



Land Monitoring

Copernicus land service to support carbon removal related policies

Earth Observation for MRV of Carbon removals

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European Environment Agency



European Commission

Copernicus Land Monitoring Service

- **Geographical** information on **land cover and its changes, land use, vegetation state, water cycle** and Earth's **surface energy variables** on European and global levels for environmental applications;
- **Harmonised, operational, and consistent** in time and space;
- Products and manuals are **free and open**;
- Implemented by **JRC and EEA**.



<https://land.copernicus.eu/>



Characteristics of the CLMS

OPERATIONAL	Copernicus delivers products after they become operational, i.e., validated. We put research into operations!
HARMONISED	Thematically, geometrically, <ul style="list-style-type: none"> - A class in Sweden means the same as in Spain - The same geometrical rules apply
CONSISTENT AND COHERENT	The portfolio is mostly stable and kept along the years
COVERAGE	Products are delivered for the whole EEA38+UK
COMMITTED	The Commission is committed to give continuity to the program



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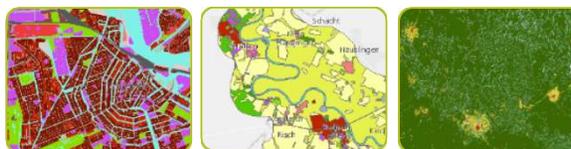
CLMS portfolio: Categories of products



**Land cover and
land use mapping**



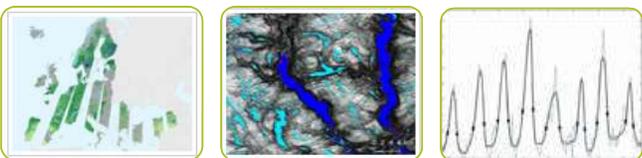
**Priority area
monitoring**



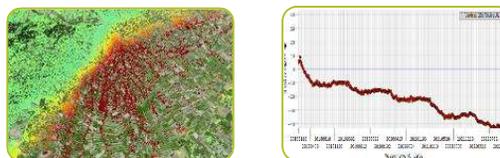
Satellite data



**Bio-geophysical
parameters**



**Ground motion
monitoring**



**Reference and
validation data**



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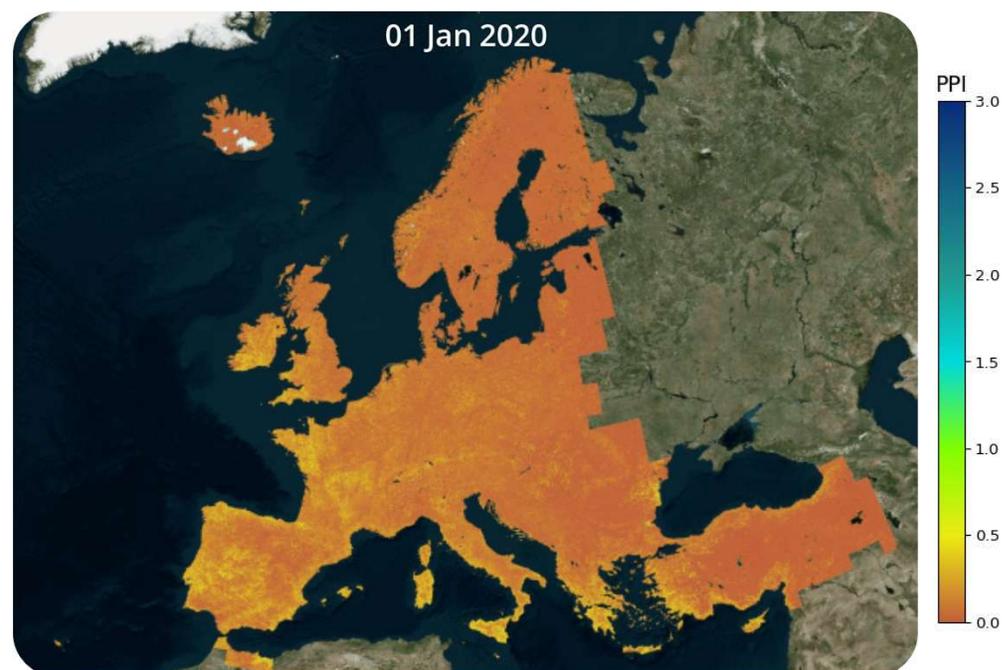


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HR – Vegetation Phenology & Productivity (HR-VPP)

- 2017-2024
- 10 meter annual processing of Phenology & Productivity metrics.
- **Near Real-Time:** vegetation indices & biophysical variables
- **Currently working on:**
 - Tree Cover Disturbances
 - Biomass Productivity (GPP/NPP)



