Sen4CAP – Supporting the CAP reform using Sentinel-1 and -2 for agriculture monitoring

Bontemps S., Defourny P., Malcorps P., Avolio C., Bajec K., Cara C., de Vendictis L., Joshi N., Kucera L., Mammone C., Milcinski G., Nicola L., Sciarretta C., Slacikova J., Tutunaru F., Udroiu C., Volpe F., Zavagli M., Koetz B.

UCL Université catholique de Louvain

CS ROMANIA

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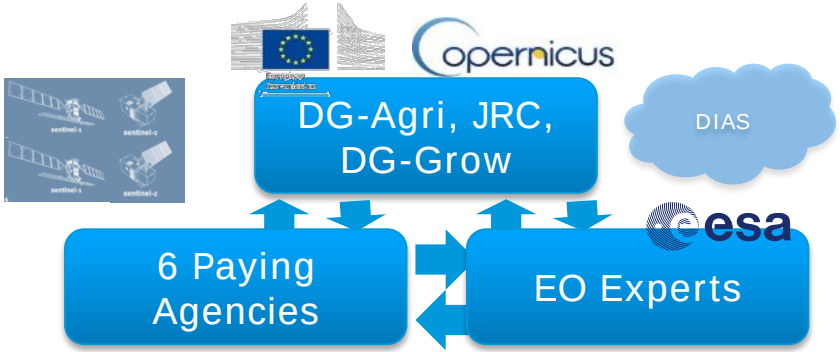
sen4cap common agricultural policy

SINERGISE

gisat

CAP monitoring approach - Technology meets Policy

sen4cap
common agricultural 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

2017 ag. season – local sites

Use cases & Algo development → Bench-marking → Valida tion

2018 ag. season – 6 national cases

Use case demo & training

2019 ag. season – 6 NRT national demo

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

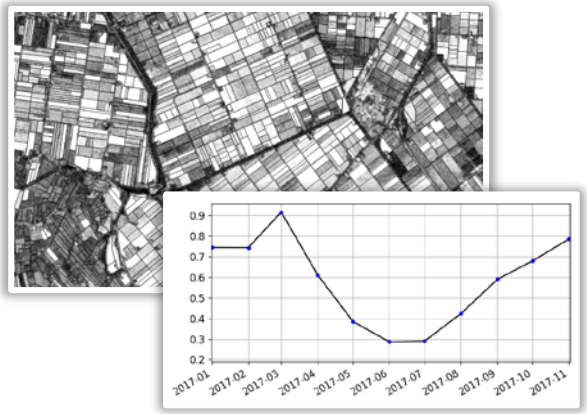
Use Cases
w/ Paying Agencies

Sentinel-derived indicators and markers

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

S2 time series data (May – Sep), CZE

S1 composite of temporal features, NDLS

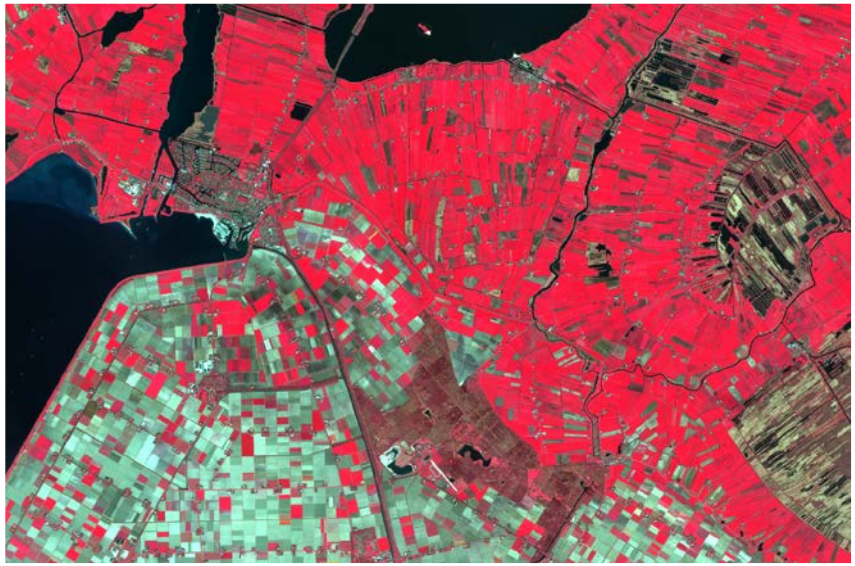


Monthly coherence over a Winter Wheat field (Netherlands)

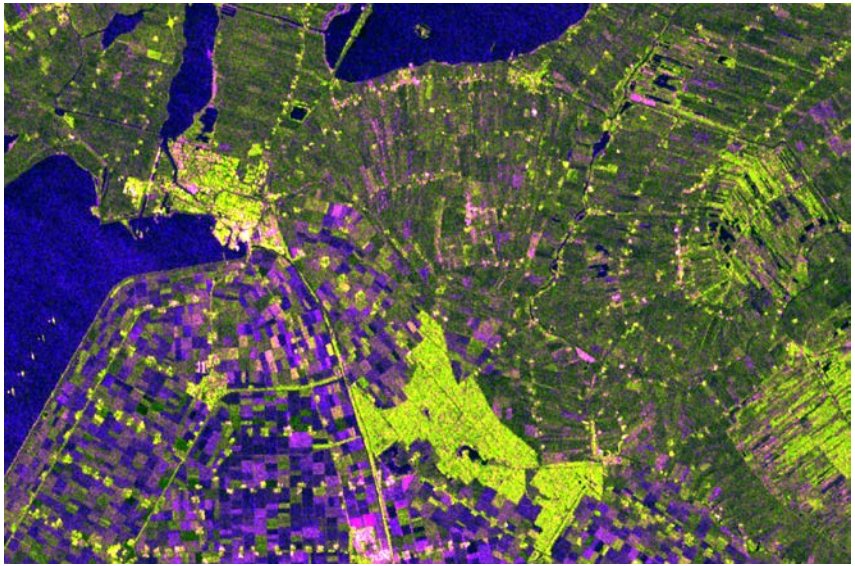
Very large dataset from Sentinel-1 & 2 for a national coverage

Sen4CAP system to process full time series on the cloud for 6 Paying Agencies

Sentinel-2 using LPIS/GSAA (min 3 10-m pixels)
22 object-based metrics every 10 days

