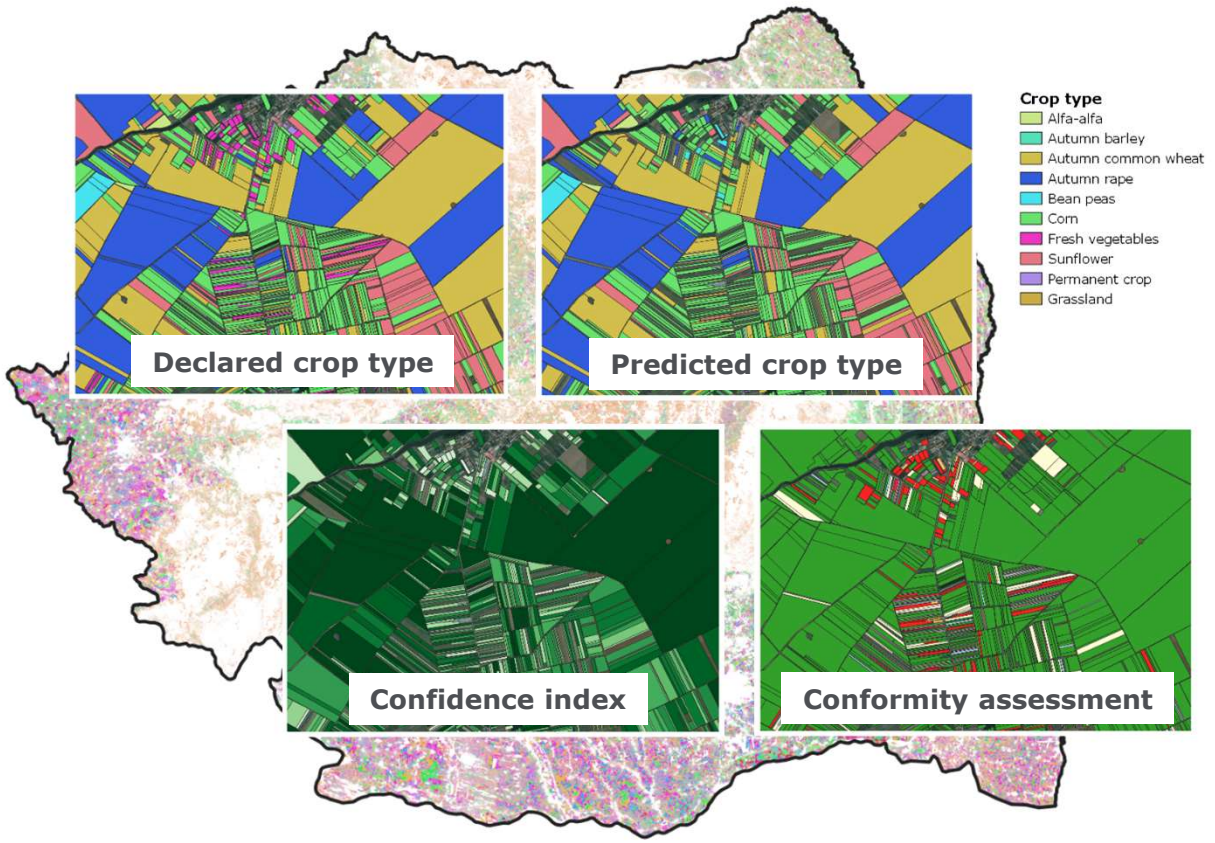
- Per-parcel analysis
  - LPIS – freely available or provided by the PA
  - GSAA (Geo Spatial Aid Application) – agricultural parcel definition, provided by the PA

- Minimum parcel to be analysed
  - Counting pixels completely within the parcel
  - All parcels with at least 1 Sentinel-1 (20x20m) and 3 Sentinel-2 (10x10m) « inside » pixels are assessed
  - Pixel count could be considered as a reliability indicator of the EO marker

