sen4cap
common agricultural policy

Final User Workshop

esa

System overview and what is new in version 2.0

Presenters:

Philippe Malcorps from *UCLouvain*

Members of the consortium available to answer your questions

UCL Université catholique de Louvain

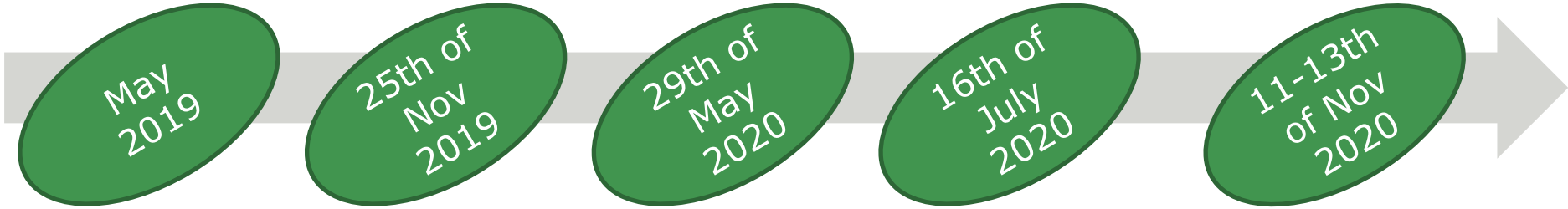
SINERGISE

gisat

e-geos
AN ASI / TELESPAZIO COMPANY

ROMÂNIA

System evolution (before version 2.0)



BETA version

Only available for the PAs

Version 1.0 release candidate

Open-source

Possibility for the PAs to access a test machine with the system

Version 1.1

1st consolidated version

Big evolutions:

- Corrections in the advanced processors
- Sen2Cor L2A compatible
- Move of the system database to a docker container
- …

=> 2 Q&A sessions organized end of June

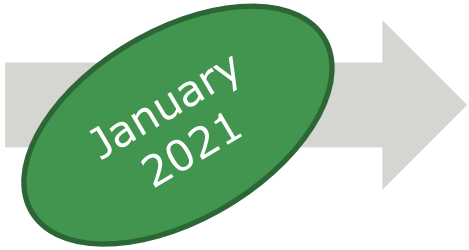
Version 1.2

Mainly corrections, adaptations and improvements based on project and user's experience

Version 1.3

Mainly corrections, adaptations and improvements based on project and user's experience

Version 2.0 released at the end of January 2021



Version 2.0

Big evolutions:
- Markers database
- Tillage processor
- Dockerization
- …

- Added
  - **Markers database** (dedicated session)
  - **Tillage processor** (dedicated session)
  - **Docker containers** for Sen4CAP components (processors, utilities, SNAP 8, orchestrator if needed)
  - Support for **MAJA 4.2.1**
  - **New DEM integration** (ASTER DEM and EU DEM) for European Northern countries
- Changed
  - DBus replaced with a HTTP communication interface
- Fixed
  - Some **database concurrency corrections** for the L2A launcher script

Sen4CAP system : **simple parametrization** and **subsidy application upload**

Before the monitoring period | **Monitoring period**

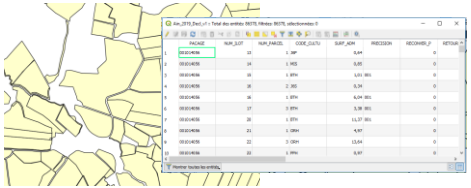
System initialization

Start of the season — **End of the season…**

Sen4CAP system : main parameters settings

Area of Interest	Shapefile to be uploaded
Monitoring period	Start and end dates to be defined
S1+S2 / S1+S2+L8	L8 to be selected

1. Subsidy application

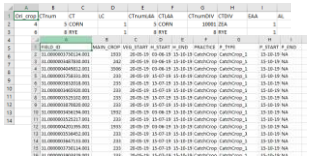


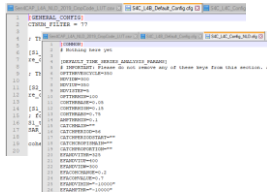
Upload data

Sen4CAP system : data from PA

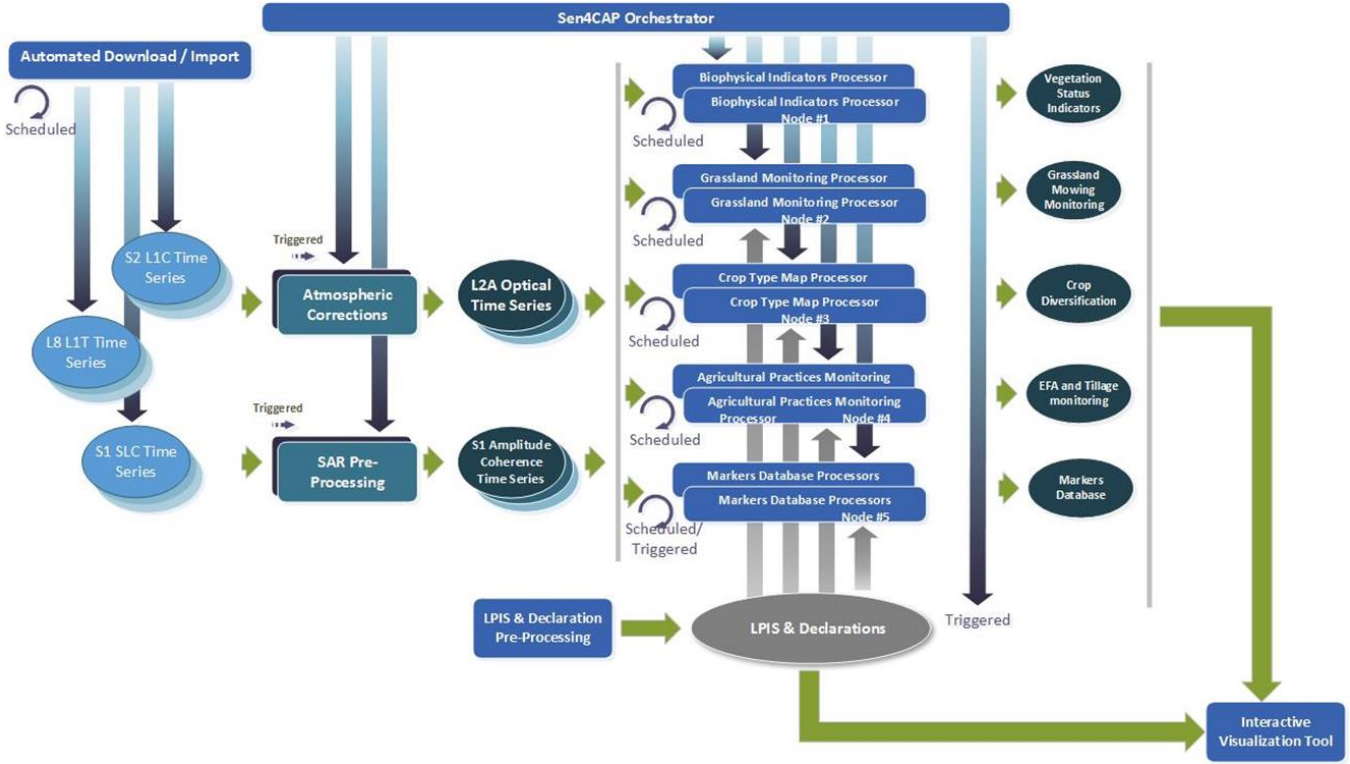
Subsidy application (shp)	Subsidy application layer (shapefile)
Tables and config files (csv)	L4A crop code LUT L4B config file L4C config file + agri practices tables