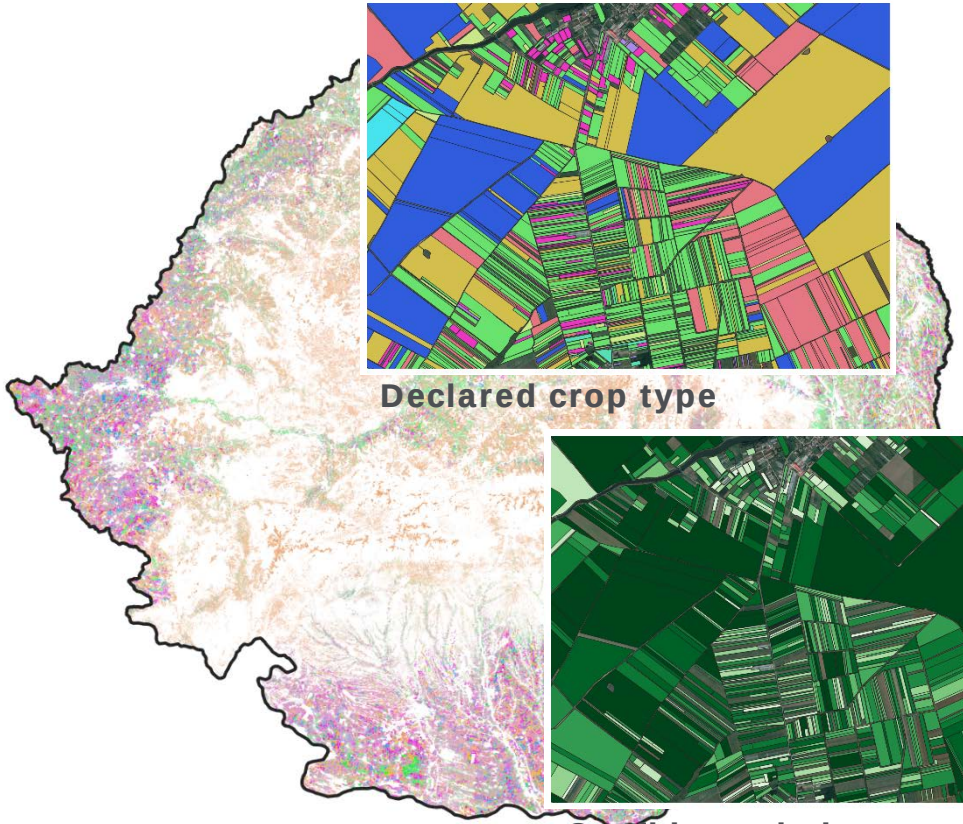


Sentinel-1 using LPIS (min 1 20-m pixel)
10 object-based metrics every 10 days + temporal features

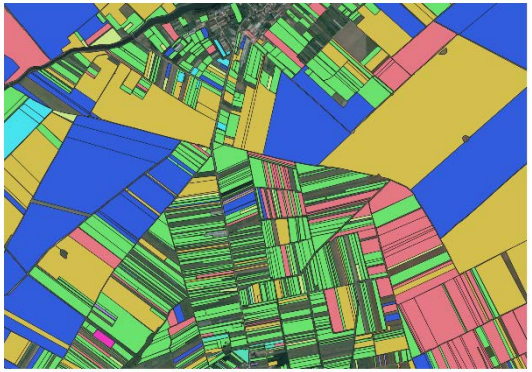


2018: National crop type mapping over 6 countries

Example – Romania (100+ crop types)



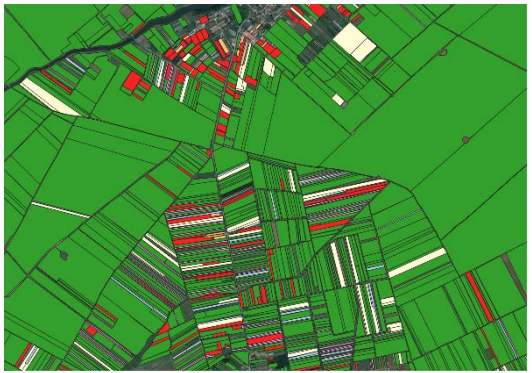
Declared crop type



Predicted crop type

Crop type
- Alfa-alfa
- Autumn barley
- Autumn common wheat
- Autumn rape
- Bean peas
- Corn
- Fresh vegetables
- Sunflower
- Permanent crop
- Grassland

Confidence index

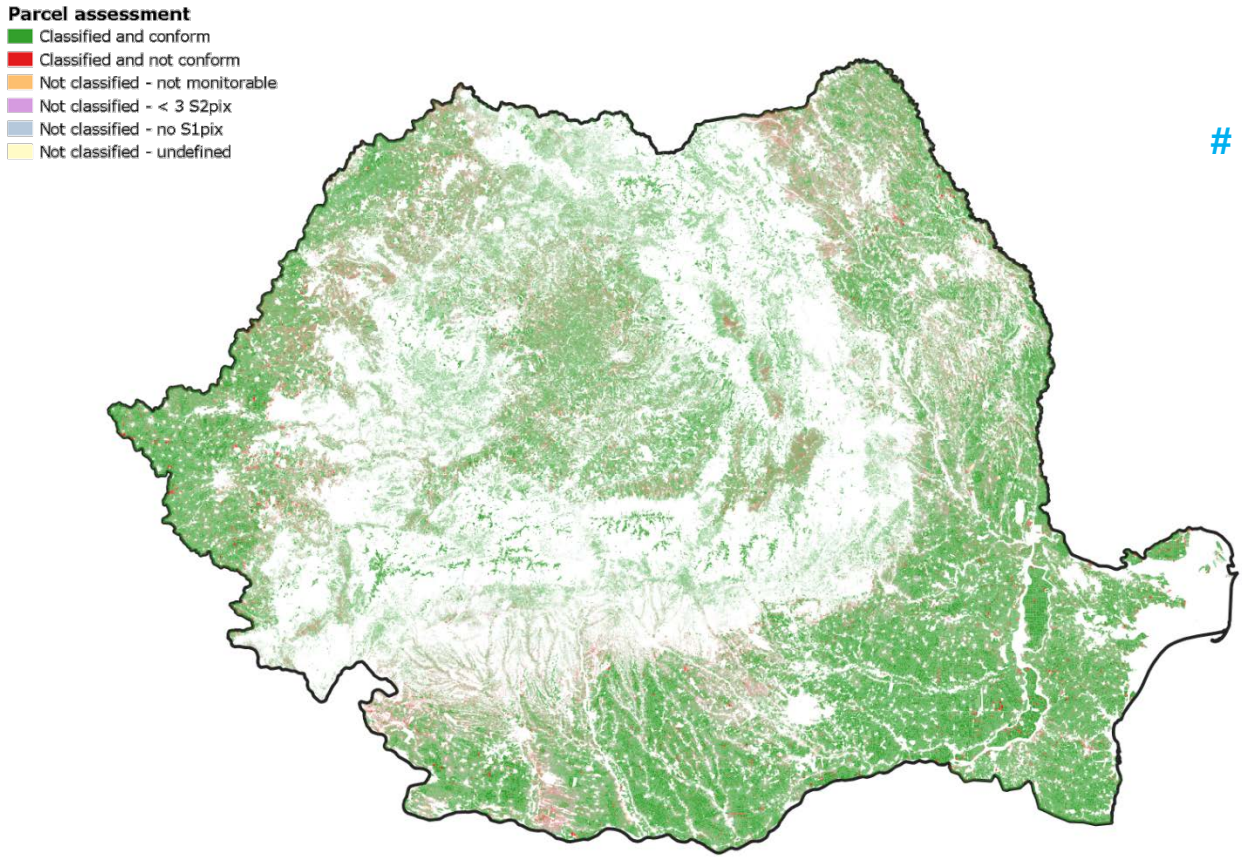


Conformity assessment

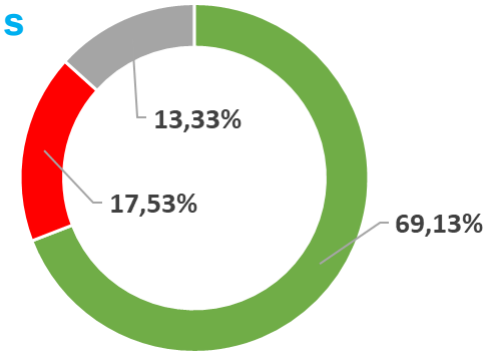
living planet symposium MILAN 13–17 May 2019