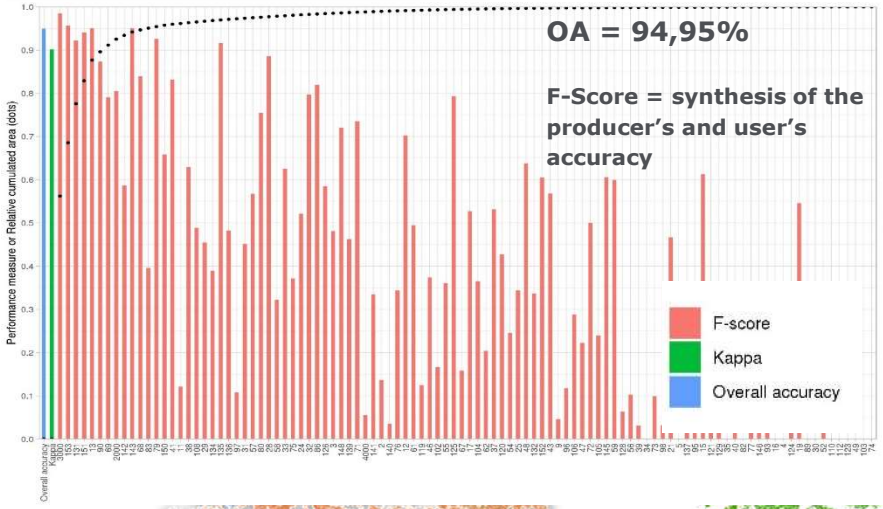


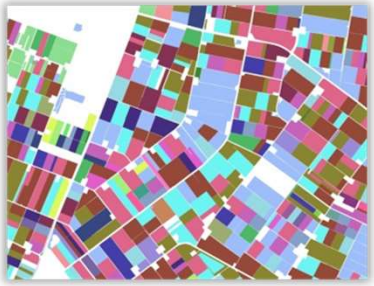
Sentinels indicators and markers: Crop type

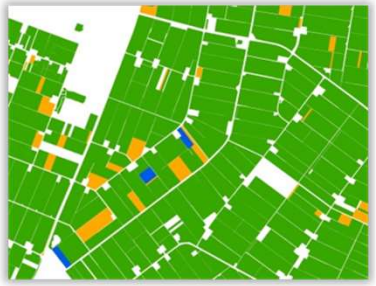
- **Crop type mapping**
- **Growing vegetation indicators**
- **Grassland mowing detection**
- **Agricultural practices monitoring**

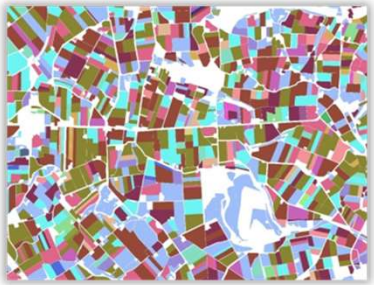


Crop type mapping in 2018 (Netherlands)









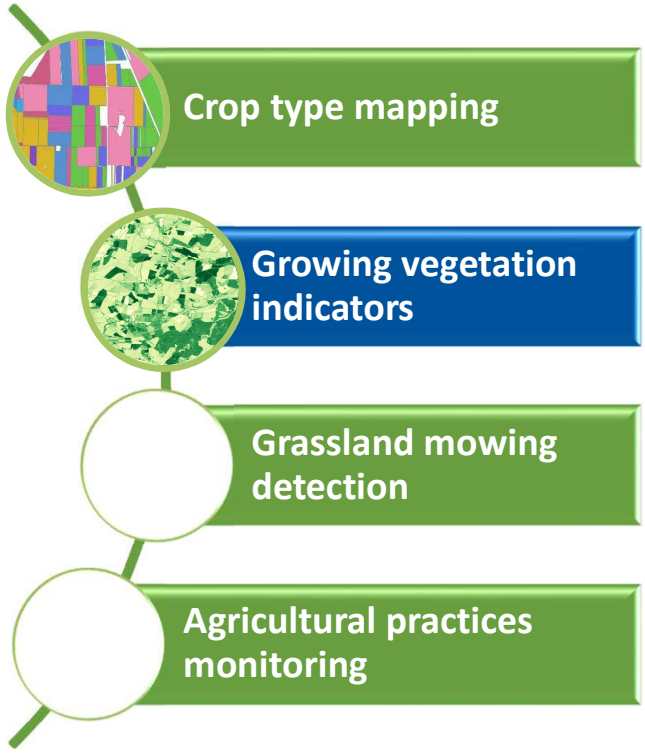
Synthesis of preliminary performances of crop type in different EU agricultural landscapes for 2018

