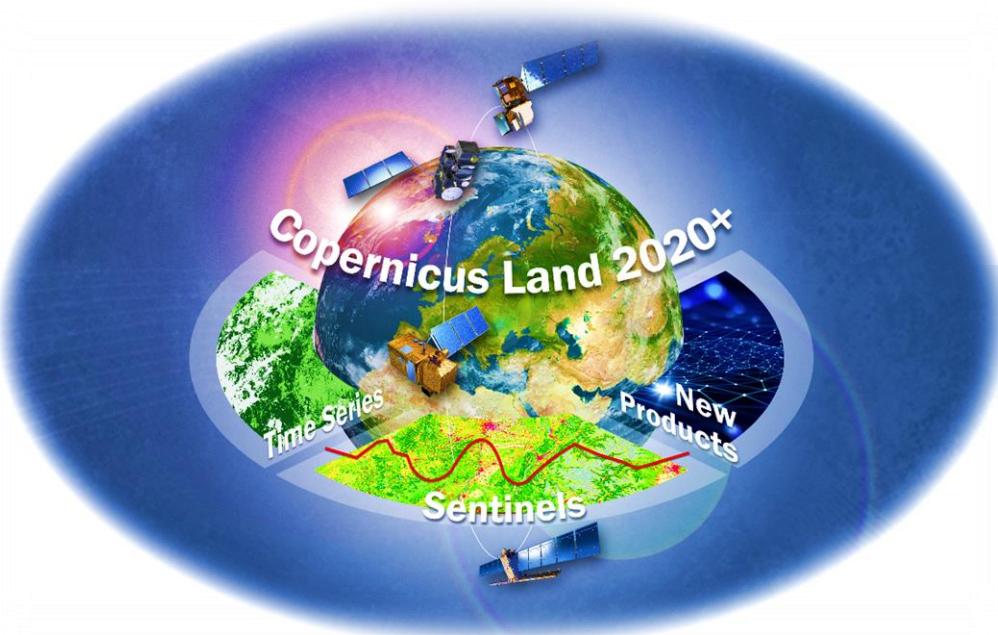


Evolution of Copernicus Land Services based on Sentinel data
INSPIRE Conference
Tuesday, 18 September 2018



ECoLaSS



Horizon 2020

Call - Earth Observation:
EO-3-2016: Evolution of Copernicus services

Sentinel Time Series for Next-generation Copernicus High Resolution Layers on Agriculture and Grassland

Omar Ali Ahmed Mohamed (UCL)

Linda Moser, Markus Probeck, Gernot Ramminger, Regine Richter, David Herrmann (GAF)

GAFAG

SIRS
A CLS GROUP COMPANY

JOANNEUM
RESEARCH

UCL
Université
catholique
de Louvain

DLR

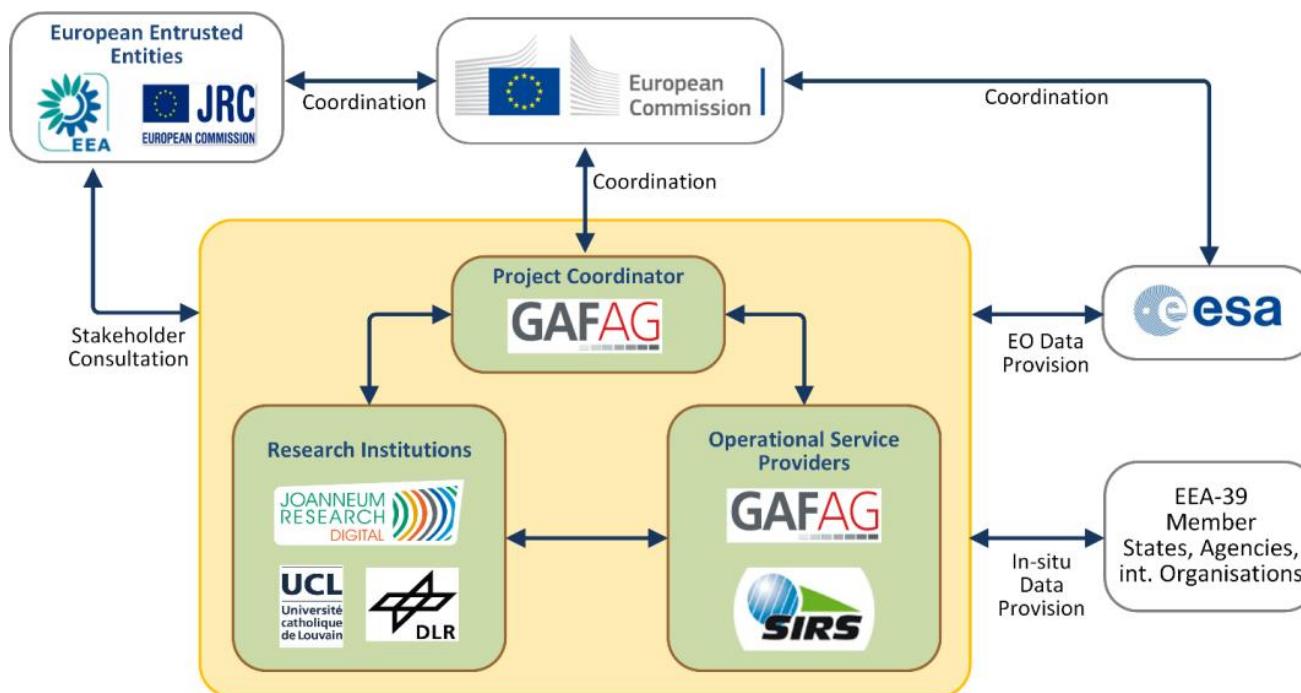


H2020 ECoLaSS – Objectives & Setup

ECoLaSS: “Evolution of **Copernicus Land Services** based on **Sentinel data**”

Key Objective = **improve** existing & develop **novel** products/services for future operational pan-European & Global Copernicus Land Components 2020+ :