2018: National crop type mapping over 6 countries

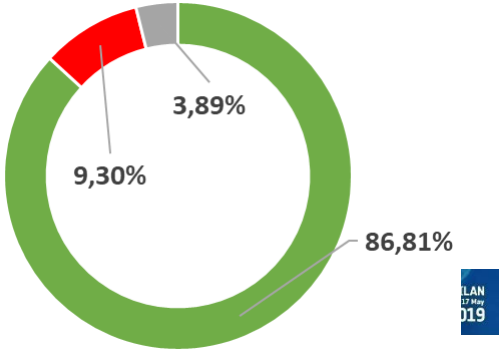
Romania (100+ crop types)



 # parcels



Area



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%)

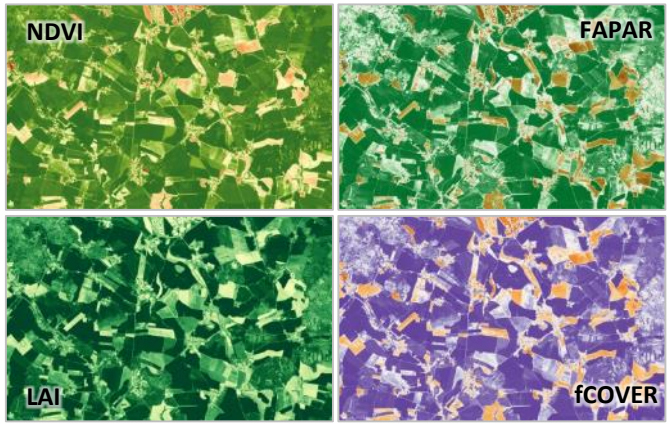
  => Improvements foreseen by refining crop type list, selecting better the calibration dataset, excluding poorly defined classes, using stratification,...
- **Limited impact of parcel size and shape** on the assessed areas (0,3 % to 8 %)

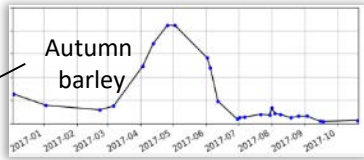
Country	Area Of Interest	EO input	Total area (km²)	Total parcels (nr)	Parcels not assessed (%)		Parcels not assessed because of the size (%)		Overall Accuracy
					Nr	Area	Nr	Area	
NLD	100 % country	S2 + S1	42508	802217	17,27%	4,49%	9,25%	**1,03%**	**94,95%**
CZE	100 % country	S2 + S1	78873	593787	14,11%	1,71%	8,40%	**0,30%**	**82,75%**
LTU	100 % country	S2 + S1	64897	1153796	19,63%	3,17%	16,16%	**1,46%**	**78,74%**
ITA	100 % of the AOI (5 Regions)	S2 + S1	67270	8527409	78,60%	36,12%	33,94%	*15,49%**	**72,37%**
ESP	100 % of the AOI (Castilla Y Leon)	S2 + S1	94226	3540880	35,71%	28,62%	34,60%	*27,78%**	**81,83%**
ROU	100 % country	S2 + S1	238369	6127057	38,22%	10,96%	35,77%	**8,34%**	**71,16%**

Sentinels indicators and markers – veg. indicators

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

4 indicators

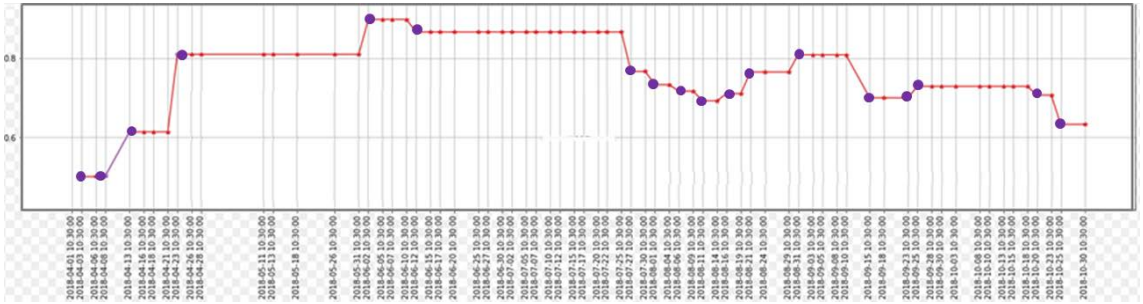




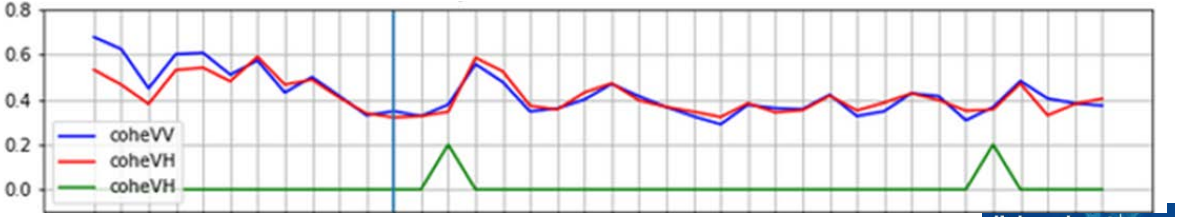
Crop type information & growing vegetation indicators