- **16 millions of parcels assessed** for 600.000 km²
- **Overall accuracies from 71 % to 95 %** (all > 70 %, 3 countries > 80%)

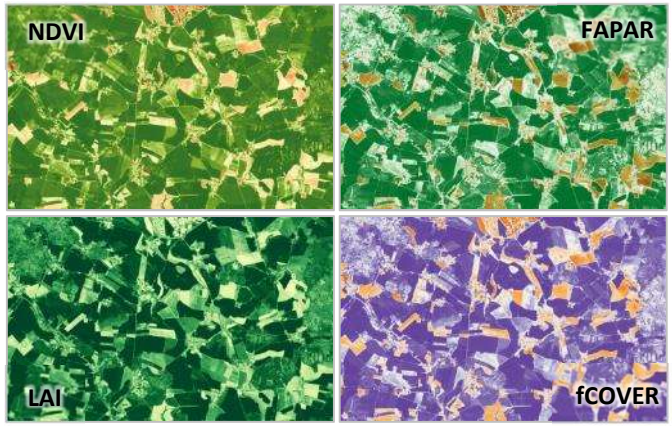
  => Improvements foreseen by refining crop type list, selecting better the calibration dataset, excluding poorly defined classes, using stratification,...
- **Limited impact of parcel size and shape** on the assessed areas (0,3 % to 8 %)

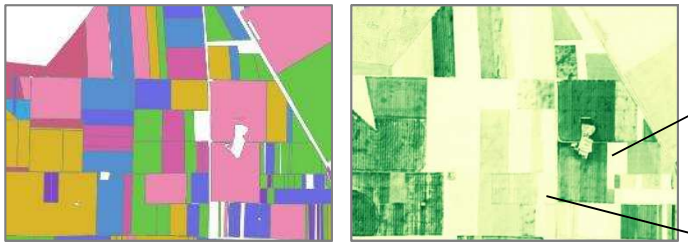
Country	Area Of Interest	EO input	Total area (km²)	Total parcels (Nr)	Parcels not assessed due to the size (%)		Overall Accuracy
					Nr	Area	
NLD	100 % country	S2 + S1	42 508	802 217	9,3%	**1,0%**	**95,0%**
CZE	100 % country	S2 + S1	78 873	593 787	8,4%	**0,3%**	**82,8%**
LTU	100 % country	S2 + S1	64 897	1 153 796	16,2%	**1,5%**	**78,7%**
ITA	100 % of the AOI (5 Regions)	S2 + S1	67 270	8 527 409	33,9%	*15,49%**	**72,4%**
ESP	100 % of the AOI (Castilla Y Leon)	S2 + S1	94 226	3 540 880	34,6%	*27,78%**	**81,8%**
ROU	100 % country	S2 + S1	238 369	6 127 057	35,8%	**8,3%**	**71,2%**

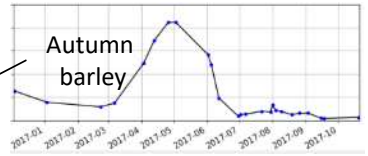
Sentinels indicators and markers: Vegetation indices