Organizational Setup

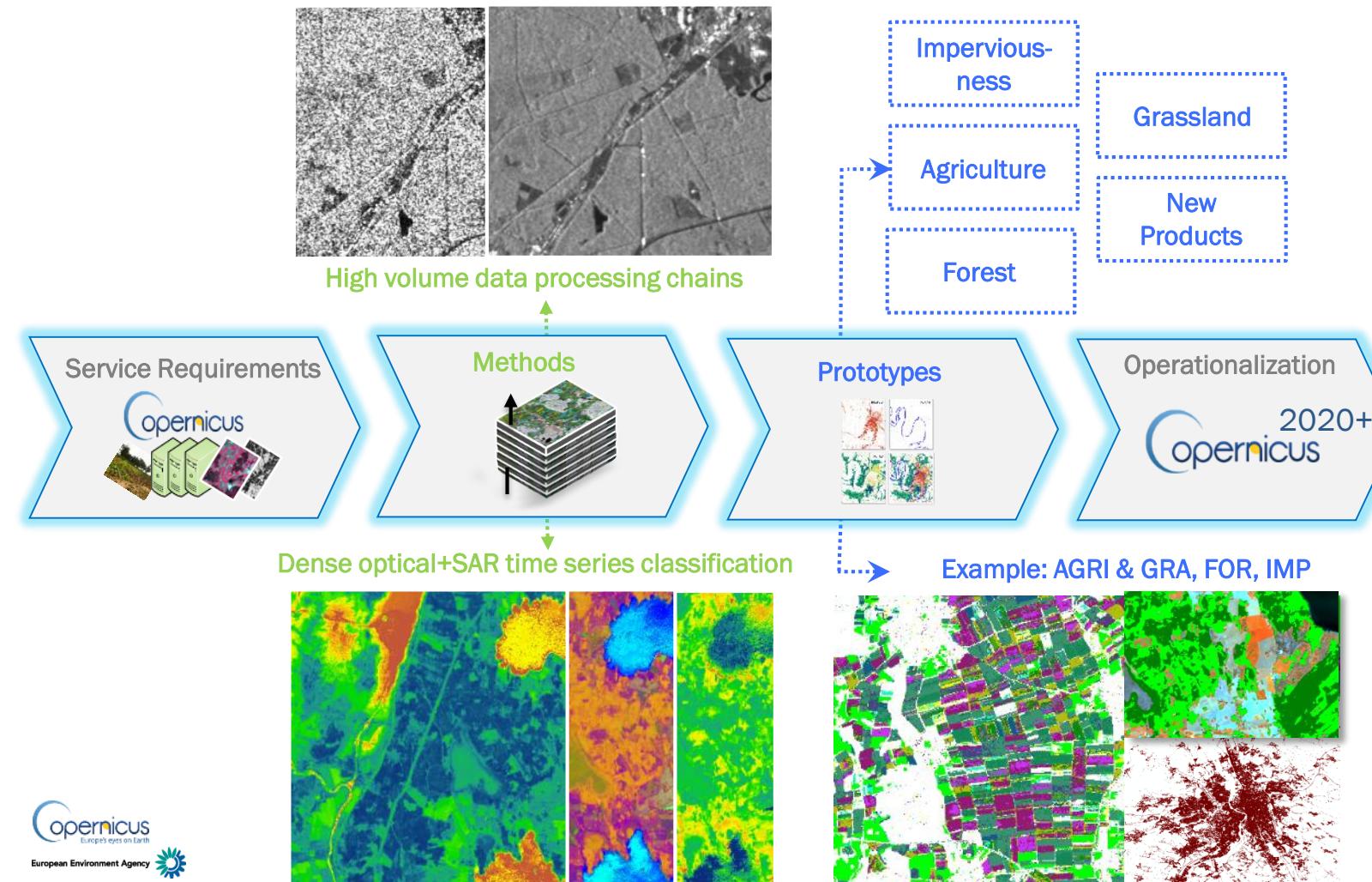


Dates & Timing:

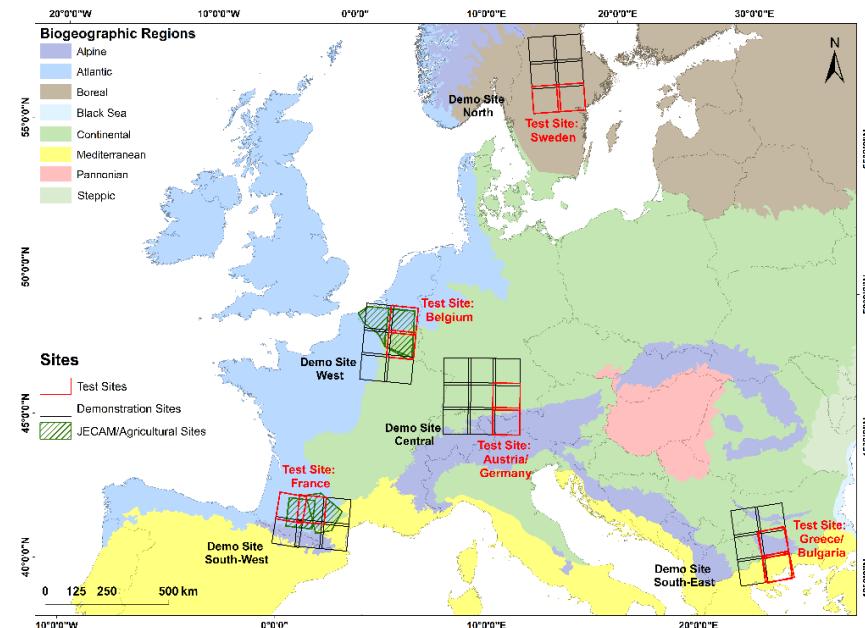
- Dez 2015: Horizon 2020 WP, Call: „*Evolution of Copernicus Land Monitoring Services*“
 - Jan 2017: Project Start
- Runtime: Jan 2017–Dec 2019 (3 years)



H2020 ECoLaSS – Concept



5 Test- and Demonstration sites
in various biogeographic regions.





Background: High Resolution Layers (HRLs) 2015

Copernicus Land Monitoring Service – High Resolution Layers (HRLs) 2015

Updated & new HRLs 2015:

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Imperviousness (sealed areas)
(IMP)

- Forest (FOR)
- Grassland (GRA)
- Water/Wetness (WaW)
- Small Woody Features (SWF)



© European Union, Copernicus Land Monitoring Service
2015, European Environment Agency (EEA).

Consortium:

GAF AG, GeoVille, SIRS, e-Geos (only GRA)

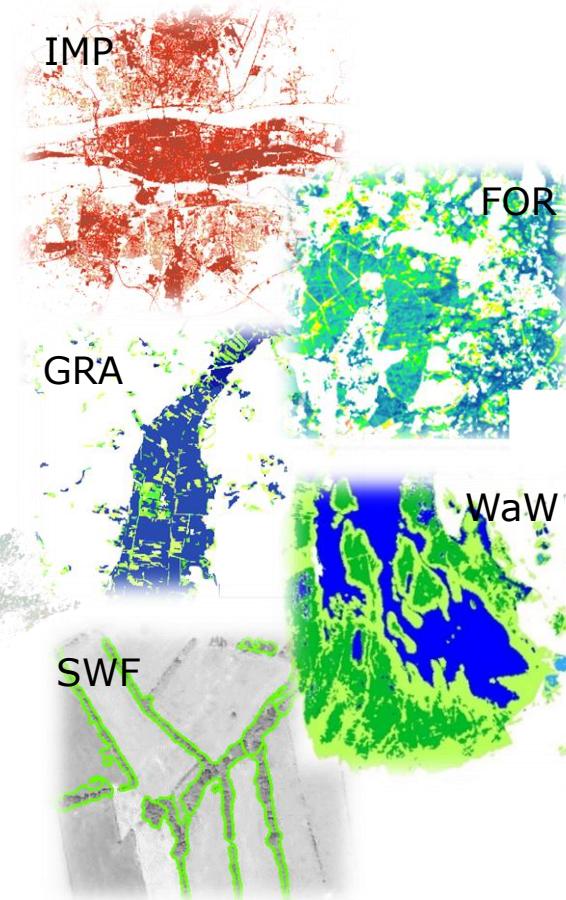


European Environment Agency



Copernicus
Europe's eyes on Earth

Land
Monitoring



Requirements:

- Consistent and harmonized products across EEA-39 – 5.8 Mio km²
- → dense S1a/b + S2a/b time series
- Thematic accuracies: exceeding 85–90%
→ Increased Automation
- 20 m high spatial resolution/5 m and 1:5000 vector product (SWF) → 10m
- Change layers → yearly incremental updates

2012/2015 (FOR),

2006/2009/2012/2015 (IMP)

L. Moser/G. Ramminger et al. (2017): Sentinel-based Evolution of Copernicus Land Services on Continental and Global Scale:
<http://worldcover2017.esa.int/files/2.3-p2.pdf>