HR-VPP 1.0

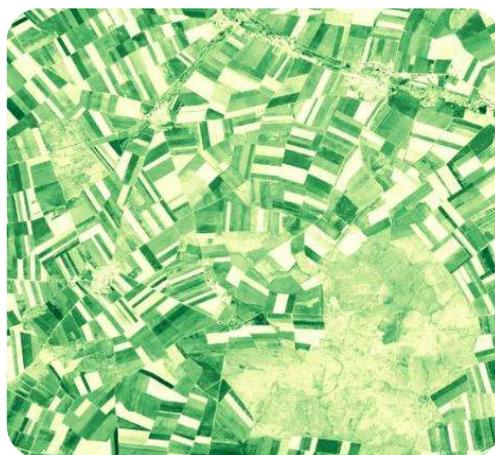
Vegetation Indices



Daily (NRT)

- ✓ PPI
- ✓ FAPAR
- ✓ LAI
- ✓ NDVI
- ✓ Quality Flag

Seasonal Trajectories



10 Days

(Plant Phenology Index)

Phenology & Productivity



Yearly (2 seasons)

- ✓ Start-of-Season
- ✓ End-of-Season
- ✓ Season length
- ✓ Season Max
- ✓ Season Min
- ✓ Amplitude
- ✓ Slope of green up/down
- ✓ Seasonal Productivity
- ✓ Total Productivity



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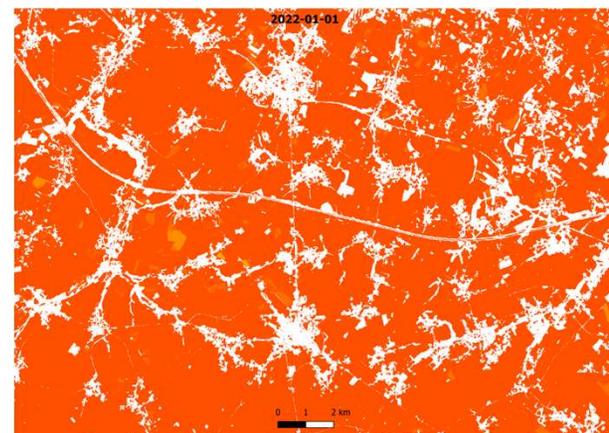


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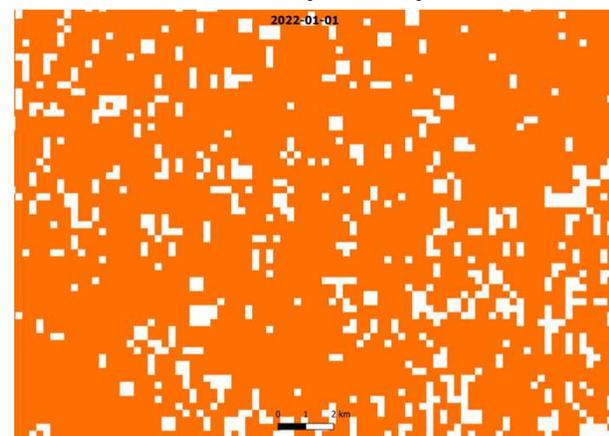
HR-VPP continuation

- Ramp-up phase ongoing;
- Reviewing and testing options:
 - BRDF normalisation of Sentinel-2;
 - fAPAR smoothing;
 - Phenology metrics derived from GPP timeseries;
 - Assessing several methods for Disturbances;
 - ...
- All tests, discussions and conclusions will be published in the **Product Calibration Report**;

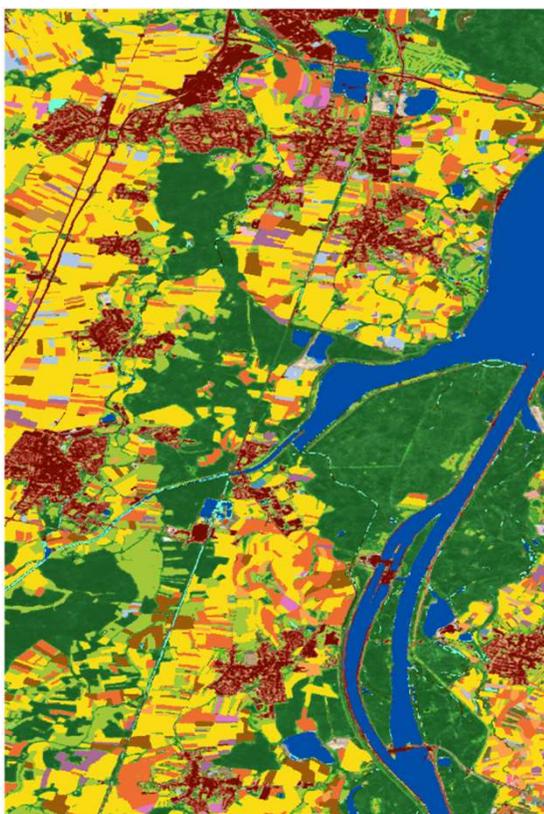
GPP (10 m)