2. Tables and config files



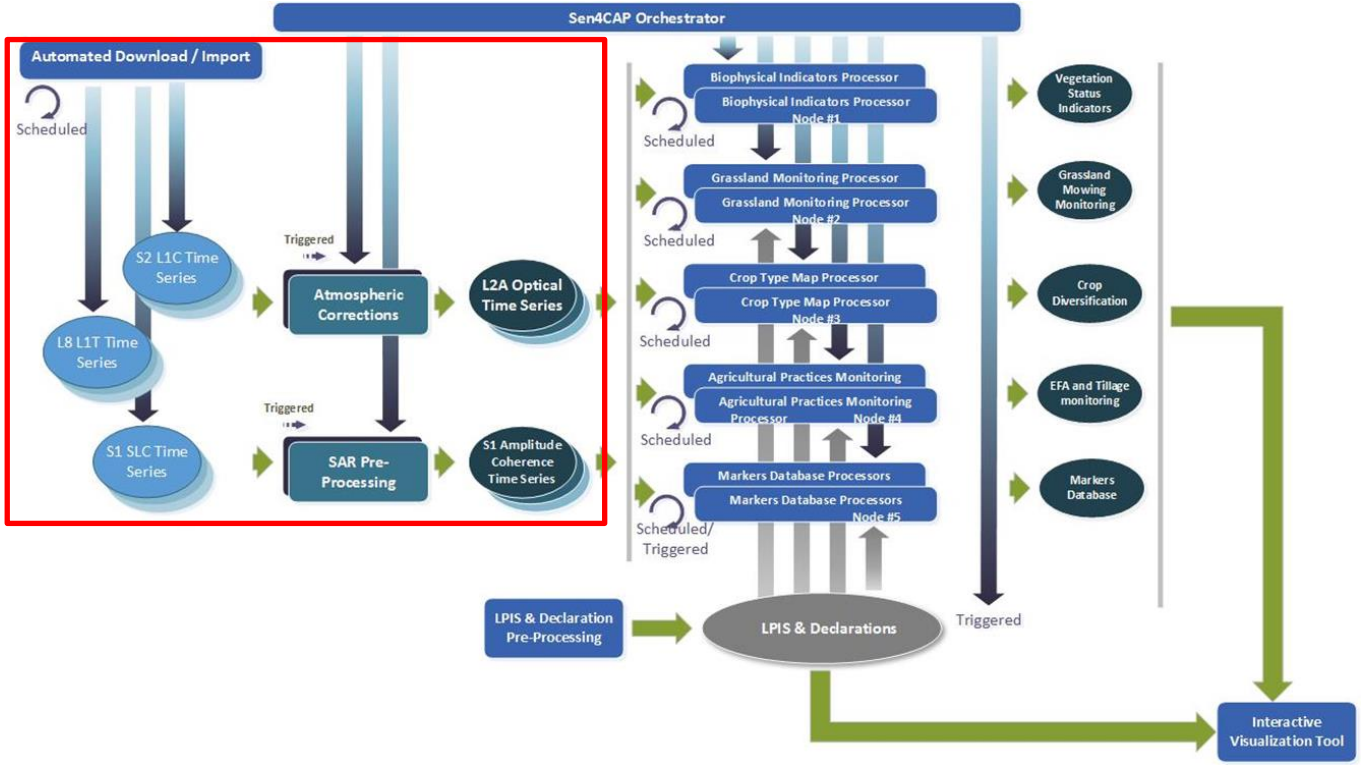


Sen4CAP system



- Sentinel-1 & Sentinel-2
- Object-based
- Markers DB
- User-friendly with web interface
- Open source
- Automated
- Modular
- Demonstrated at national scale
- NRT or off-line production
- Locally or in the cloud

Sen4CAP system – S1/S2/L8 ingestion and pre-processing



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Automated import / download of the low-level satellite data

- **Query of the list** of low-level products corresponding to the site and monitoring period done **on ESA SciHub** (Copernicus Open Access Hub) => with any configuration

- **If a local root** is defined in the data sources configuration, **direct link** / **symbolic link** to the low-level products corresponding to the list (**or copy**) (+ automatic download in the case of missing products)

- **Otherwise**, **download** of the low-level products corresponding to the list **from ESA SciHub** (Copernicus Open Access Hub)

Automatic

Sentinel-2 pre-processing (from S2 Level-1C)

- **Correcting** single-date Level-1C products from the **effects of the atmosphere** that reduce the quality of the images

- Level-2A products are systematically generated at the ground segment over Europe since March 2018 using Sen2COR processor

- **Sen4CAP reads L2A Sen2COR products**, **but also proposes MAJA** as alternative L2A pre-processing module

https://earth.esa.int/web/sentinel/user-guides/sentinel-2-msi/product-types/level-2a

Sentinel-1 pre-processing (from S1 SLC Interferometric Wide images)

- **SAR backscattering** (after calibration, sigma nought $\sigma 0$)

The **SAR backscattering** is a measure of the **outgoing radar signal that the target redirects directly back towards the radar antenna**. It is a measure of the reflective strength of a target. The normalised measure of the radar return from a distributed target is called the backscatter coefficient, or **sigma nought** (σ_0), and is defined as per unit area on the ground. In general, due to the high dynamic of the SAR backscatter coefficient, **the amplitude** = sqrt(σ_0) is preferred for visualization purposes.

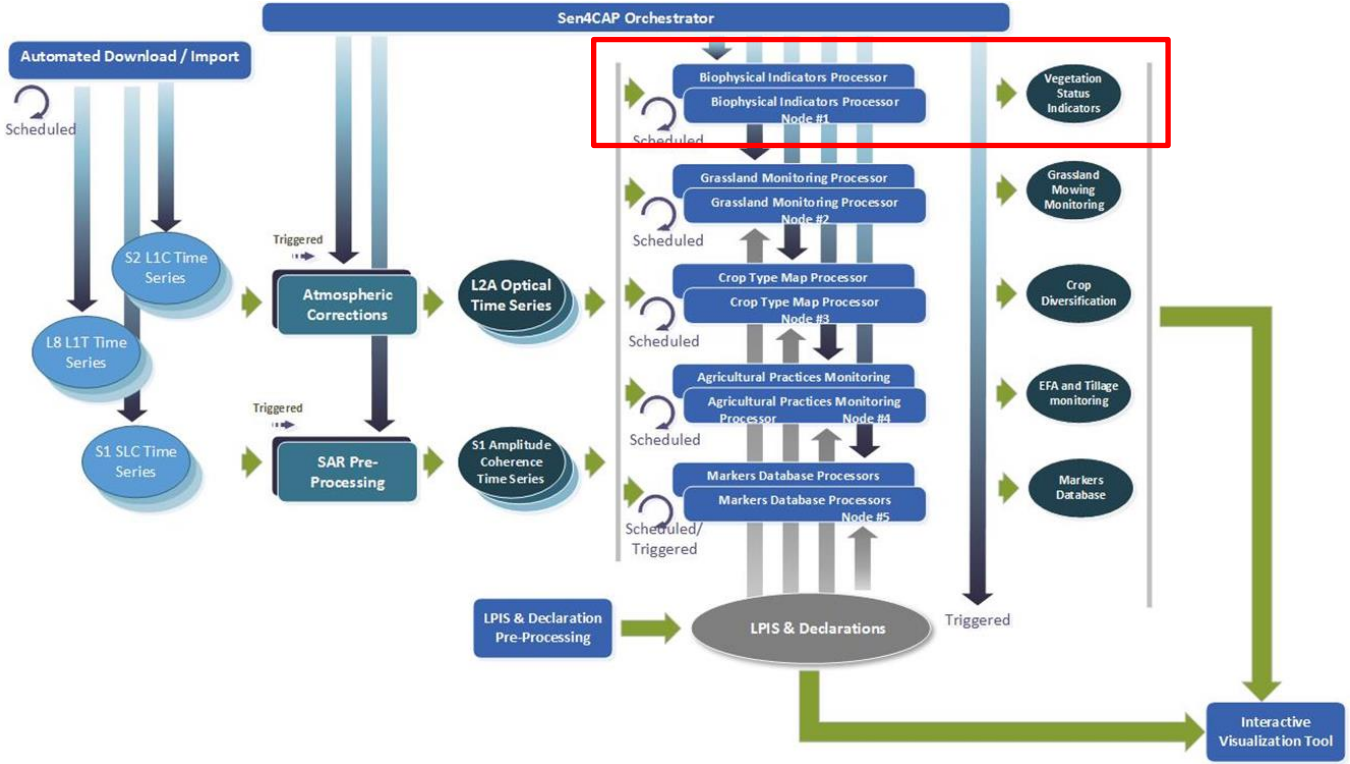
- **SAR coherence**

The coherence, which assume values in the range [0.0, 1.0], gives an **estimation of changes in the scene taking into account variation of the phase of the backscattered radar signal:** high coherence (close to 1.0) implies that the scene is steady (e.g. urban areas, bare soil, rocks and so on), low coherence indicates changes between the two acquisition dates.