Sentinels indicators and markers – grassland mowing

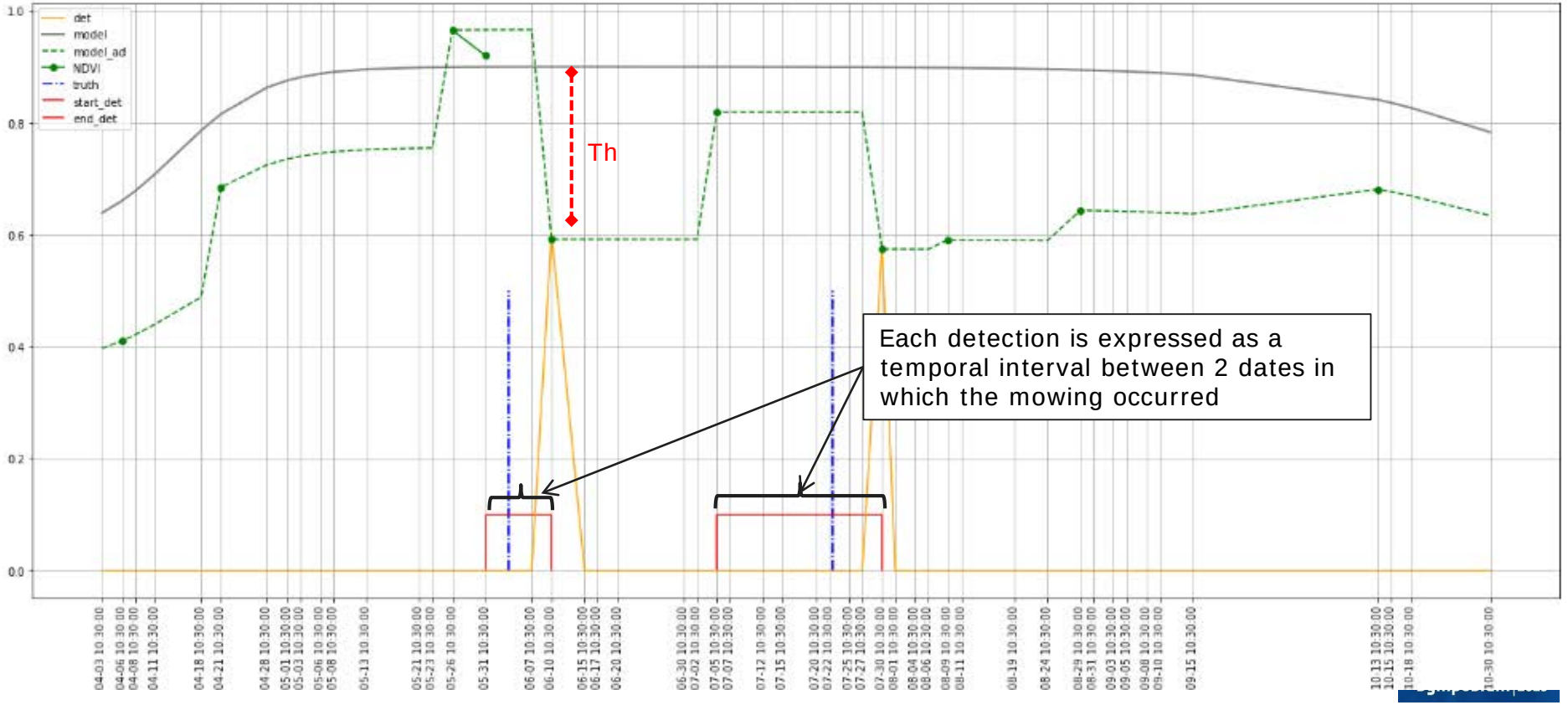
- Crop type mapping
- Growing vegetation indicators
- Grassland mowing detection
- Agricultural practices monitoring



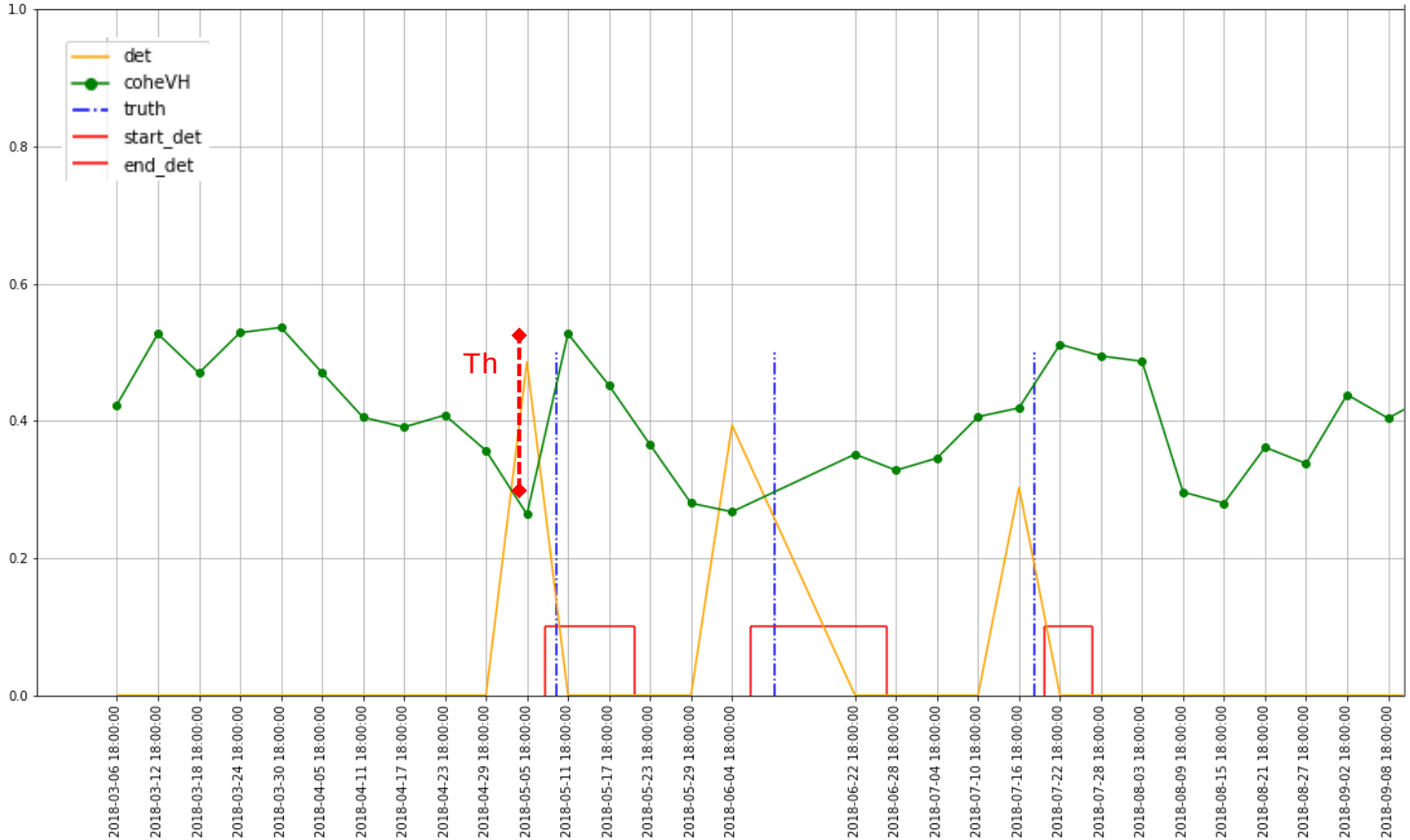
Mowing detection based on the detection of **S2 Vegetation Indices (NDVI, LAI and FAPAR) decrease** and **S1 coherence increase**