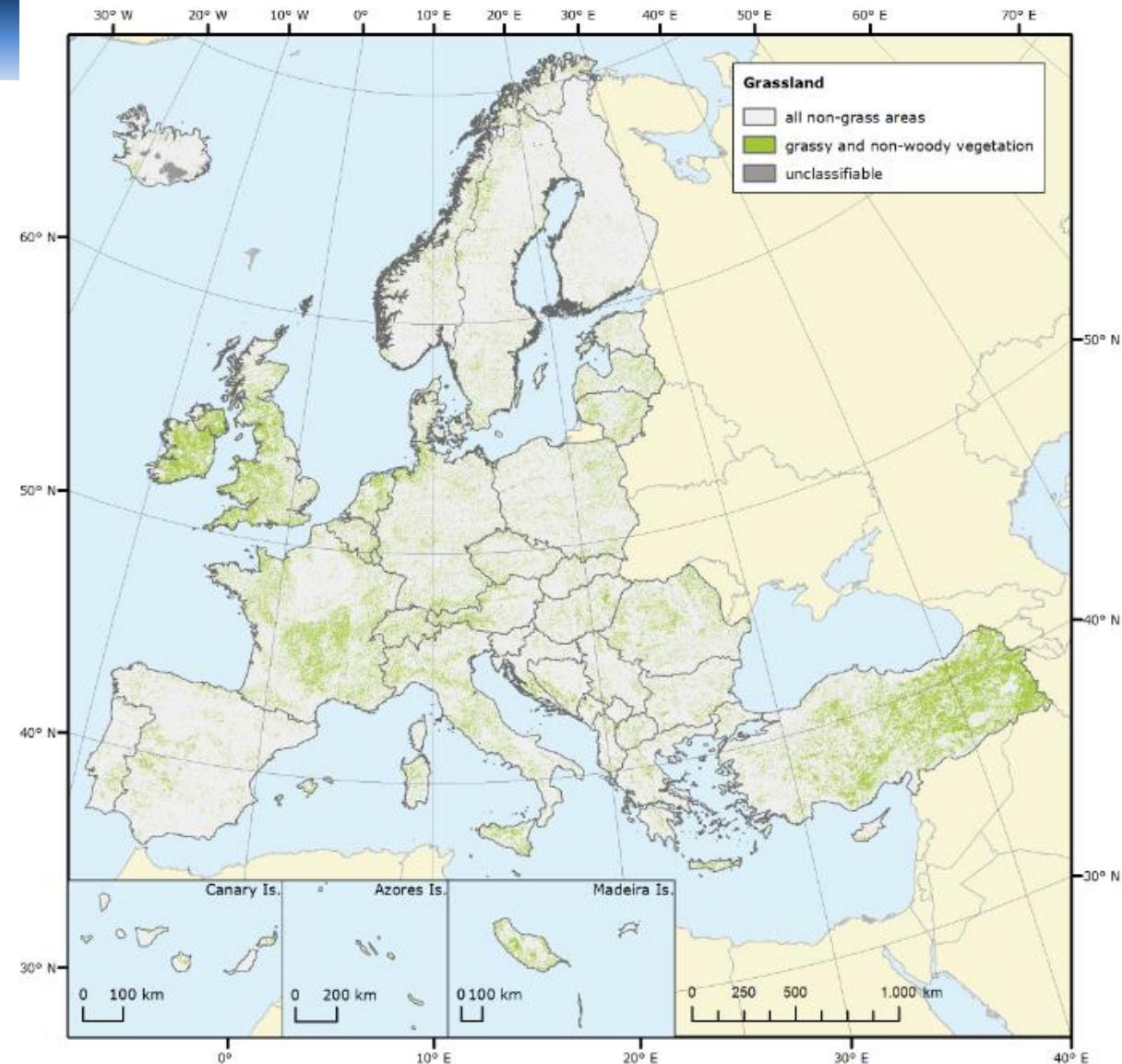
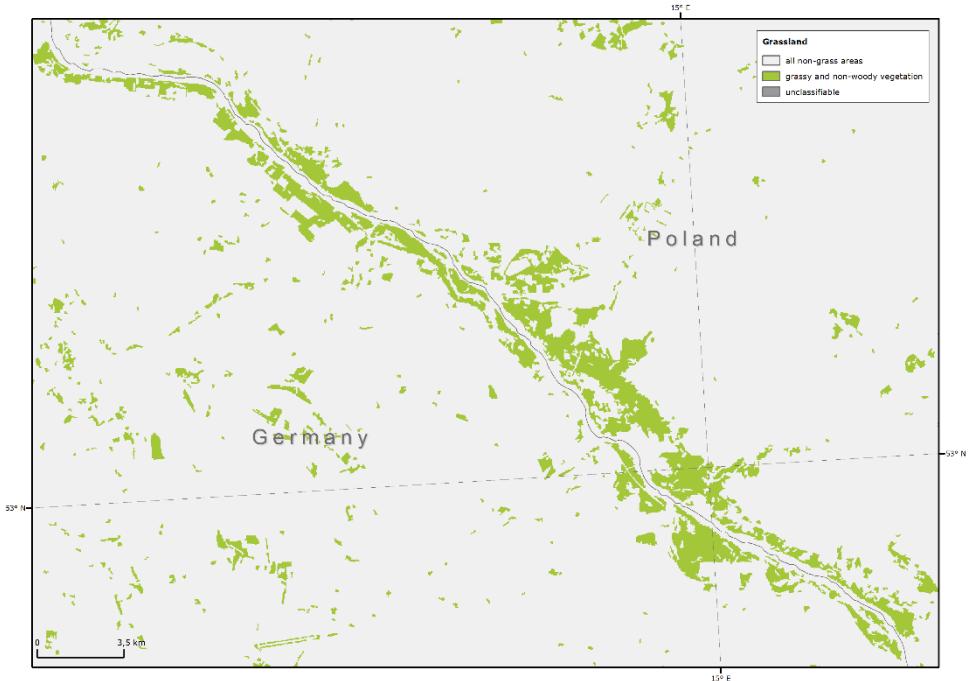
ECoLaSS Methodology





Copernicus HRL Grassland 2015

- ✓ Seamless, pan-European 20 m grassland/non-grassland mask for EEA39
- ✓ National 20 m grassland/non-grassland mask for each European country including 100 m buffer
- ✓ Aggregated, pan-European 100 m product
- ✓ National 100 m grassland /non-grassland layers
- ✓ Dataset freely available: <https://land.copernicus.eu/>