The coherence is **calculated from a couple of SAR images acquired from the same** orbit (in order to have significant coherence values the images must be acquired with similar sight of view). The high revisit time of Sentinel-1 mission allows to calculate **short term coherence** from couples of images acquired one **6 days** from the other.

https://earth.esa.int/handbooks/asar/CNTR5-2.html

Sen4CAP system – Biophysical indicators (L3B)



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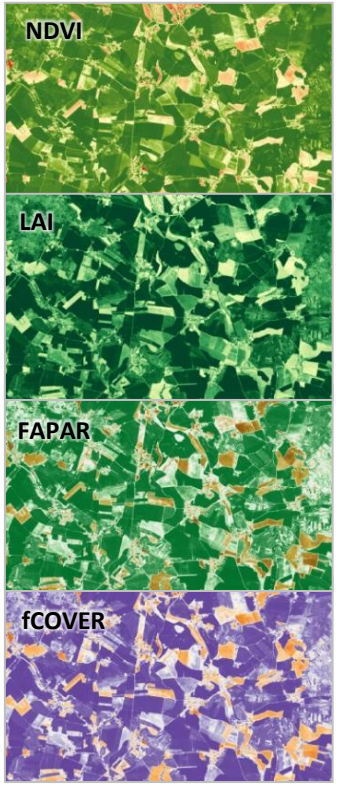
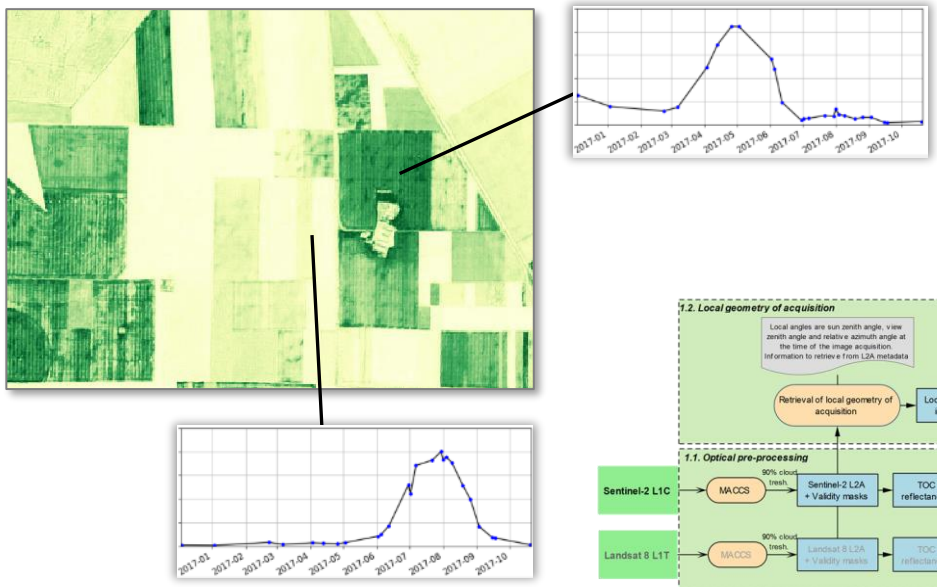
Biophysical indicators – LAI, FAPAR, FCover retrieval using BV-Net approach + NDVI

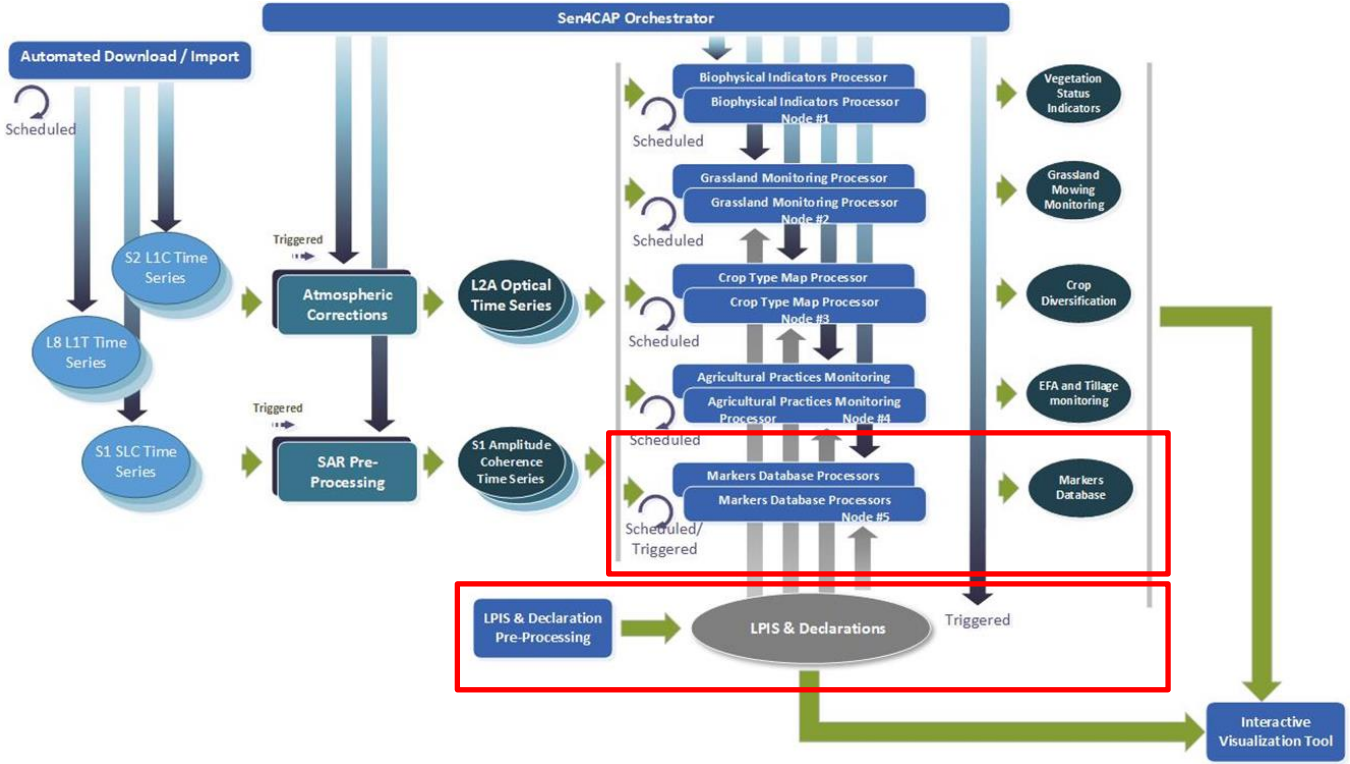
Growing vegetation indicators



4 indicators about the evolution of the green vegetation corresponding to the vegetative development of the crop