4 indicators





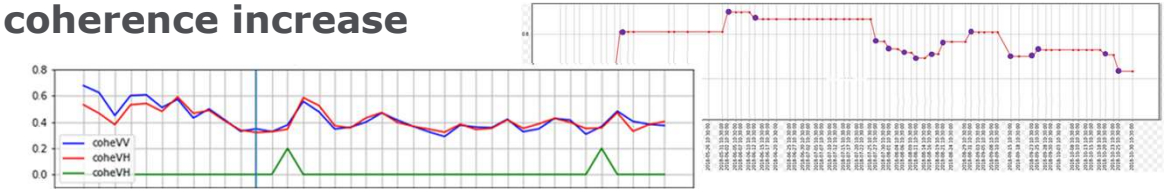


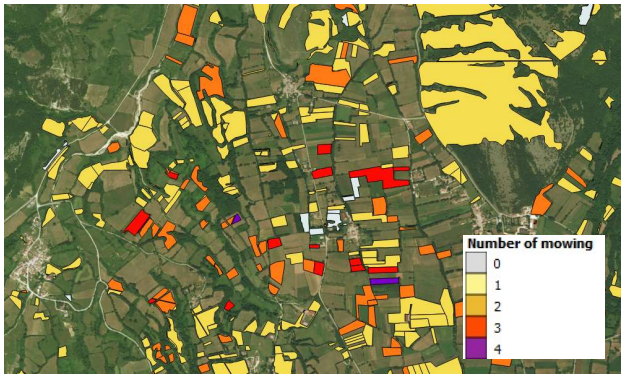
Crop type information & growing vegetation indicators

Sentinels indicators and markers: Grassland mowing

- Crop type mapping
- Growing vegetation indicators
- **Grassland mowing detection**
- Agricultural practices monitoring

Mowing detection based on the detection of **S2 Vegetation Indices (NDVI, LAI and FAPAR) decrease** and **S1 coherence increase**





Product info for each parcel

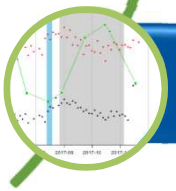
- ✓ Parcel identifier
- ✓ Grassland Crop type
- ✓ Number of mowing events (maximum 4)
- ✓ For each mowing event (up to 4):
  - Temporal interval in which the mowing event occurred (t_start and t_end)
  - Confidence level in terms of probability of right mowing (conf)
  - Satellite mission data used for detection of mowing (S1, S2 or both)
  - Compliancy level

Sentinels indicators and markers: Agricultural practices (EFA)