S2 mowing detection by VIs decrease w.r.t expected model for unmowned grass



S1 mowing detection by sudden increase of 6-day coherences



Grassland mowing detection
Thematic content

Product info for each parcel

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

Number of mowing

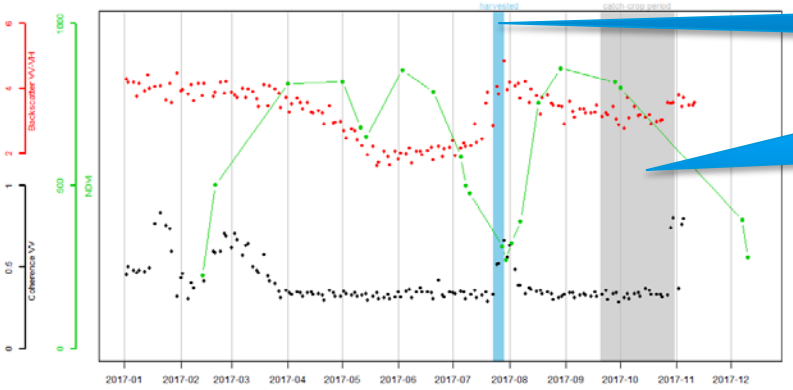
- 0
- 1
- 2
- 3
- 4

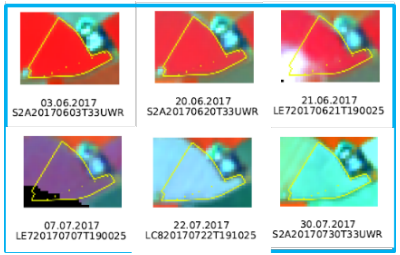
parcel_id	crop_code	mow_n	m1_dstart	m1_dend	m1_conf	m1_mis	m2_dstart	m2_dend	m2_conf	m2_mis	m3_dstart	m3_dend	m3_conf	m3_mis	m4_dstart	m4_dend	m4_conf	m4_mis	compl
31.0000002869728.001	265	3	2018-05-08 00:0...	2018-05-21 00:0...	0.554000...	S2	2018-07-12...	2018-07-20 ...	0.55300...	S2	2018-08-24...	2018-09-18 ...	0.518...	S2	0	0	0.0000...	0	1
31.0000002869729.001	265	3	2018-05-08 00:0...	2018-05-21 00:0...	0.522000...	S2	2018-07-07...	2018-07-12 ...	0.50200...	S2	2018-08-24...	2018-09-13 ...	0.517...	S2	0	0	0.0000...	0	1
31.0000002869730.001	265	3	2018-05-08 00:0...	2018-05-21 00:0...	0.519000...	S2	2018-07-07...	2018-07-12 ...	0.50700...	S2	2018-08-24...	2018-09-13 ...	0.517...	S2	0	0	0.0000...	0	1
31.0000002811919.002	265	3	2018-05-08 00:0...	2018-05-11 00:0...	0.777000...	S2	2018-05-21...	2018-06-20 ...	0.71200...	S2	2018-08-06...	2018-08-26 ...	0.712...	S2	0	0	0.0000...	0	1
31.0000002869731.001	265	1	2018-09-08 18:0	2018-09-14 18:0	0.486000	S1	0	0	0.00000	0	0	0	0.000	0	0	0	0.0000	0	1

Sentinels indicators and markers – Agricultural practices (EFA)

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

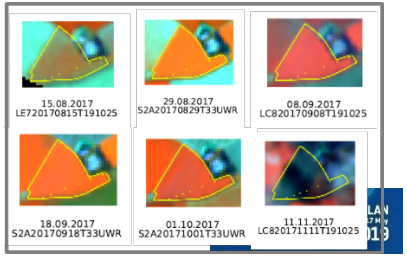
RULE: Winter Catch Crop must be sown before 20 Sept. and must not be harvested before 31 Oct. During this period, crop coverage must not be mechanically or chemically removed or limited in growth.





Winter Catch Crop – Visual check

Harvest – Visual check

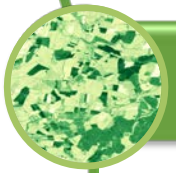


10 markers related to vegetation state or vegetation change on a parcel

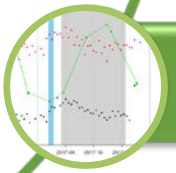
MARKERS FOR HARVEST		
M1	M1: Presence of vegetation in the main vegetation season (pre-requisite)	High values of NDVI
M2	M2: Loss of vegetation	Break in NDVI (decrease)
M3	Loss of vegetation	Break in backscatter ratio (increase)
M4	Low/no vegetation	High values of backscatter ratio
M5	Low/no vegetation (stable conditions)	Break in VV Coherence (increase) or high values of VV Coherence
MARKERS FOR DECLARED PRATICES		
M6	Presence of vegetation	High values of NDVI
M7	Growth of vegetation	Break in NDVI (increase)
M8	No loss of vegetation	No break in NDVI (decrease)
M9	No loss of vegetation	No increase of the backscatter ratio
M10	Presence of vegetation (dynamic conditions)	No Break in VV Coherence (increase) and no high values of VV Coherence

Use Cases
Sentinels to support payment decisions


Crop type mapping


Vegetation growing indicators


Grassland mowing detection


Agricultural practices monitoring

Use Cases
w/ Paying Agencies

Use case
Crop diversification
Permanent grassland identification
EFA-Land lying fallo
EFA-Catch crops
EFA-Nitrogen-fixi
Interactive visu
Land abandor
LPIS update
Claimless system

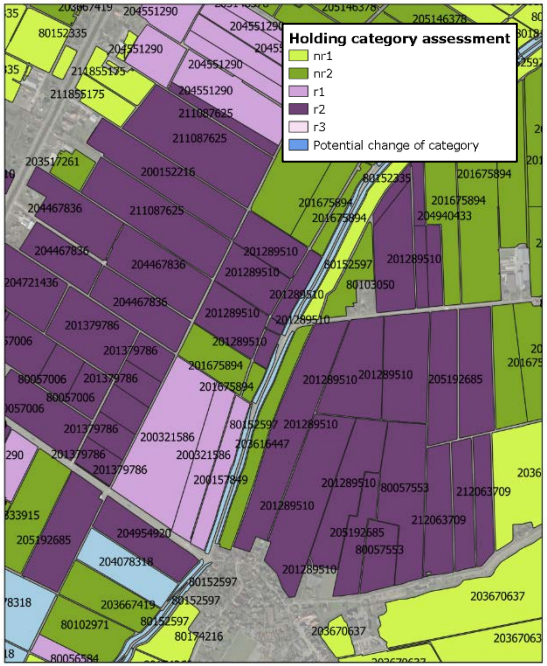
From CT mapping to crop diversification
Assessments at parcel- and holding-level