Sen4CAP system – Markers database



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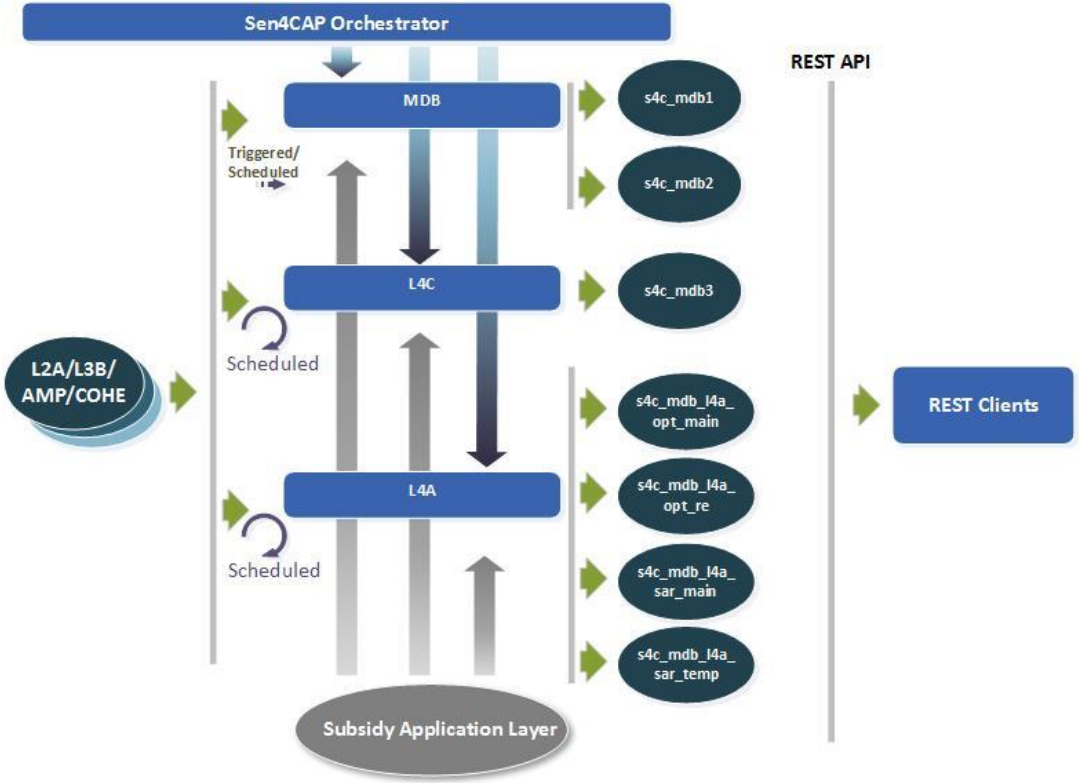
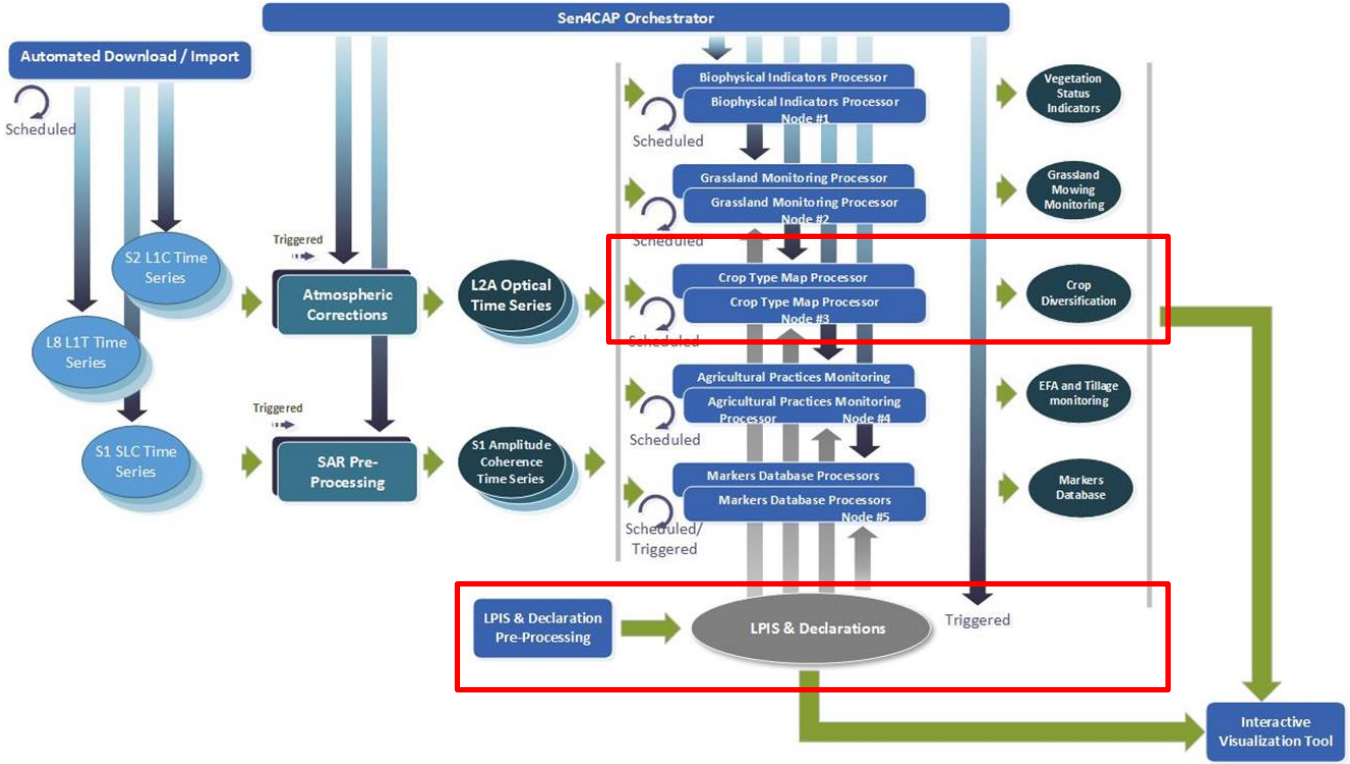
Markers Database – Overview



- **New markers products** are generated:
  - ✓ MDB processor: s4c_mdb1 and s4c_mdb2
  - ✓ L4C processor: s4c_mdb3
  - ✓ L4A processor: s4c_mdb_l4a_opt_main, s4c_mdb_l4a_opt_re, s4c_mdb_l4a_sar_main, s4c_mdb_l4a_sar_temp
- **Access via REST API** provided by Sen4CAP Services
- Or, **read markers** directly from **Arrow IPC files**

Sen4CAP system – Crop type mapping (L4A)



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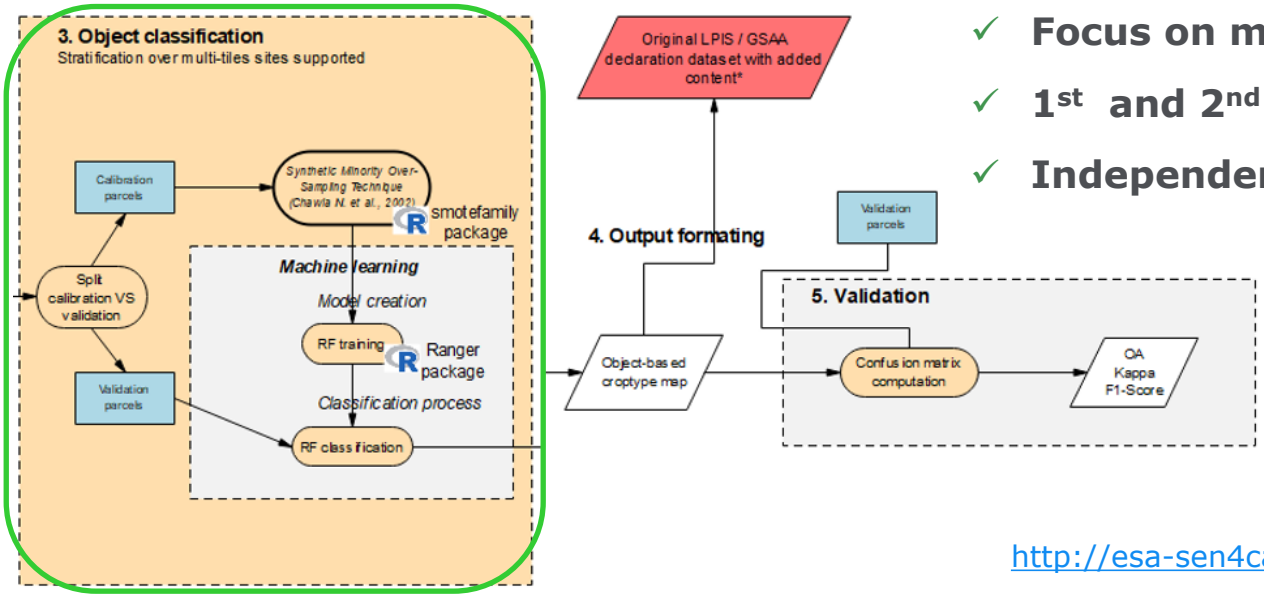
Crop type mapping (L4A) – Fine-tuned Random Forest classification