Crop type mapping

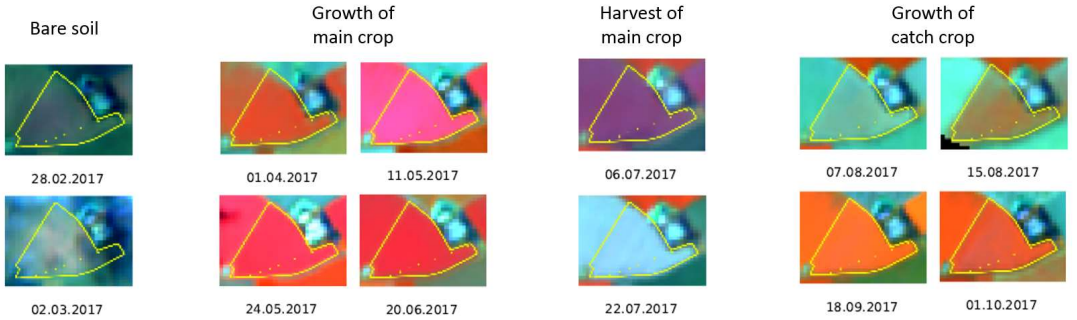
Growing vegetation indicators

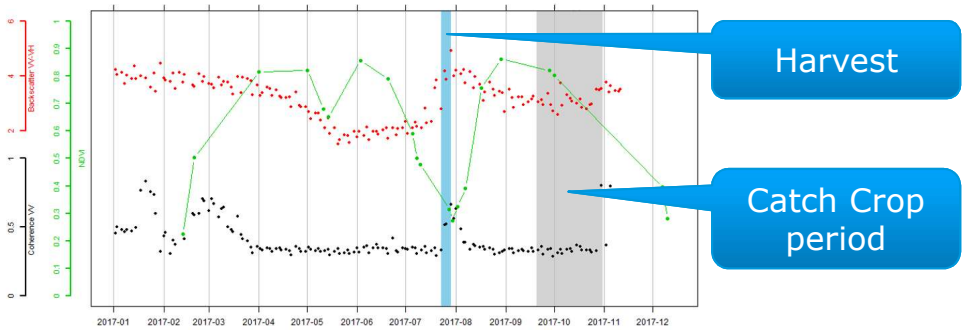
Grassland mowing detection



Agricultural practices monitoring

RULE: Winter Catch Crop must be sown before 20 Sept. and must not be harvested before 31 Oct. During this period, crop coverage must not be mechanically or chemically removed or limited in growth.





In-situ data

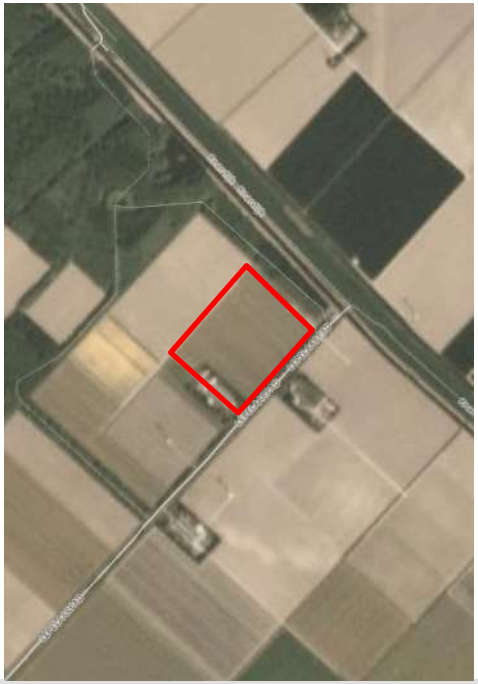
- Benchmarking activities, parametrization and validation of algorithms, validation of prototype products (2017)
- Validation of demonstration products (2018, 2019)
  - Crop map
    - ✓ Subsidy applications
  - Grassland mowing & grazing, Harvest, Agricultural practices
    - ✓ Interview with farmers
    - ✓ Planet imagery

Validation: Grassland mowing (Netherlands)