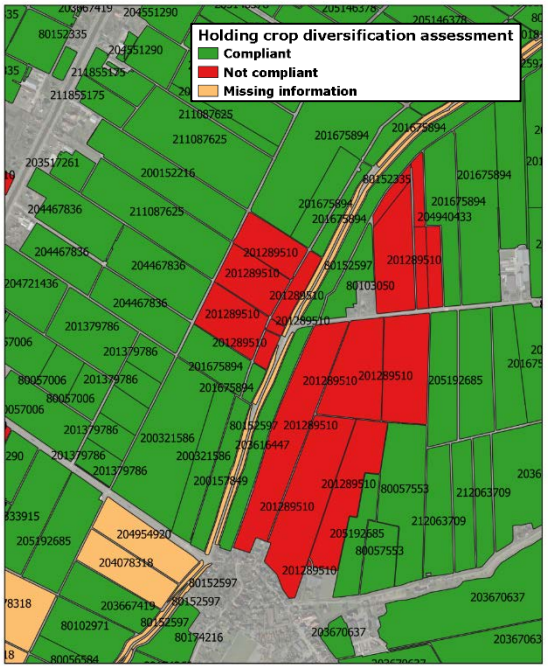
Parcel-level

Assess if the crop type declared by the farmer is confirmed by the satellite signal

Holding-level

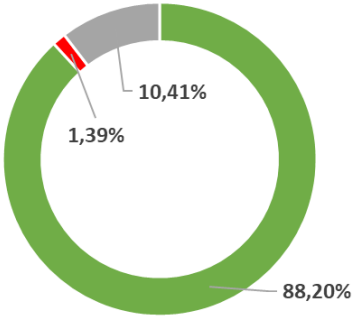
Assess the compliancy of the holding with regard to the crop diversification rules



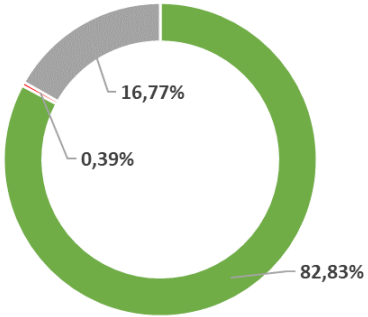


Crop diversification monitoring at national scale

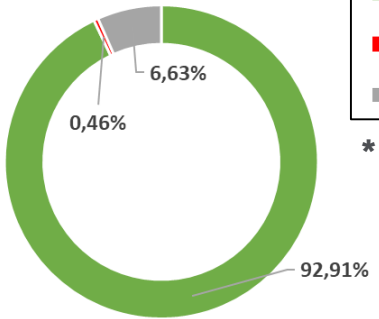
CZECH REPUBLIC



CASTILLA Y LEON



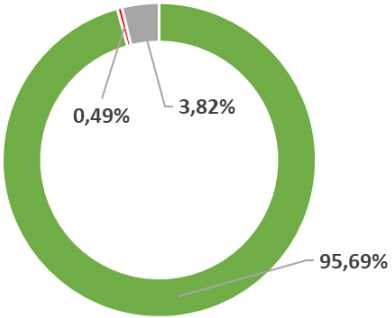
ITALY



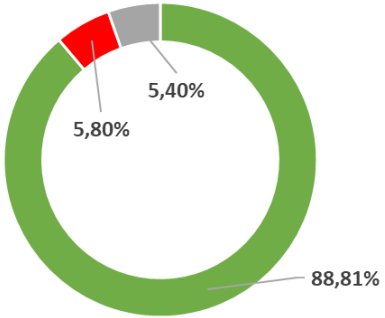
Compliant
Not compliant
Missing information

*At holding level

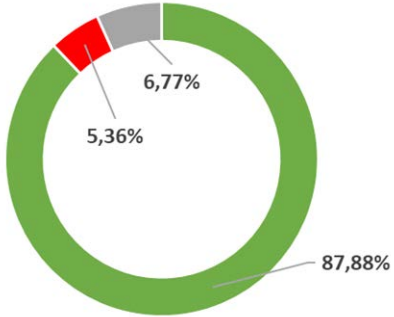
LITHUANIA



NETHERLANDS



ROMANIA



Agricultural Practices Monitoring
Detection of catch crop - NLD

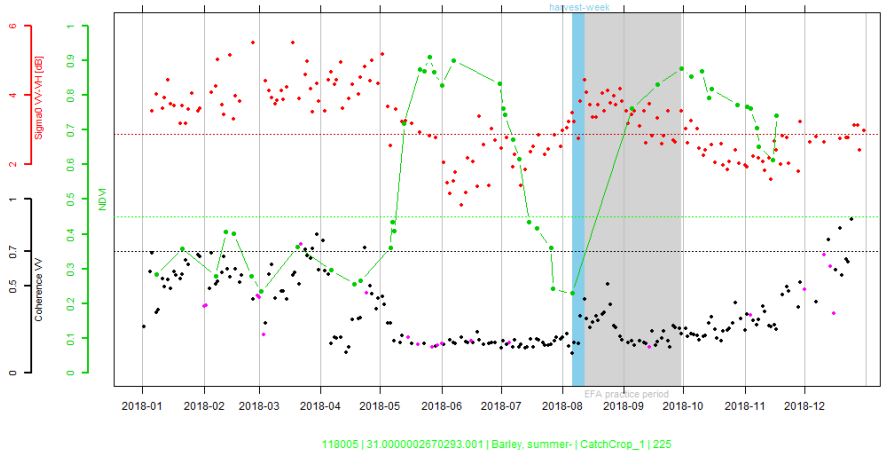
ORIG_ID	FIELD_ID	COUNTRY	YEAR	MAIN_CROP	VEG_START	H_START	H_END	PRACTICE	P_TYPE	P_START	P_END
31.0000002670293.001	118005	NL	2018	236	2018-05-01	2018-05-15	2018-10-15	CatchCrop	CatchCrop_1	2018-08-06	2018-09-30

M1	M2	M3	M4	M5	H_WEEK	M6	M7	M8	M9	M10	C_INDEX
TRUE	TRUE	TRUE	TRUE	TRUE	32	TRUE	TRUE	TRUE	TRUE	TRUE	STRONG

W_GAPS	S1PIX	H_W_START	H_W_END
0	225	2018-08-06	2018-08-12

Farmer interview:

Declared crop	Sow crop	Harvest crop	Sow catch-crop
Barley, summer-	17.4.2018	27.7.2018	20.8.2018



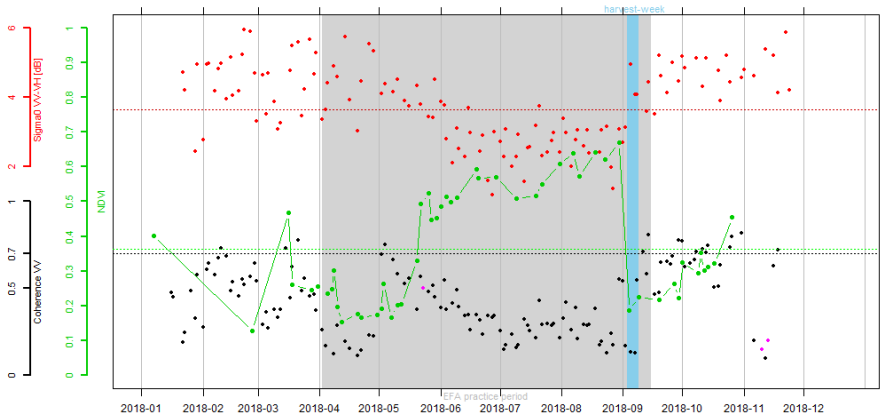
Agricultural Practices Monitoring
Detection of fallow land - LTU