- ✓ **Benchmarked markers generation**
- ✓ **Optimized parcels selection for calibration**
- ✓ **Focus on minor crops: SMOTE**
- ✓ **1st and 2nd most probable crop types**
- ✓ **Independent validation**

Crop type classification

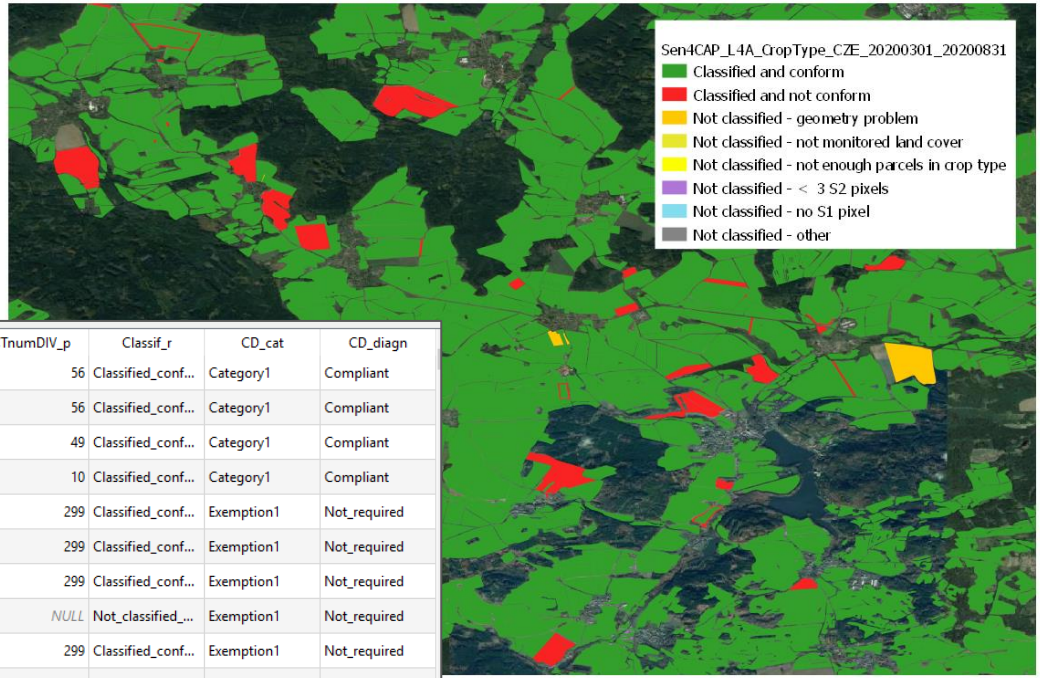


http://esa-sen4cap.org/content/technical-documents

Crop type mapping (L4A) – results

Crop type mapping

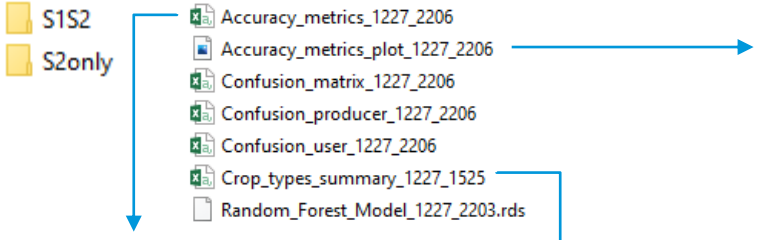
- **Results of the classification**: the 2 first predictions with the highest confidence levels + the confidence levels
- **Results of the conformity assessment** at the parcel level
- **Results of the crop diversification assessment** at the holding level



CT_decl	CT_pred_1	CT_conf_1	CT_pred_2	CT_conf_2	CTnumDIV_p	Classif_r	CD_cat	CD_diagn
56	56	0.88500	58	0.04500	56	Classified_conf...	Category1	Compliant
56	56	0.68900	58	0.19100	56	Classified_conf...	Category1	Compliant
49	49	0.54000	55	0.13800	49	Classified_conf...	Category1	Compliant
10	10	0.99200	11	0.00800	10	Classified_conf...	Category1	Compliant
3000	3000	0.93700	802	0.03000	299	Classified_conf...	Exemption1	Not_required
3000	3000	0.90900	802	0.02400	299	Classified_conf...	Exemption1	Not_required
3000	3000	0.81600	802	0.08900	299	Classified_conf...	Exemption1	Not_required
NULL	NULL		NULL		NULL	Not_classified_...	Exemption1	Not_required
3000	3000	0.96800	802	0.01600	299	Classified_conf...	Exemption1	Not_required
3000	3000	0.87800	802	0.03300	299	Classified_conf...	Exemption1	Not_required
3000	3000	0.69100	707	0.06700	299	Classified_conf...	Exemption1	Not_required

Crop type mapping (L4A) – automatic validation

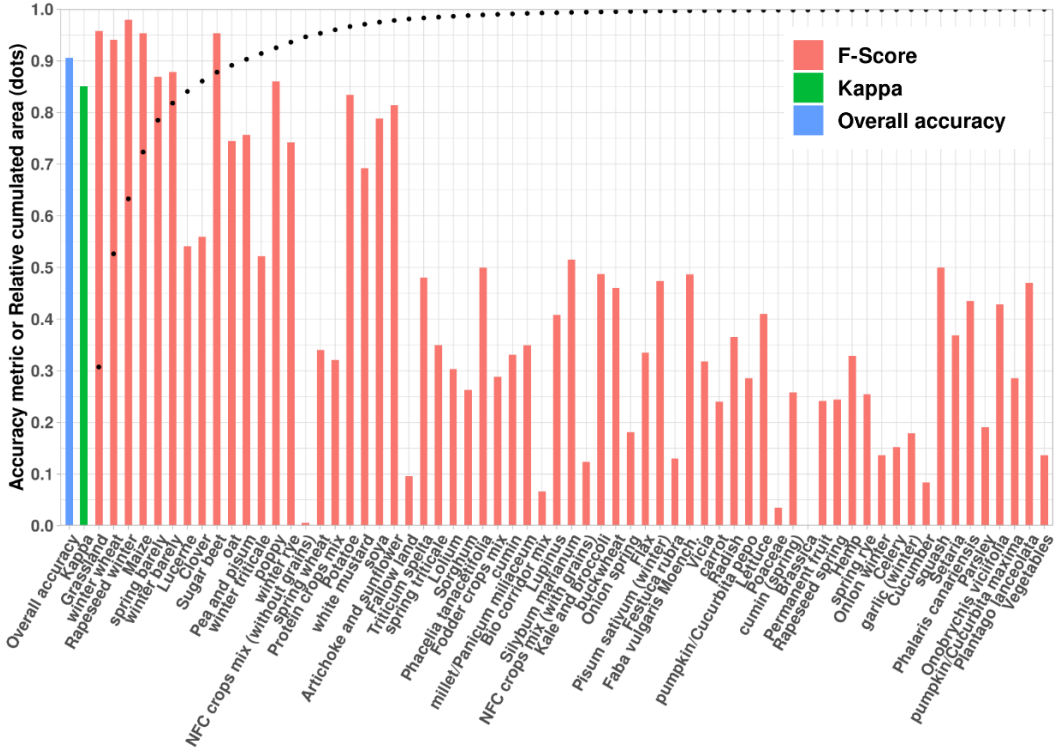
- **Information about the classification and validation results**