GPP (300 m)



Vegetated High Resolution Layers (HRL)



- The **Vegetated High Resolution Layers** are receiving a many new features;
- **Increase to annual** provision of many layers;
- Addition of **Croplands** monitoring, and Grassland Mowing Events;
- Well-suited for **policy support**:
 - **Ecosystem restoration** (Nature Restoration) assessments and indicators for urban, forests, agricultural, marine, and rivers.
 - **Common Agriculture Policy** (e.g. crop diversity, farming in N2K);
 - Proposed **Soil** monitoring; **Forest** monitoring;

HRL VLCC product lines

HRL Tree Cover and Forests

Annual from 2018
10 meter resolution
EEA38

Products:

- Dominant Leaf Type
- Tree Cover Density
- Forest Type
- Change layers

HRL Grasslands

Annual from 2017
10 meter resolution
EEA38

Products:

- Grassland status
- Herbaceous Cover
- Ploughing indicator
- Change layers
- Grassland Mowing Events

HRL Croplands

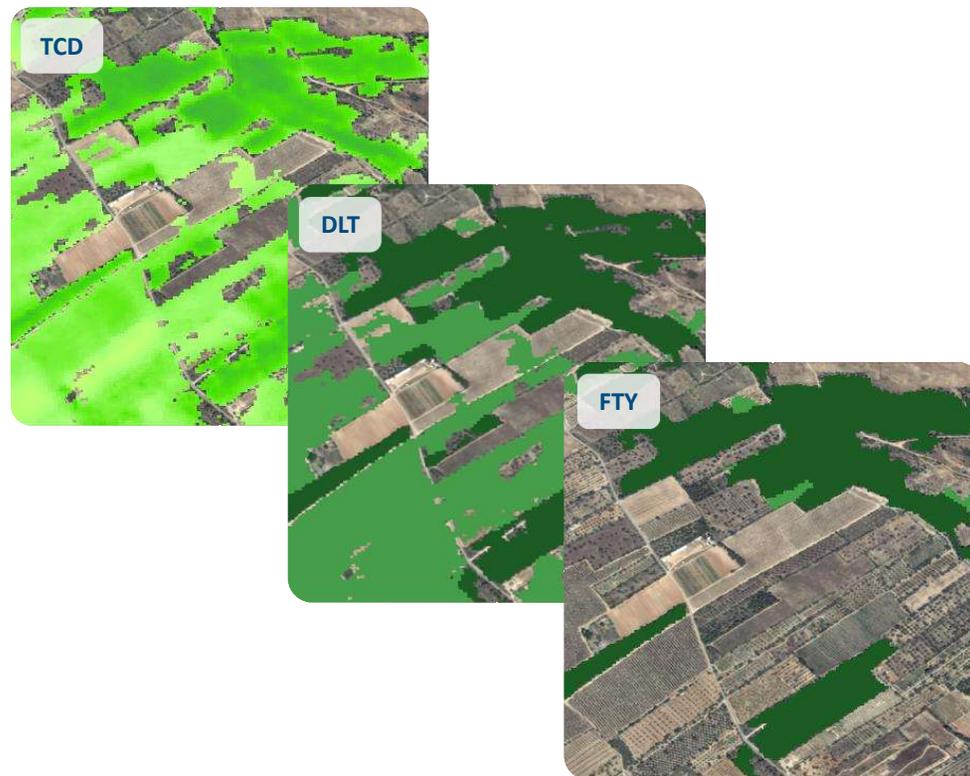
Annual from 2017
10 meter resolution
EEA38

Products:

- Crop Types (*17 classes*)
- Main crop practises
- Secondary crop practises
- Bare Soil detection
- Fallow Land detection
- Annual Crop Characteristics

HRL Tree Cover & Forests

- **Tree Cover Density (TCD) and Dominant Leaf Type (DLT) - Annual**
 - TCD: 0 – 100 % canopy density;
DLT: **Coniferous / Broadleaved** classification;
 - 10 meter resolution for EEA38+UK;
 - overall >90% accuracy with high spatial consistency
 - Change Layers.
- **Forest Type (FTY) – 3 yearly:**
 - FAO forest definition, filtering:
>10% TCD;
<0.5 ha MMU;
omitting **trees in agricultural and urban context.**