Mowing date from farmer interview: **8 May**

Planet Data: **7 May**

Planet Data: **9 May**



Mowing date from farmer interview: **19 June**

Planet Data: **7 June**

Planet Data: **26 June**

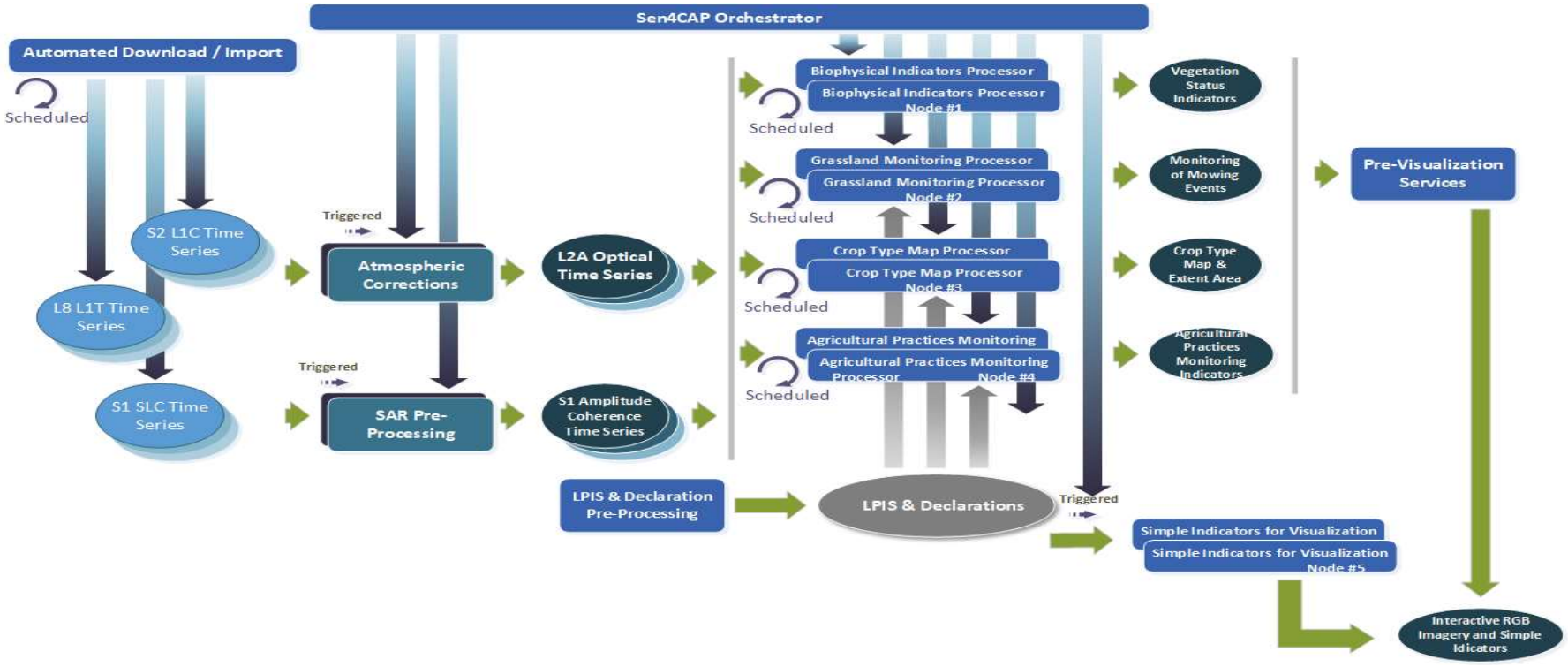
Validation: Agricultural practices (Czechia)

Declared: Rapeseed + Summer catch crop

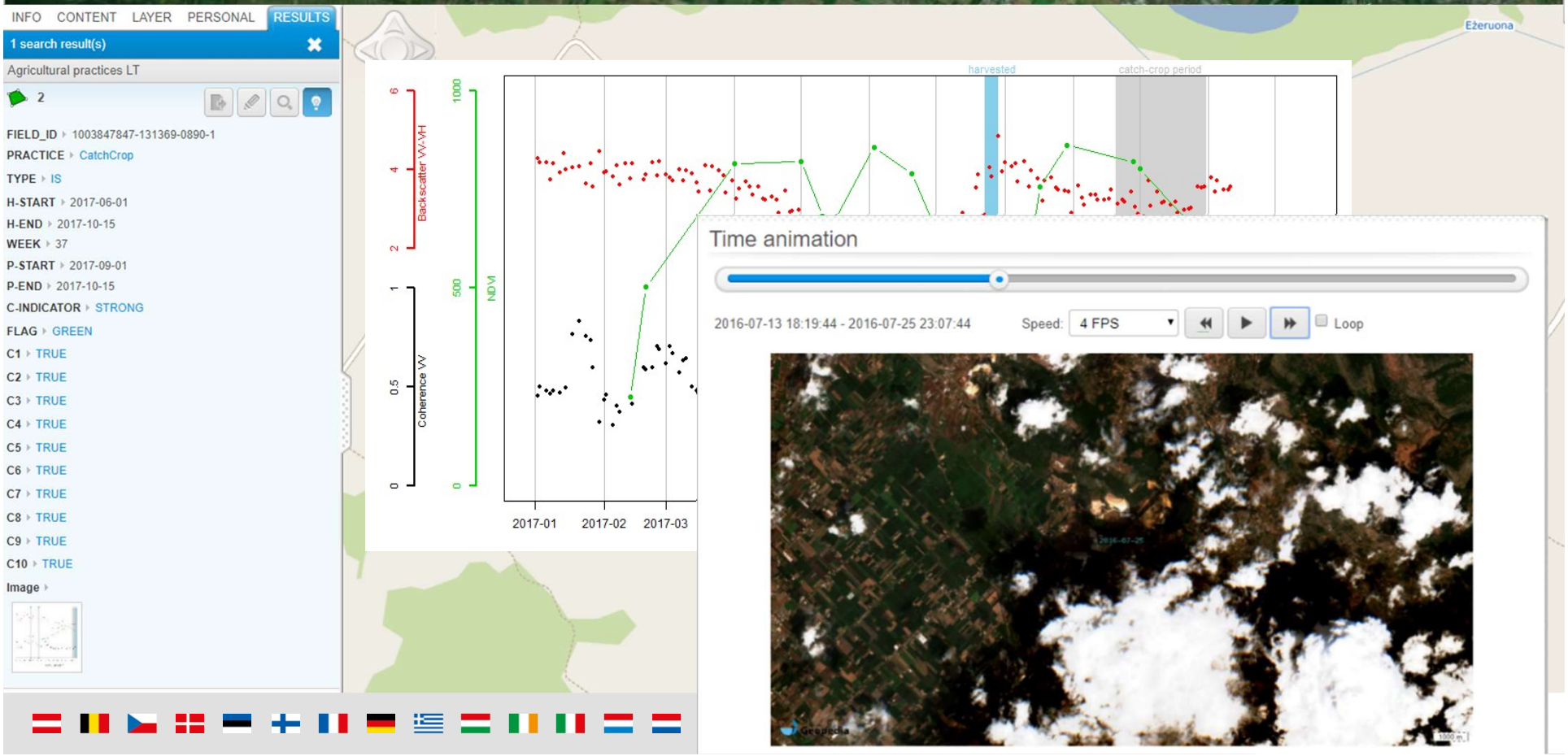
Reported by the farmer:

- Seedbed preparation for main crop 11.8.17-13.8.17 (deep plowing)
- Sowing of main crop 25.8.17 (combined sowing)
- Harvest of main crop 09.7.-15.7.18
- Seedbed preparation for catch crop 24.7.-26.7.18
- Sowing of catch crop: 26.7.18
- Harvest of catch crop: 24.9.18 (mulching)
- Plowing 25.9.18

Sen4CAP System overview – open source code



Visualisation tool to access all products at the parcel level as a web application or as WMS in QGIS



Sen4CAP: A collaborative effort to prepare for CAP2020

- ✓ CAP monitoring evidence provided based on Sentinels **prototype** products
- ✓ **2018 national demonstration** with wall-to-wall coverage
  - **- 6 countries** (1.2 Mkm²) with diverse cropping systems, LPIS, landscapes, etc.
  - good to very good performances but still to be improved by specific fine tuning
  - critical importance to work hand-to-hand with Paying Agencies
- ✓ **Sen4CAP training completed for 6 Paying Agencies** at their premises and VMs available to each for testing
- ✓ **Operational cloud computing on DIAS for 2019 national demonstration**
- ○ Key emphasis on product **validation and markers/products use** by PAs
- ○ **Open source system** for uptake and customization by all PAs

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SEN4CAP BETA RELEASE MAY 2019

Sen4CAP: Crop rotation

- **General conclusions**
  - ✓ National (EU wall-to-wall) crop monitoring is feasible
  - ✓ Integrating S1 & S2 imagery, running on the cloud
  - ✓ Efficient analysis due to the parcel based approach (not dealing with spatial crop variability within the parcel)
- **Crop rotation**
  - ✓ Crop declared on parcel level is part of IACS (not 100% coverage)
  - ✓ LPIS: Highly accurate reference layer, freely available (for most countries)
  - ✓ Parcel boundaries: Availability of GSAA? To be replaced by automated delineation?
  - ✓ High classification accuracy for the main crops (> 90%)
  - ✓ Monitoring of agricultural practices based on the same datasets (EO, LPIS)


Thank you for your attention
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