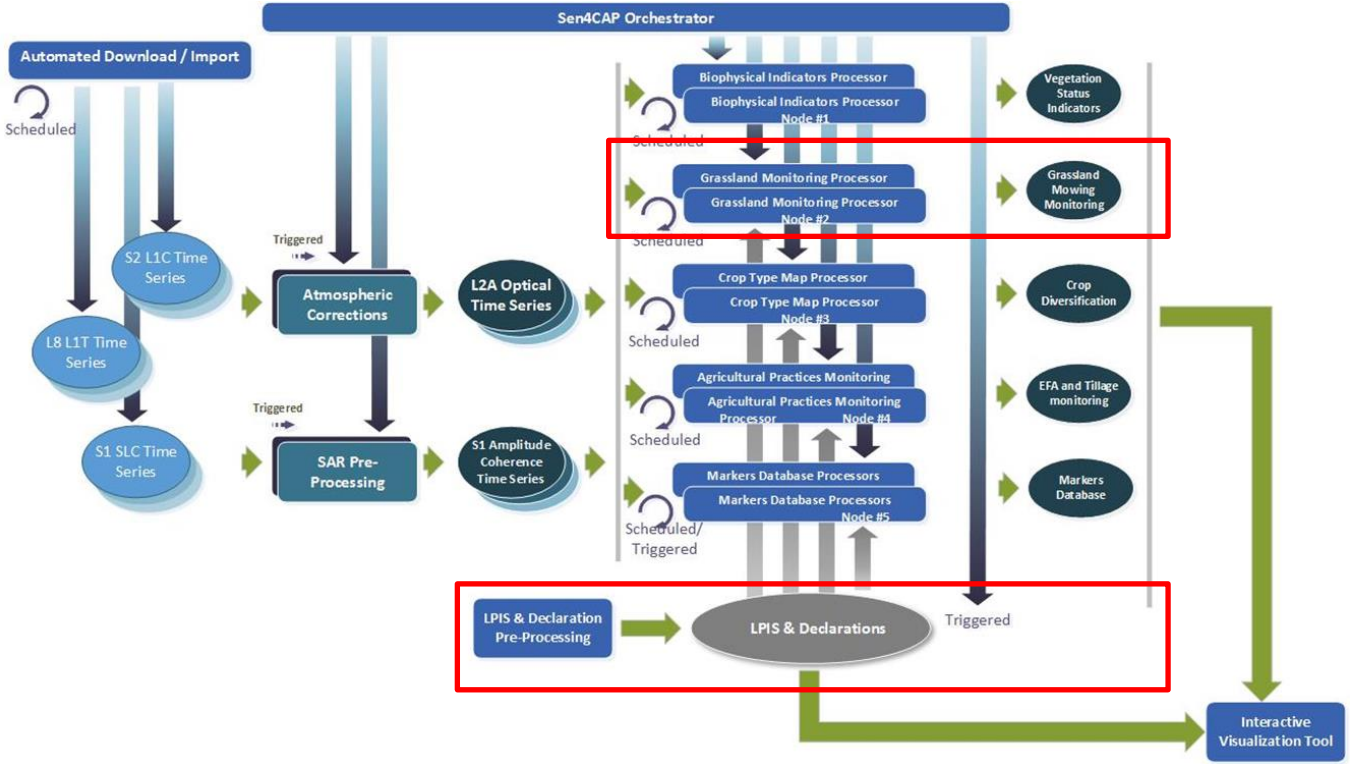
Accuracy	Kappa
0.9060348	0.85032722

CTnumL4A	CTL4A	Count	Countratio	Area	Arearatio	Classified	Strategy
3000	Grassland	350231	0.56329966	1.0633E+10	0.30693716	TRUE	1
56	winter whea	70461	0.11332708	7587215212	0.21901153	TRUE	1
10	Rapeseed wi	29500	0.0474468	3687048421	0.10642984	TRUE	1
51	Maize	27206	0.04375721	3134962663	0.09049341	TRUE	1
49	spring barely	24329	0.03912994	2130951341	0.06151175	TRUE	1
50	winter barel	11022	0.01772741	1144456055	0.03303571	TRUE	1
348	Lucerne	13983	0.02248978	784356887	0.02264114	TRUE	1
347	Clover	9599	0.01543871	690033830	0.01991842	TRUE	1
2	Sugar beet	3975	0.00639326	601821914	0.01737211	TRUE	2
52	oat	8366	0.01345559	455907907	0.01316018	TRUE	1
37	Pea and pisu	5300	0.00852434	410377860	0.01184591	TRUE	1
58	winter tritica	5328	0.00856937	383416165	0.01106764	TRUE	1
64	poppy	3268	0.00525614	382843362	0.0110511	TRUE	2

...



Sen4CAP system – Grassland mowing detection (L4B)



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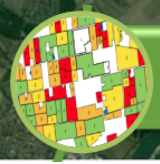
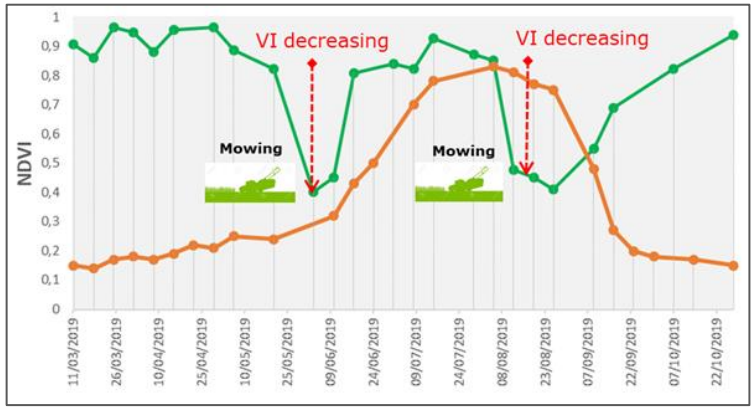
Grassland mowing detection (L4B) - S1 & S2 time series analysis