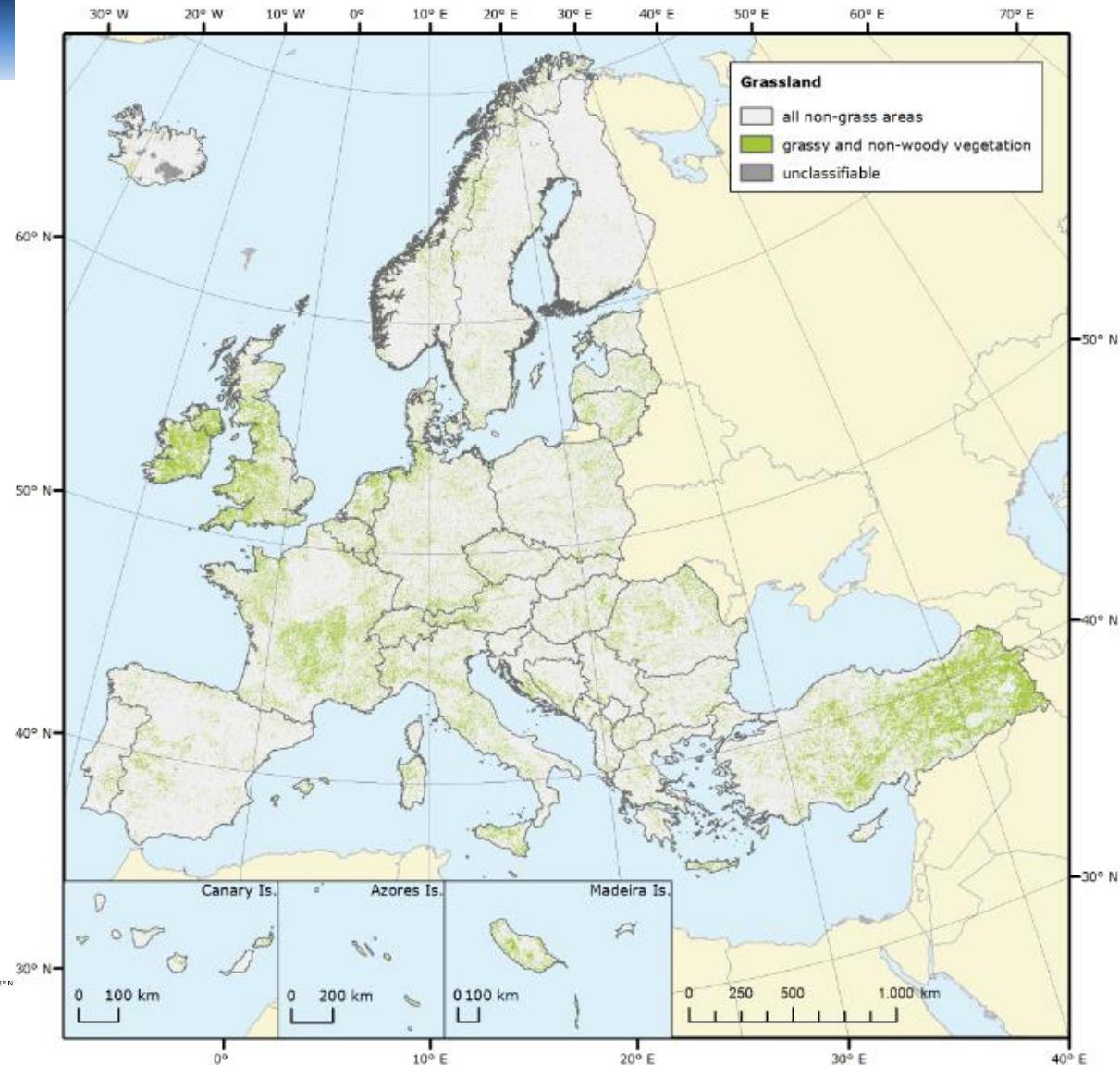


© European Union, Copernicus Land Monitoring Service
2015, European Environment Agency (EEA)

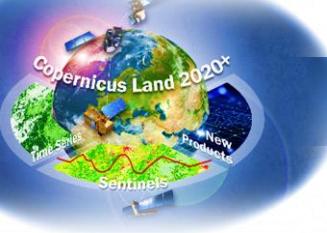


Copernicus HRL Grassland 2015

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- ✓ National 100 m grassland /non-grassland layers
- ✓ Dataset freely available: <https://land.copernicus.eu/>



© European Union, Copernicus Land Monitoring Service
2015, European Environment Agency (EEA)



Improved Permanent Grassland Identification – Improved HRL GRA

Objectives:

- To explore and set up a robust classification approach for improved identification of permanent grasslands based on S1/2 time series and in-situ data for pan-European land monitoring.
- Improve HRL2015 (higher automation, optical/SAR full time series combination, 20m → 10m, higher accuracies,...)

ECoLaSS Grassland Prototype 2017:



Input Features:

- Optical band features (S2)
- SAR band features (S1)
- Vegetation indices
- Seasonal indices

Accuracy:

- OA = 97.74 %
- PA = 87.78 %
- UA = 96.08 %



ECoLaSS Prototype classification result



LGP grassland polygons in yellow

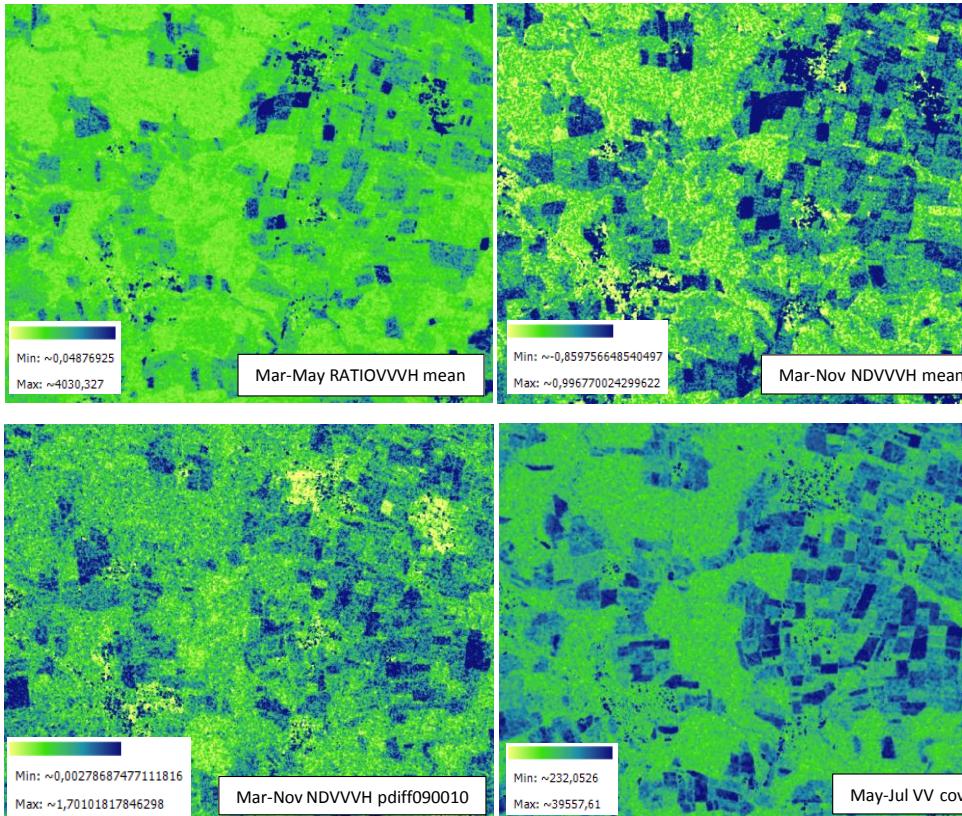


Selected Time Features based on optical and radar data

Objectives:

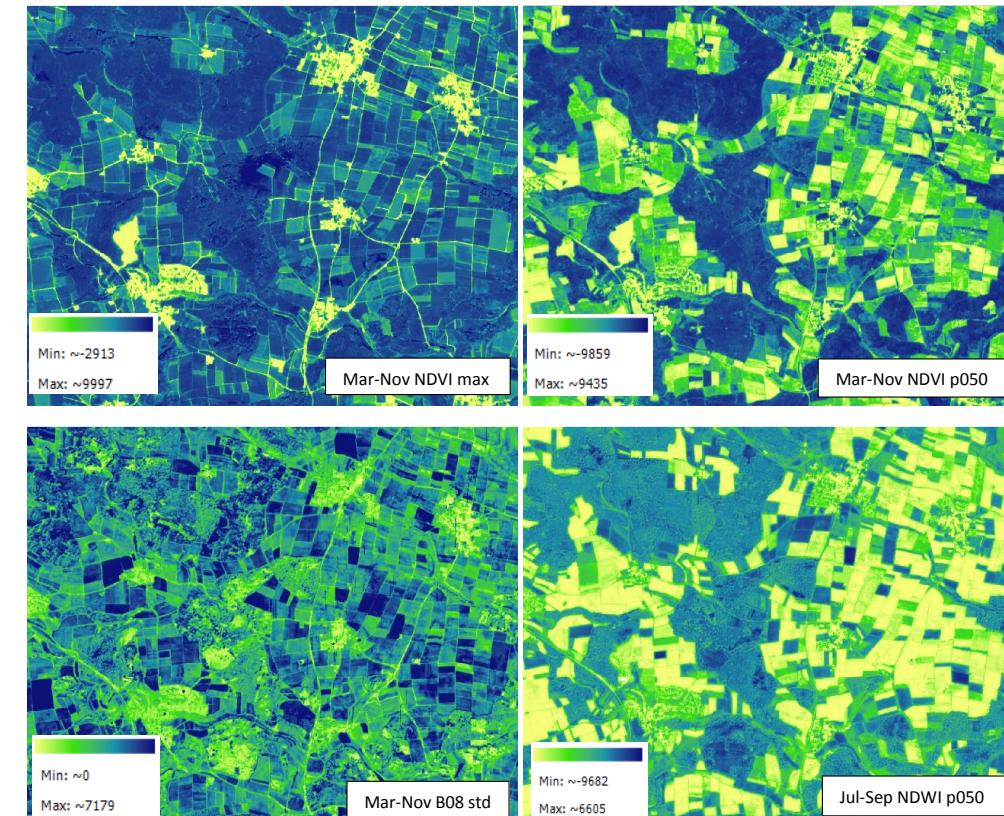
- Demonstrate a prototype for delivering agriculture-related products on future pan-European scale
- Exploit dense Sentinel-1/-2 time series, calculate annual and seasonal time features

Sentinel-1 Time Features



mean, std, pdiff090010, and cov
derived from different Sentinel-1 based indices/bands.