ORIG_ID	FIELD_ID	COUNTRY	YEAR	MAIN_CROP	VEG_START	H_START	H_END	PRACTICE	P_TYPE	P_START	P_END
1005664722-039468-6719-1	104421	LTU	2018	PDZ	2018-04-02	2018-04-02	2018-09-30	Fallow	PDZ	2018-04-02	2018-09-15

M1	M2	M3	M4	M5	H_WEEK	M6	M7	M8	M9	M10	C_INDEX
TRUE	TRUE	TRUE	TRUE	TRUE	36	TRUE	NR	NR	NR	TRUE	STRONG

W_GAPS	S1PIX	H_W_START	H_W_END
0	22	2018-09-03	2018-09-09

Green fallow



2-day trainings of 6 PAs in their premisses (Feb.- Apr.19)

Training at AGEA (Rome, ITALY)

19-20/03/2019

Training at NMA (Vilnius, LITHUANIA)

06-07/03/2019

- Better understanding of products & methods
- Prioritization of improvements
- Further validation of 2018 products

- Plan for 2019
- Validation data collection
- Request for more capacity building

Training at NVWA (Zwolle, THE NETHERLANDS)

11-12/03/2019

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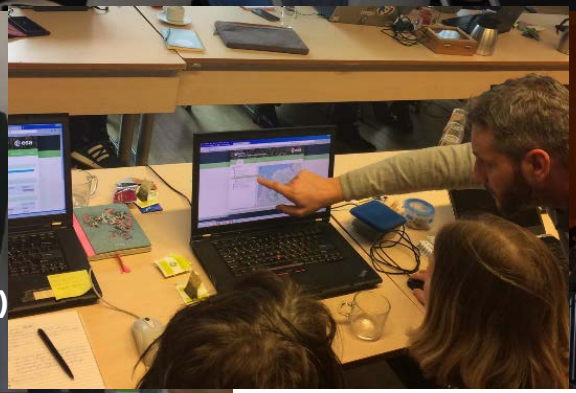
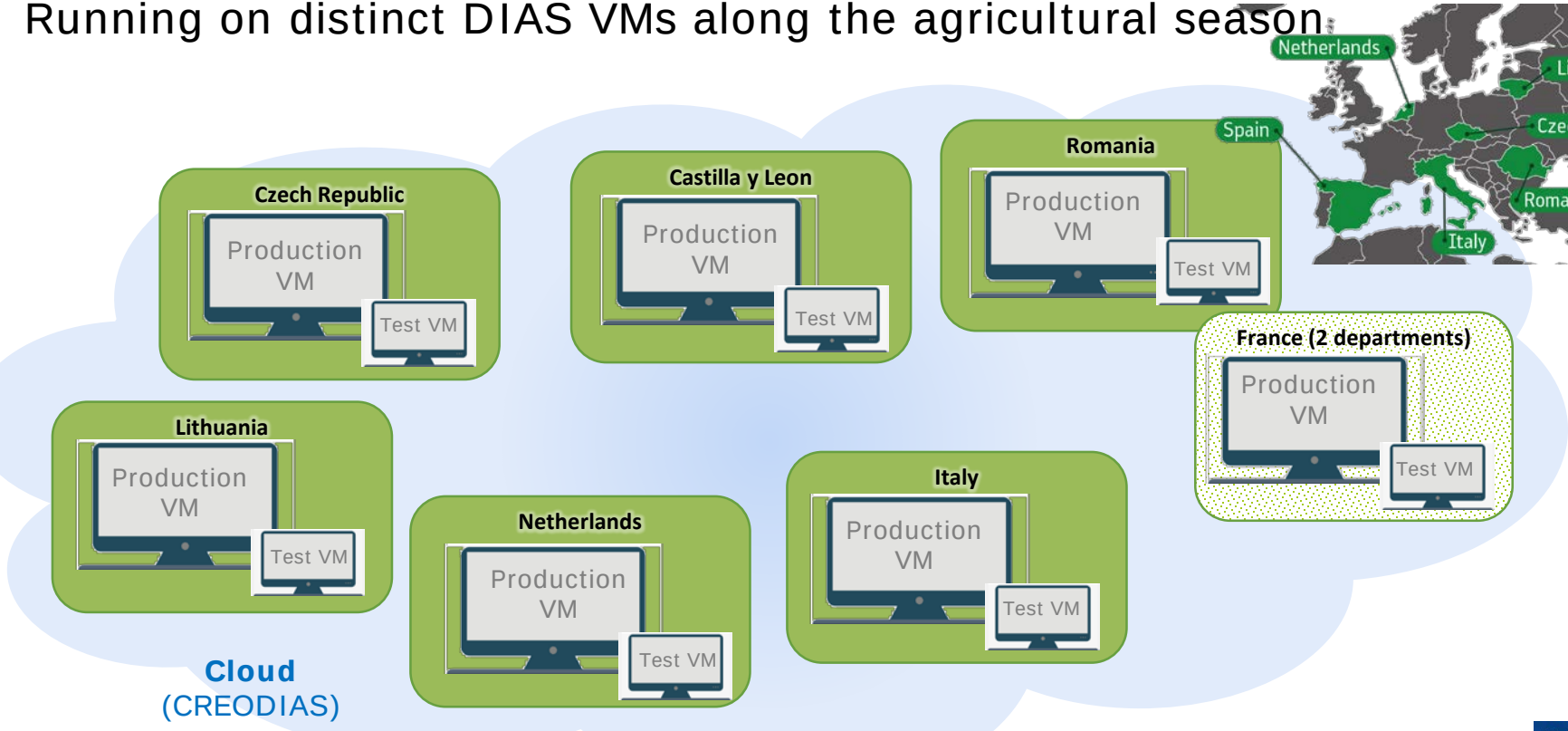
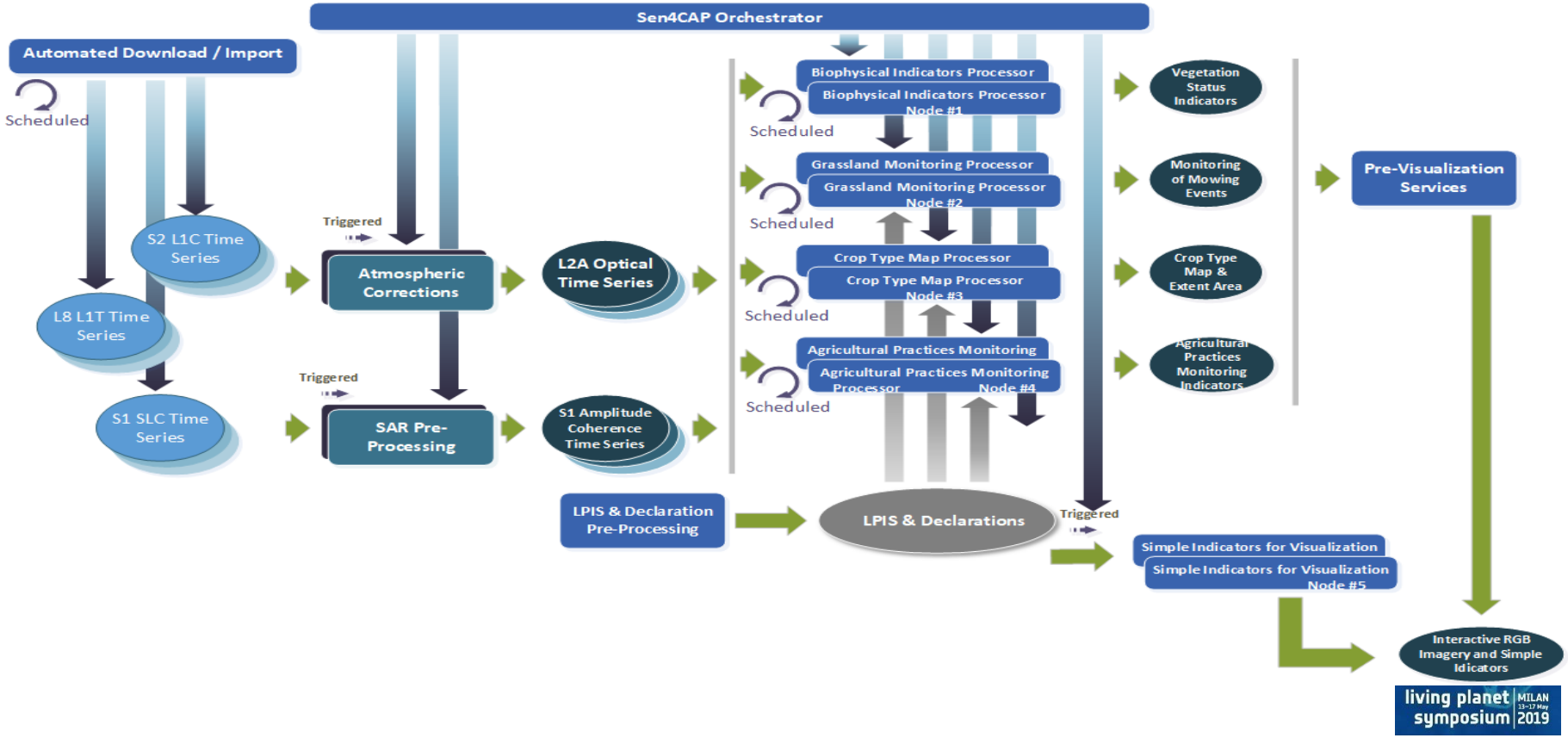