Grassland mowing detection

- **S2 NDVI**



esa

Sen4CAP - Sentinels for Common Agricultural Policy

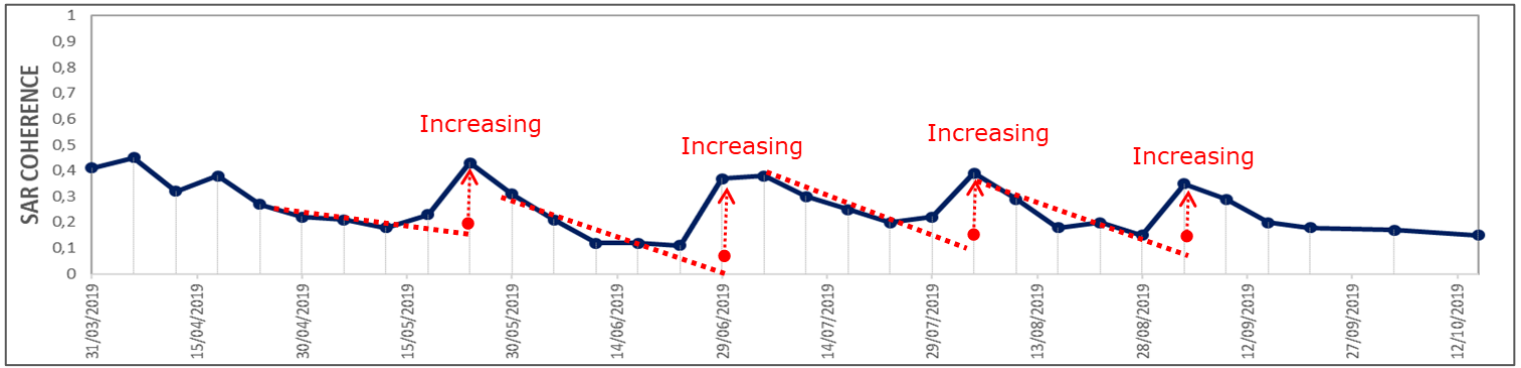
Design Definition File

ATBD for L4B grassland mowing detection product

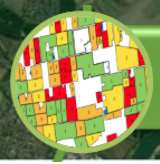
sen4cap common agricultural policy

http://esa-sen4cap.org/content/technical-documents

- **S1 Coherence**



Grassland mowing detection (L4B) - results



- **Results of the L4B grassland mowing detection with:**

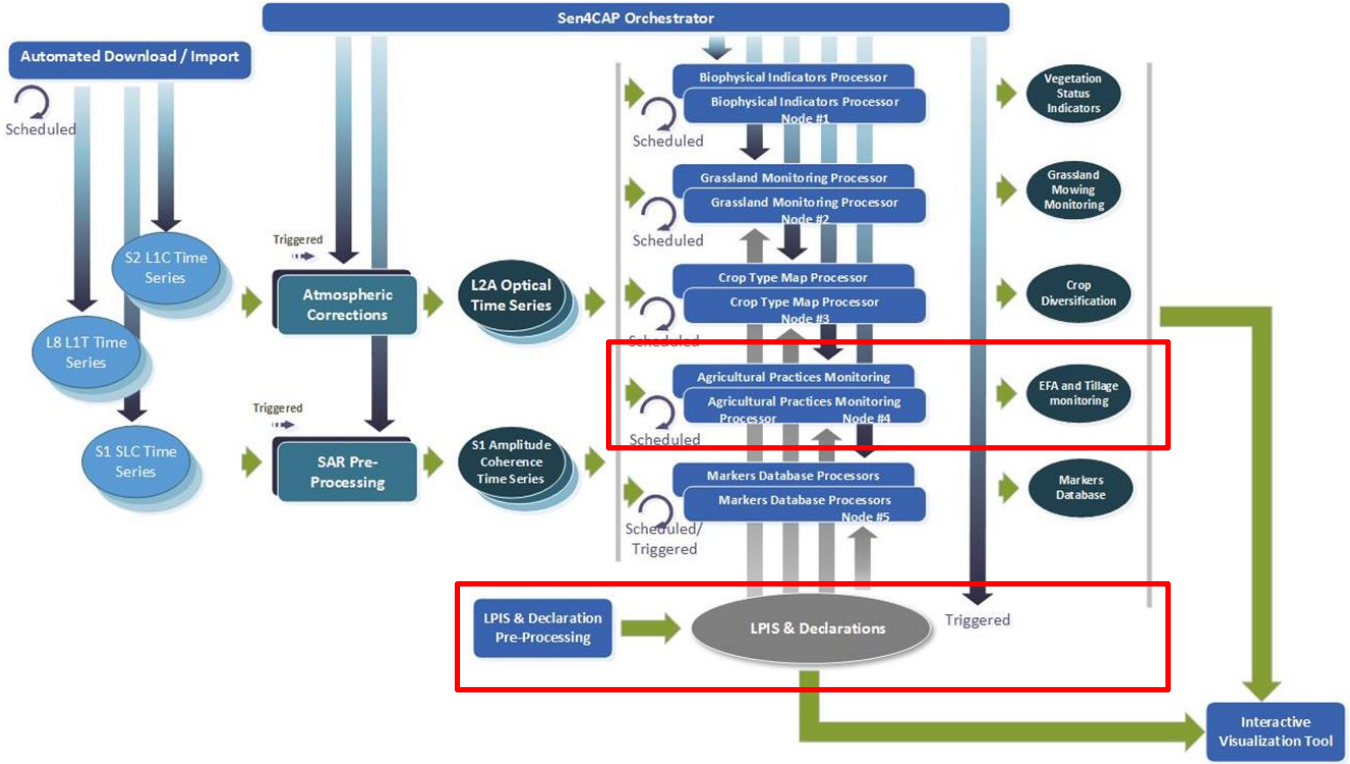
⇒ **Number** of detected mowing events

⇒ **Date** of each detected mowing event

⇒ **Conformity regarding the rules**

mow_n	m1_dstart	m1_dend	m1_conf	m1_mis	m2_dstart	m2_dend	m2_conf	m2_mis	m3_dst	compl
0	0	0	0.000000000000...	0	0	0	0.000000000000...	0	0	2
1	2020-07-04 10:3...	2020-07-14 10:3...	0.825000000000...	S2	0	0	0.000000000000...	0	0	1
0	0	0	0.000000000000...	0	0	0	0.000000000000...	0	0	2
0	0	0	0.000000000000...	0	0	0	0.000000000000...	0	0	2
2	2020-05-18 10:3...	2020-06-02 10:3...	0.875000000000...	S2/S1	2020-06-27 10:3...	2020-07-05 10:3...	0.825000000000...	S2	0	1
0	0	0	0.000000000000...	0	0	0	0.000000000000...	0	0	2
2	2020-06-10 18:0...	2020-06-16 18:0...	0.238000000000...	S1	2020-08-21 10:3...	2020-08-26 10:3...	0.777000000000...	S2	0	1
2	2020-06-03 18:0...	2020-06-09 18:0...	0.394000000000...	S1	2020-07-22 10:3...	2020-07-27 10:3...	0.820000000000...	S2	0	1
1	2020-07-22 10:3...	2020-07-27 10:3...	0.833000000000...	S2/S1	0	0	0.000000000000...	0	0	1

Sen4CAP system – EFA practices monitoring (L4C)



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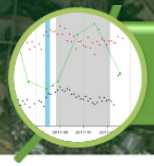
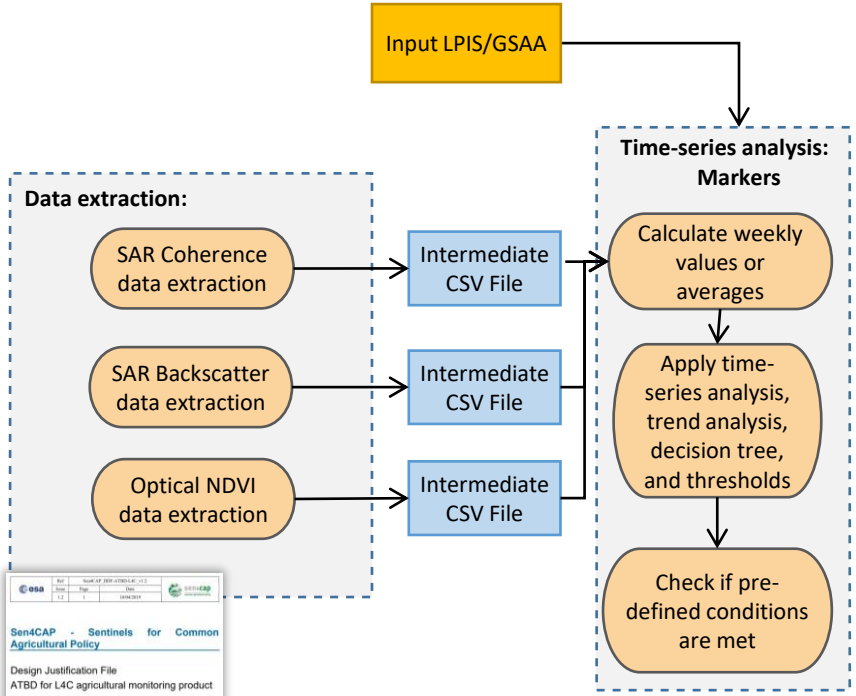
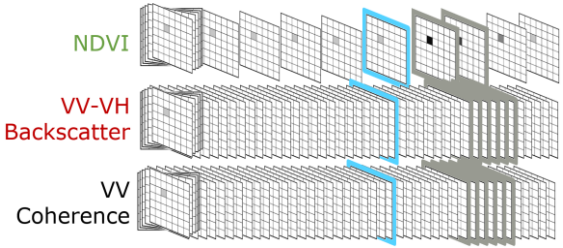
EFA practices monitoring (L4C) - from Sentinel-1 and Sentinel-2 markers analysis





http://esa-sen4cap.org/content/technical-documents

- **Analysing the dense S1 and S2/L8 time series per parcel**



- **Generation of weekly PRACTICE markers**
- **4 monitored practices: harvest, catch crop, nitrogen fixing crop and fallow land**