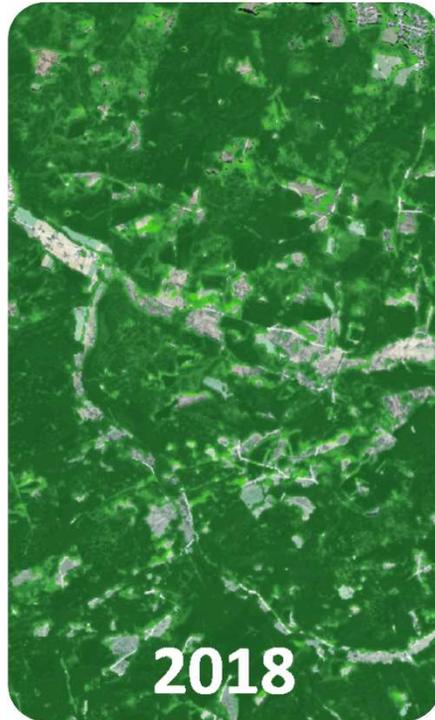


Annual Forest Monitoring

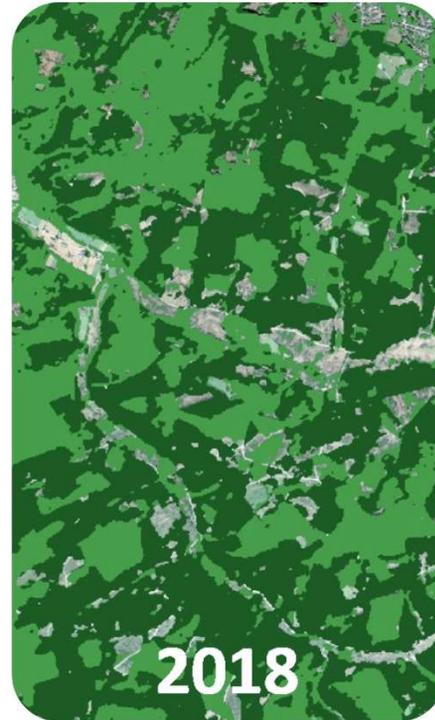
2018



Tree Cover Density



Dominant Leaf Type



2021



HRL Crop Types (CTY)

- Annual and continuous information opens **new possibilities** for policy applications
- What **analytics** and **indicators** for policy impact evaluation can be developed using Copernicus EO products?
 - Crop rotation and diversity
 - Bare soils and secondary crops
- How can these EO data streams be combined with IACS, in-situ, survey, and statistical data?



Crop Types 2021

0:	No Cropland
1110:	Wheat
1120:	Barley
1130:	Maize
1140:	Rice
1150:	Other Cereals
1210:	Fresh Vegetables
1220:	Dry Pulses
1310:	Potatoes
1320:	Sugar Beet
1410:	Sunflower
1420:	Soybeans
1430:	Rapeseed
1440:	Flax, cotton and hemp
2100:	Grapes
2200:	Olives
2310:	Fruits
2320:	Nuts



Cropping Patterns

Group	Metric	Unit
 Main Crops	Emergence	DOY
	Harvest	DOY
	Duration	Nr. Days
 Secondary Crops	Type	Cover Crop (L/S-Summer/Winter)
	Emergence	DOY
	Duration	Nr. Days
 Bare Soil	Before Main Crop	Nr. Days
	After Main Crop	Nr. Days
 Fallow Land	Presence	1: Fallow
	Duration	Nr. Days of timeseries (2017-2021)
 Cropping Seasons	Yearly Seasons	0, 1, 2
	Over 3 years	0, 1, 2, 3+

HRL Crop Types (CTY) – key messages from JRC

- **Robust European Union-wide level data** for EU policies increasingly needed – not only for the CAP >> but also for the Nature Restoration Law, Climate Law, Water Framework Directive, etc.
- **Copernicus Earth Observation based ‘impact’ indicators** are becoming a reality >> continuity in the product required
- Added value and appropriately position these new EO indicators in **existing policy evaluation frameworks**
- Optimize synergy with anonymized data from **IACS on interventions and farming practices** >> exploit and showcase uses



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HRL Grassland Portfolio



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HRL Vegetated Land Cover Plan

Production **2022-2023**: Expected to be delivered by **October 2025**

Production **2024**: Expected to be delivered by **March 2026**

Production **2025-2028**: Call for tender launched

Activity	2025				2026				2027				2028				2029			
	Q1	Q2	Q3	Q4																
T1: Ramp-up				■	■	■	■													
T2: Production 2025							■	■	■	■										
T3: Production 2026									■	■	■	■	■	■						
T4: Production 2027											■	■	■	■	■	■	■	■		
T5: Production 2028															■	■	■	■	■	■
T6: Production Tree species (2025 - 2028)									■	■	■	■	■	■	■	■	■	■	■	■
T7: Storage and Dissemination				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
T8: User Engagement, Uptake and Helpdesk				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
T9: Consultancy									■	■	■	■	■	■	■	■	■	■	■	■



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Small Woody Features

- **Harmonised information on linear structures** e.g. hedgerows and woody element areas.
- Maps woody vegetation at 5m resolution.
- Includes Street Tree Layer



(Viernheim, Germany)



CLMS – preparing for the future





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