2019 Sen4CAP processing just started for 6+1 Paying Agencies

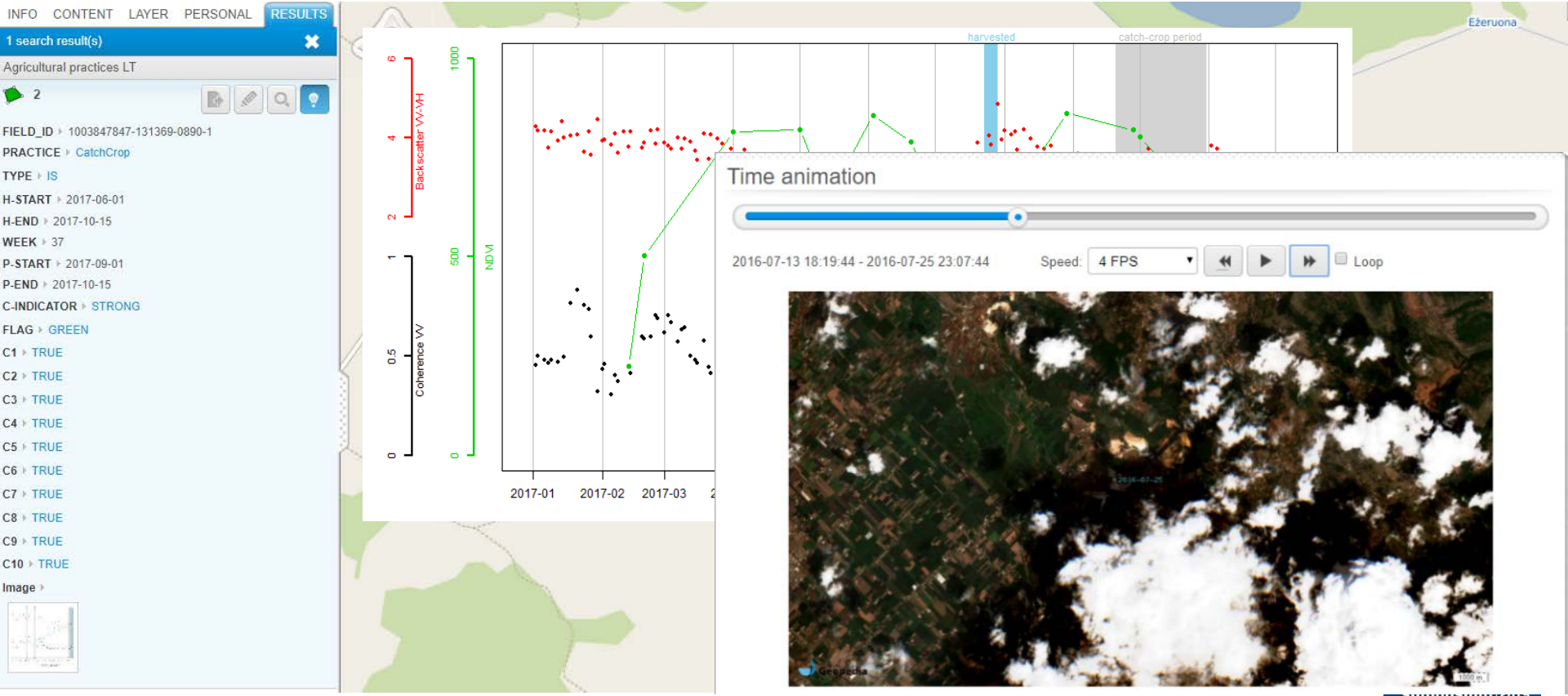
Running on distinct DIAS VMs along the agricultural season



Sen4CAP System overview – open source code



Visualisation tool to access all products at the parcel-level



Scientific challenges for CAP ...
... and much more

- Crop diversification < crop type mapping
  - General CT mapping nicely done by most users
  - Small parcels? Marginal crops? Permanent crops? Fallows?

- Permanent grassland monitoring < mowing detection
  - Link with land use intensity and more sustainable agriculture

2 posters in sessions **A3.02** and **A3.17**

- EFA < agriculture practices monitoring
  - EFA will evolve in the CAP 2020, but agriculture practices will remain
  - Exploit the huge density of S1 time series

Sen4CAP: a collaborative effort to prepare for CAP2020

- ✓ CAP monitoring evidence provided based 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**
- o Key emphasis on product **validation and markers / products use** by PAs
- o **Open source system** for uptake and customization by all PAs

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common agricultural policy

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Thank you for your attention
and your contribution
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