+ TILLAGE DETECTION

- **Applying decision trees to determine the degree of compliancy of the declared agricultural practice (defined with the PAs)**

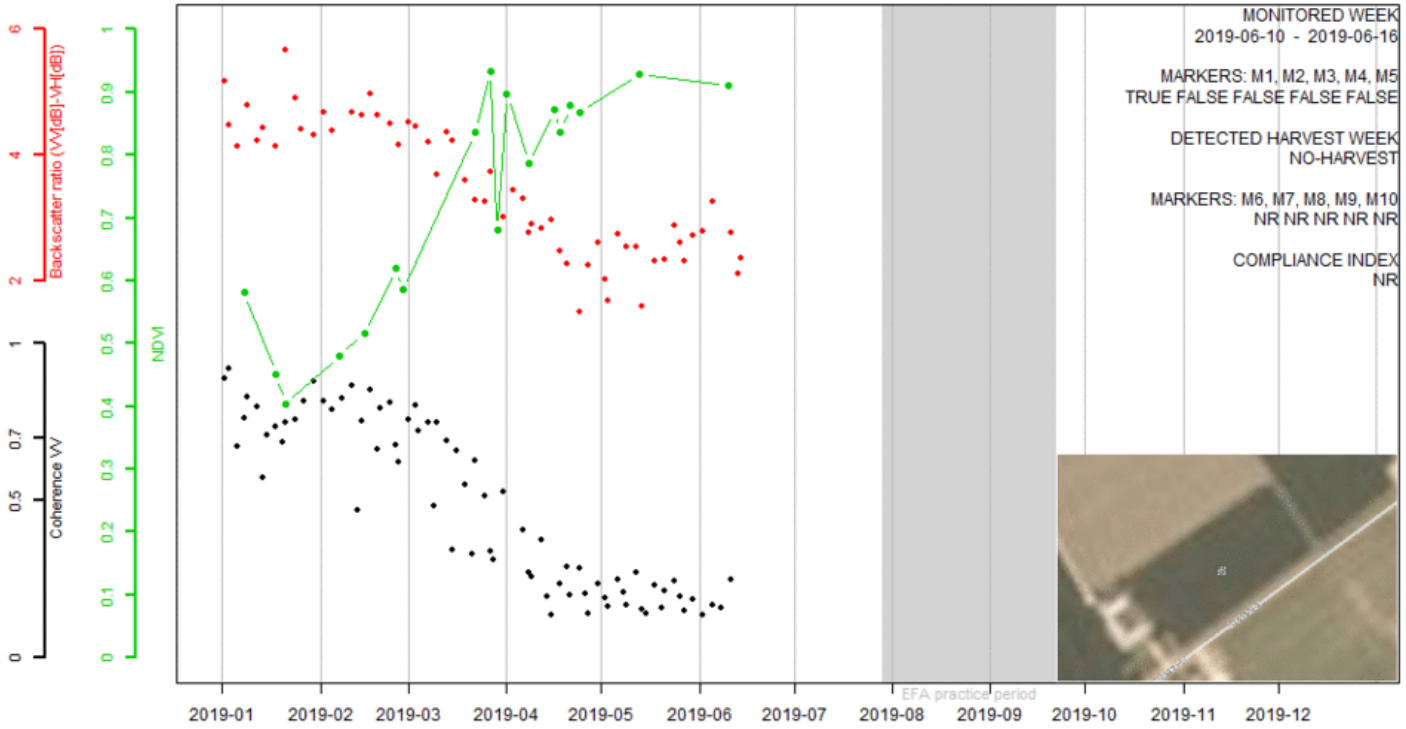
EFA practices monitoring (L4C) - markers

Agricultural practices monitoring (EFA)

- 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

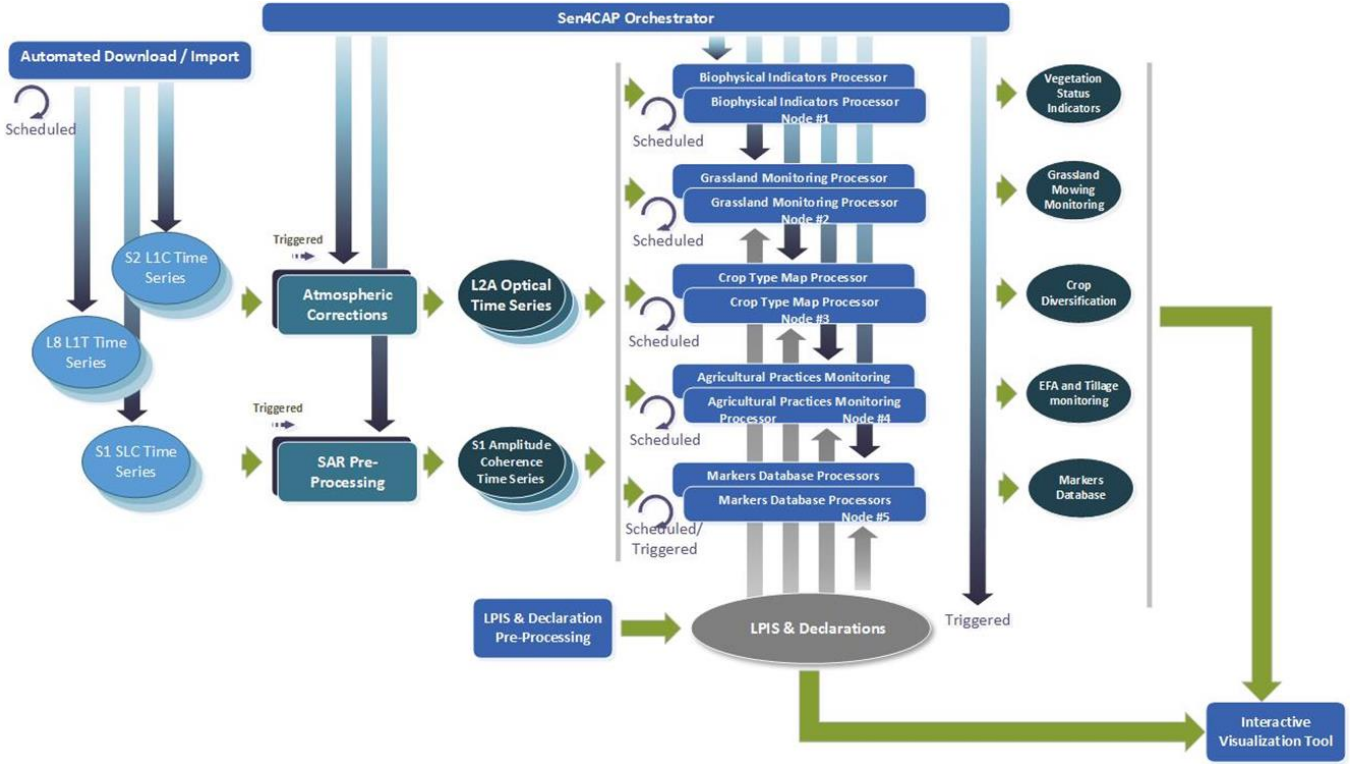
EFA practices monitoring (L4C) - Monitoring of harvest/clearance of a parcel with winter wheat + catch crop (NLD)



Catch crop in the period from 29.7.2019 to 29.9.2019

Area: 2.5 ha

Sen4CAP system



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Thank you for your attention
and your contribution
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