Sentinel-2 Time Features



max, p050 and std
derived from different Sentinel-2 based indices/bands.

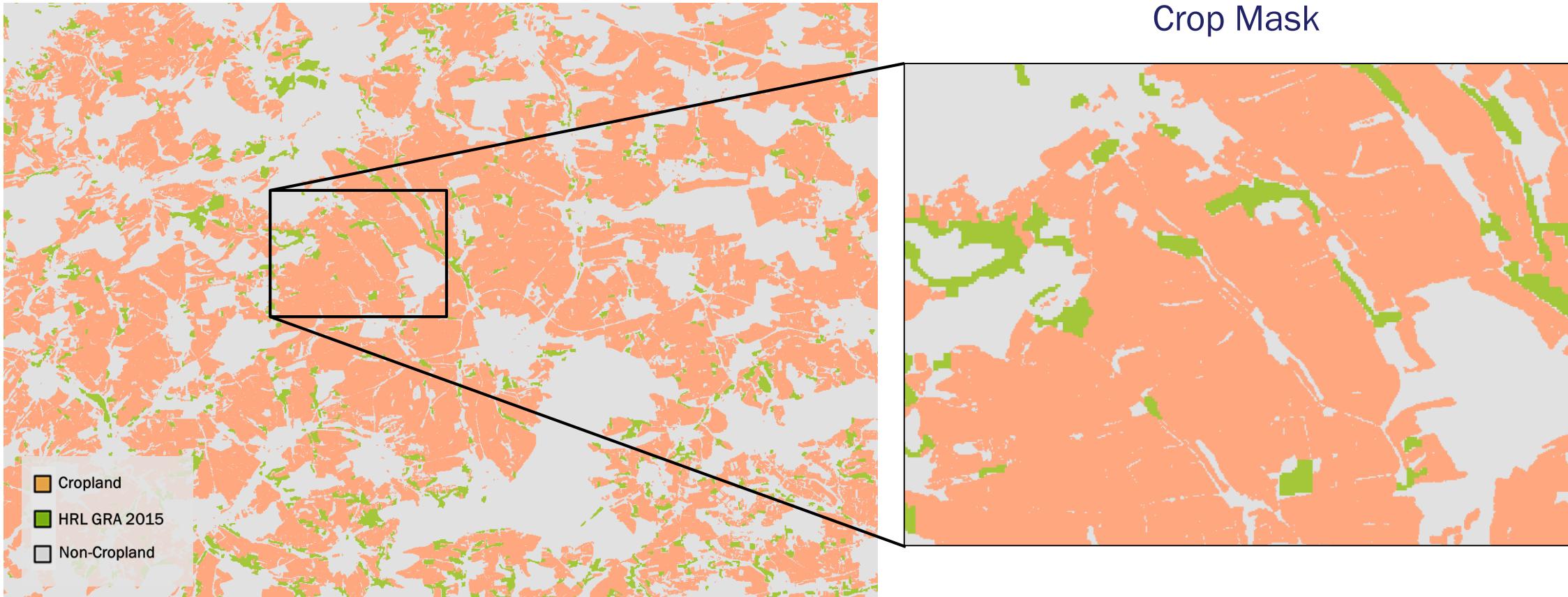
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Crop Mask/Type – Potential future Copernicus Agricultural Layers

Demonstration Site: Central (Subset: Baden-Württemberg, Germany)

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ECoLaSS Crop Mask and
Copernicus HRL Grassland 2015
nicely complement each other

Overall Accuracy (OA) = 96%
Producer's Accuracy = 86 – 99%
User's Accuracy = 94 – 97 %

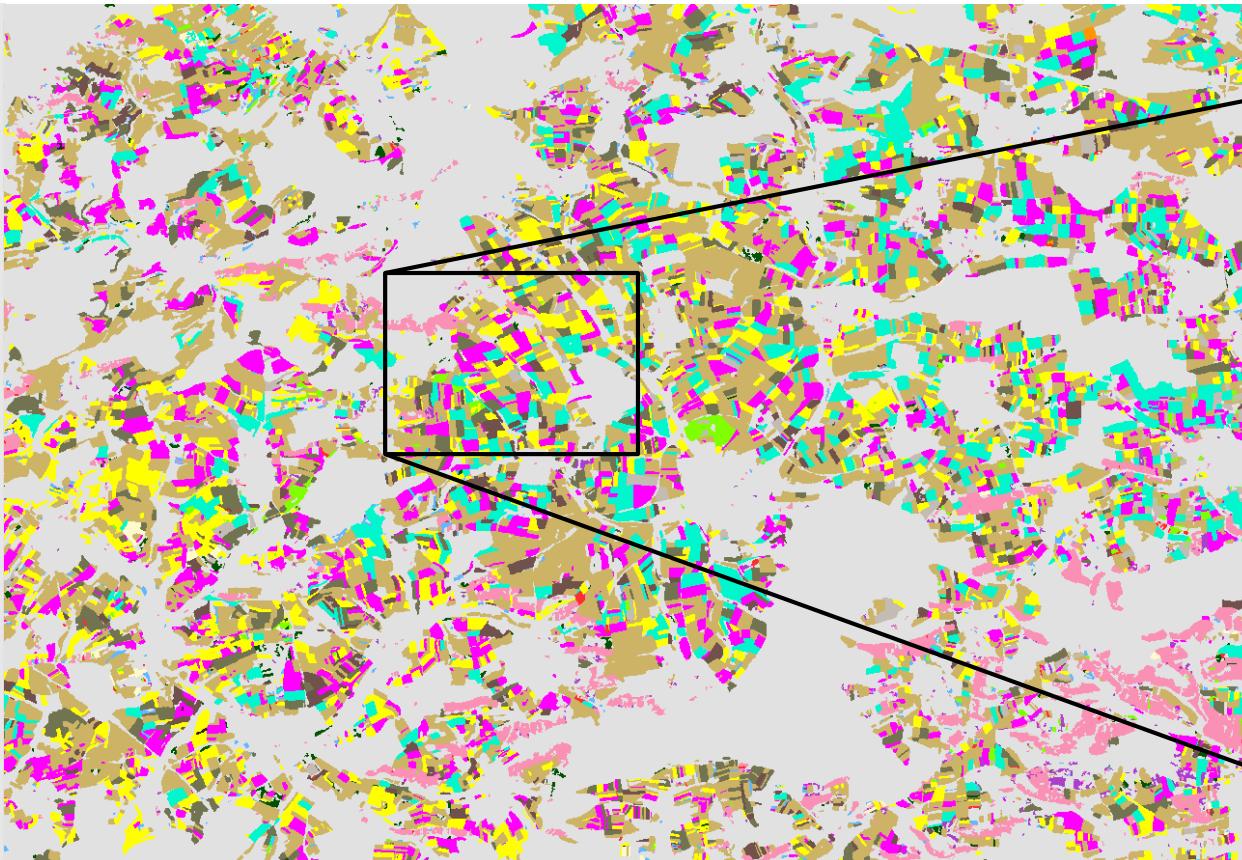
Produced using Copernicus Sentinel data [2017]
© European Union, Copernicus Land Monitoring Service 2015, European Environment Agency (EEA).



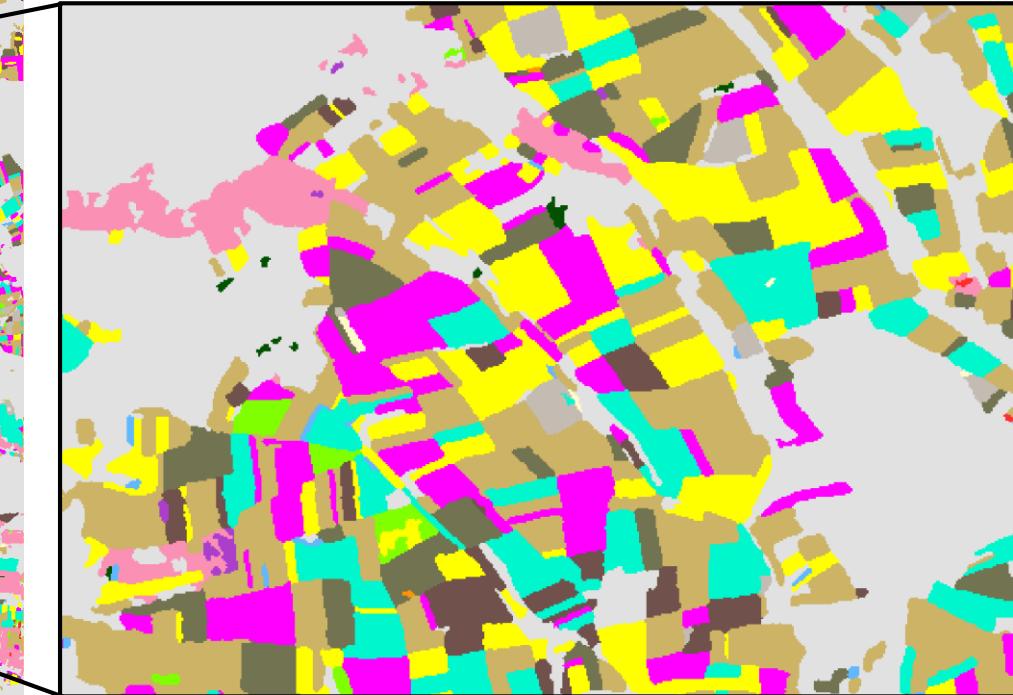
Crop Mask/Type – Potential future Copernicus Agricultural Layers

Demonstration Site: Central (Subset: Baden-Württemberg, Germany)

GAFAG



Crop Type Map (16 crop types)



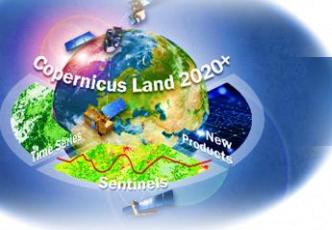
LPIS data © MLR BW

Maize (PA=94%, UA=95%), SugarBeets (PA=95%, UA=91%), WinterCrop (PA=94%, UA=94%), WinterRape (PA=98, UA=93%), SummerRape (PA=46%, UA=21%), Sunfl/Topinamb (PA=64%, UA=28%)

Overall Accuracy (OA) = 89%
Producer's Accuracy = 46 – 98%
User's Accuracy = 21 – 95%

Produced using Copernicus Sentinel data [2017]

© European Union, Copernicus Land Monitoring Service 2015, European Environment Agency (EEA).



Crop Mask/Type – Potential future Copernicus Agricultural Layers

Demonstration Site: West (French part)



Crop Type Map (16 crop types)

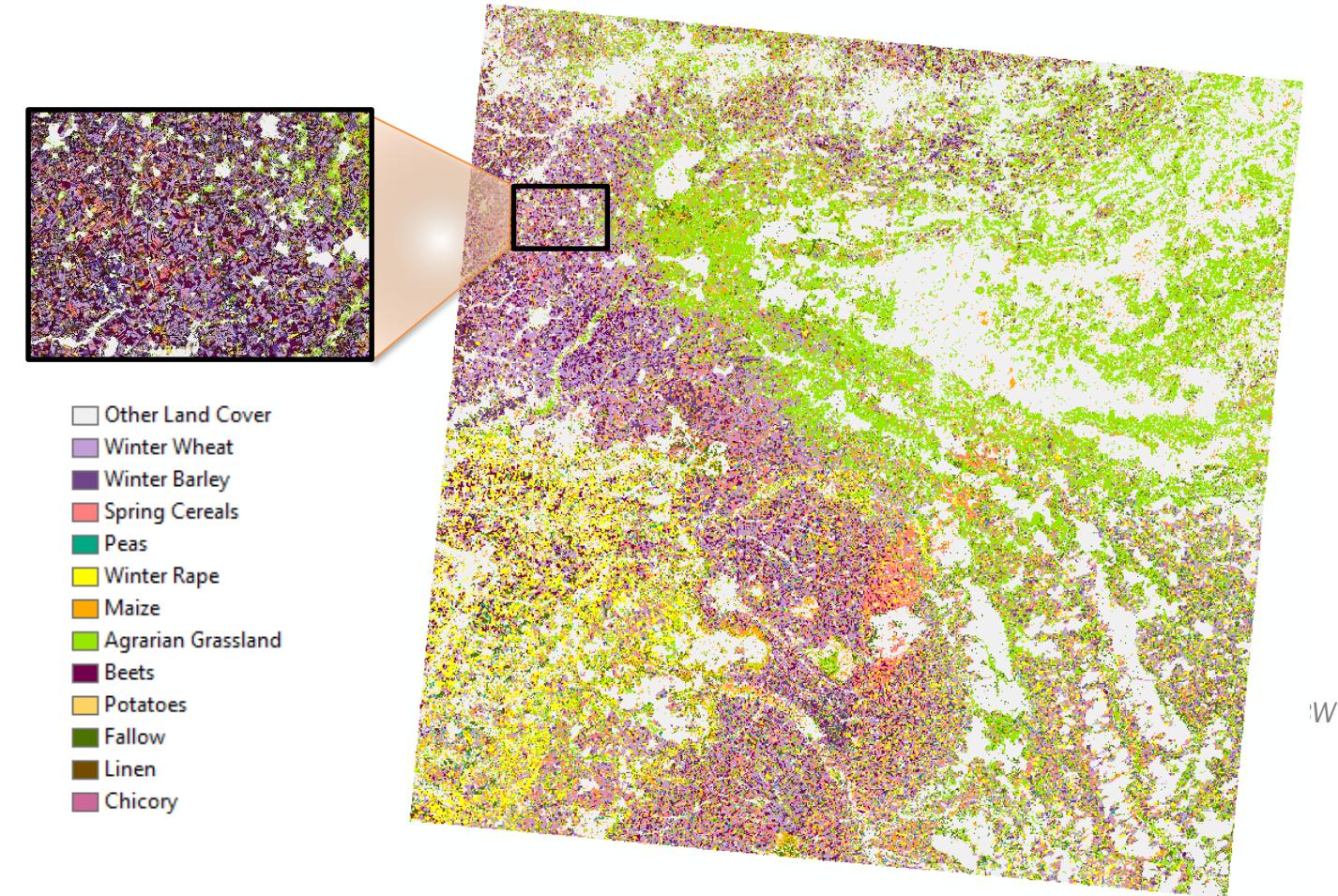
Input Features:

- Optical band features (S2)
- Vegetation indices
- Seasonal indices

OA = 77%, PA = 46-96%, UA = 46-96%,
Kappa = 0.7, F-Score = 0.27-0.47

Output classes:

16 crop types regrouped to 12 + 4
non-cropland classes (settlements,
forest, water and grassland)





Crop Mask/Type – Potential future Copernicus Agricultural Layers

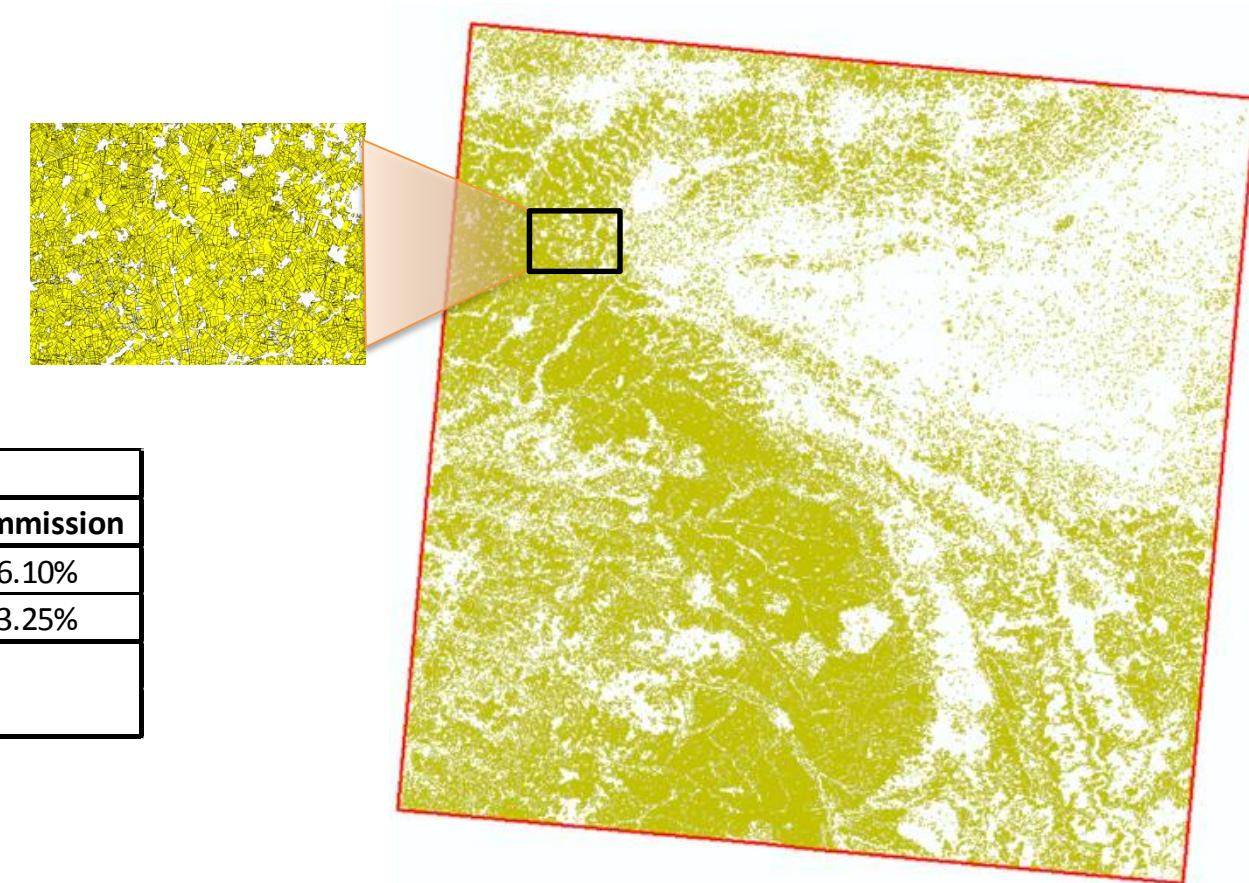
Demonstration Site: West (French part)



Crop Type Map (16 crop types)

- Proposition of one additional layer: cropland_mask
 - Based on a reclassification of the previous results
 - Aggregation of all cropland types

| CROPLAND MASK (plausibility) | | REFERENCE LABELS | | | |
|---------------------------------|-------------------|------------------|---------------|------------|-------|
| PRODUCT LABELS | Non-Cropland | Cropland | User Accuracy | Commission | |
| | Non-Cropland | 245.19 | 15.92 | 93.90% | 6.10% |
| | Cropland | 4.51 | 134.38 | 96.75% | 3.25% |
| | Producer Accuracy | 98.19% | 89.41% | 94.89% | |
| Omission | 1.81% | 10.59% | | | |





Crop Mask/Type – Potential future Copernicus Agricultural Layers

Demonstration Site: West (Belgian part)



Input Features:

- Optical band features (S2)
- SAR band features (S1)
- Vegetation indices
- Seasonal indices

1. Training & applying RF classifier for each tile individually

| Tile | OA before grouping classes (up to 159 different classes) | OA for classes grouped (24 classes) | OA after majority filtering (24 classes) |
|-------|--|-------------------------------------|--|
| 31UFR | 88.81 % | 92.35 % | 93.92 % |
| 31UFS | 84.13 % | 88.55 % | 90.76 % |
| 31UES | 82.99 % | 91.13 % | 93.55 % |

2. Training RF on the 31UFR tile and then applied on other tiles.

| Tile | OA for classes grouped (24 classes) |
|-------|-------------------------------------|
| 31UFR | 92.35 % |
| 31UFS | 68.59 % |
| 31UES | 59.71 % |

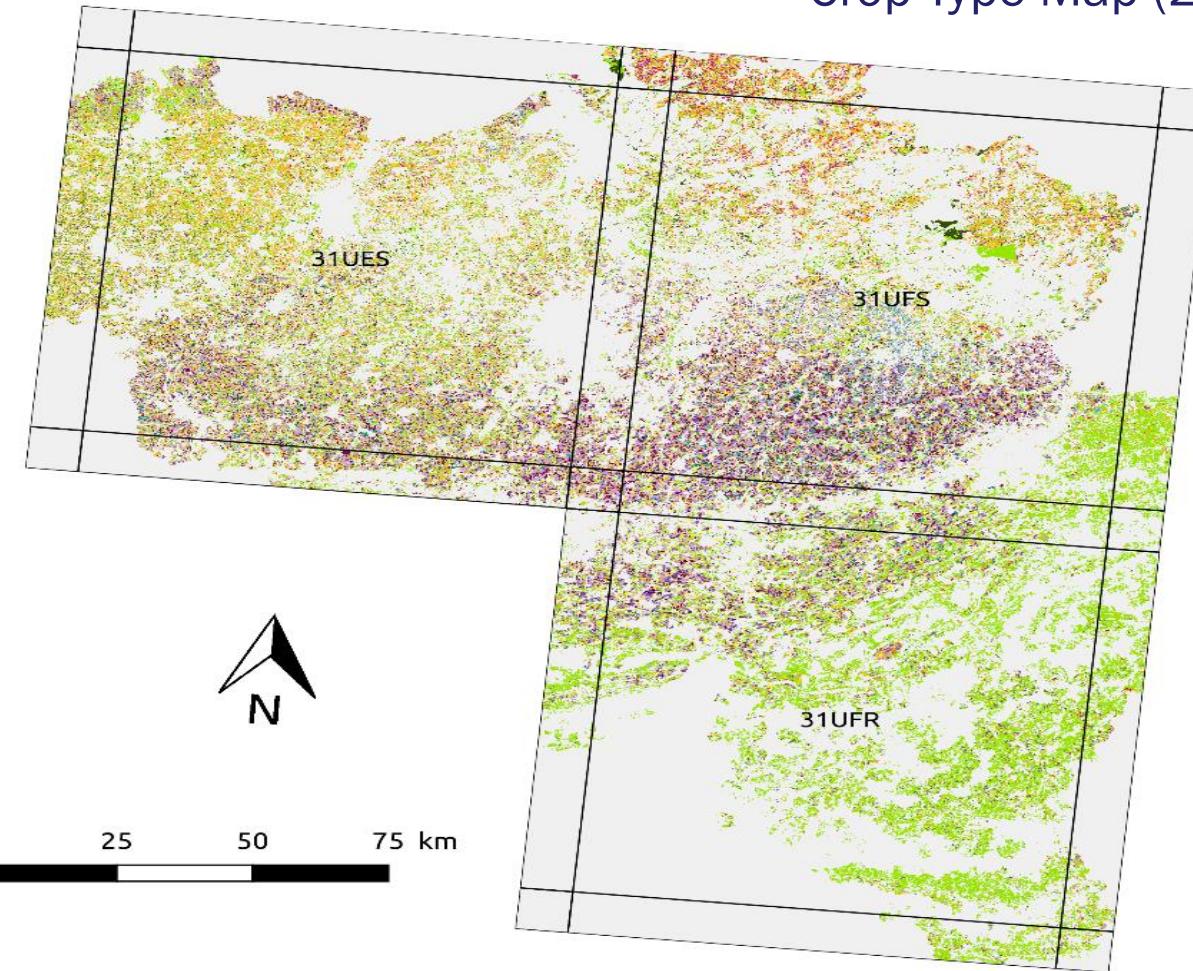


Crop Mask/Type – Potential future Copernicus Agricultural Layers

Demonstration Site: West (Belgian part)

Legend

- Not classified
- Grassland
- Winter Wheat
- Maize
- Winter Barley
- Sugar Beet
- Spelt
- Rapeseed
- Potato
- Flax
- Summer Oat
- Other Vegetables
- Other Fodder
- Peas
- Summer Barley
- Summer Cereals
- Chicory
- Winter Cereals
- Summer Wheat
- Hemp
- Green Beans
- Onions
- Fruit Crops
- Other Crops
- Grape Vines



Crop Type Map (24 crop types)

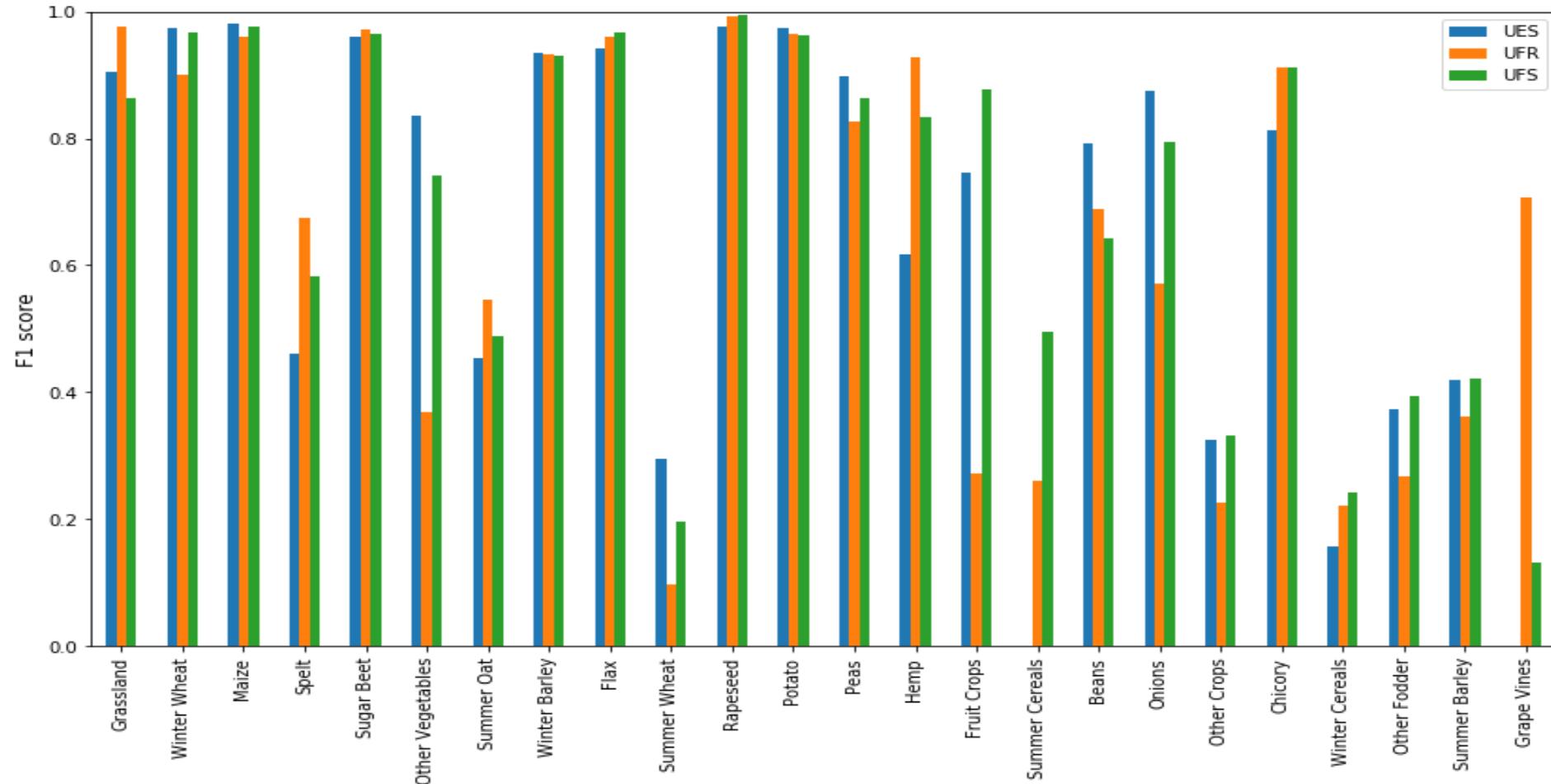
Classification results on UFR-UFS-UES tiles after majority filtering



Crop Mask/Type – Potential future Copernicus Agricultural Layers

Demonstration Site: West (Belgian part)

Crop Type Map (24 crop types)



F1-score per crop type for UFR, UFS and UES tiles. Ordered by decreasing area over the 3 tiles



Summary & Conclusions

Summary – ECoLaSS:

- **Methods:** High volume data processing chains: automated, flexible, customizable, scalable
- **Prototypes for next-generation existing services:** improvement of existing HRLs → 2020+
- **New Service:** new Agricultural Service for EEA-39 under conceptualization and testing
- **Stakeholder Interaction** → towards future Operational Service

Conclusions:

- **GRA + AGRI Results promising:** High accuracies for grassland mask, crop mask and type (good accuracies for large and wide-spread crop types)
- **Grouping agricultural classes = complex**, European diversity, complexity of smaller classes
- **In-situ data (LPIS) not available everywhere** (thinking global, pan-European level)
→ no LPIS data included in the crop mask classification



Follow the ECoLaSS team !!

www.ecolass.eu

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GAFAG L. Moser, M. Probeck, G. Ramminger, D. Herrmann, K. Schwab & Team

 C. Sannier, S. Villerot, B. Desclée, A. Masse & Development Team

 H. Gallau, M. Schardt, P. Miletich, J. Deutscher, K. Granica

 P. Defourny, O. A. Mohamed, J. Wolter, I. Moreau, X. Blaes

 A. Metz-Marconcini, I. Klein, A. Hirner, T. Esch



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 | Horizon2020