



This project is funded by the European Union

## ENI SEIS II East

Implementation of the Shared Environmental Information System (SEIS) principles and practices in the ENP East region



Land Monitoring

# CLMS Copernicus land monitoring Service

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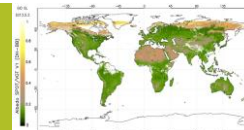


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# Copernicus Land Monitoring Service (CLMS)



Systematic Biophysical Monitoring



Land Cover & Land Use mapping



Thematic hotspot mapping



Reference data





# CLMS - Portfolio

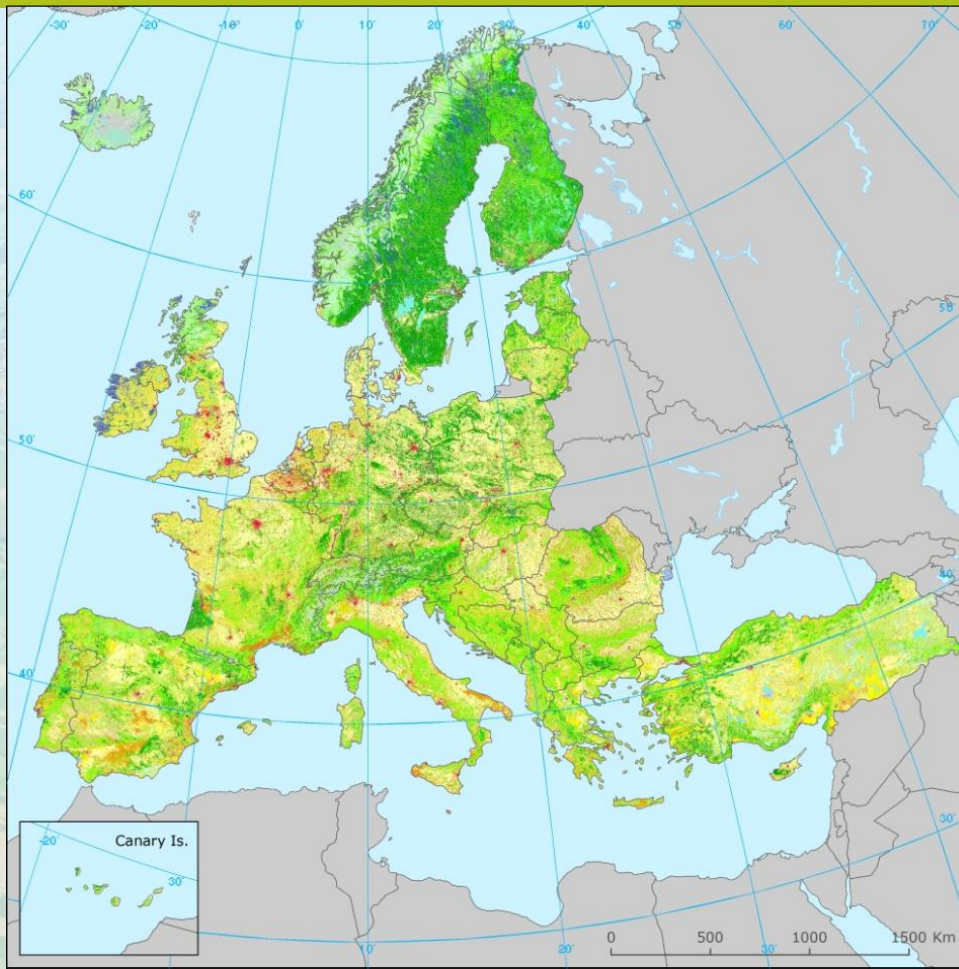
| Part of portfolio                 | Product name           | Individual products                                       | Spatial resolution                  | Reference years (grey: ongoing production or planned) | Status                                      |
|-----------------------------------|------------------------|---|-------------------------------------|---|---|
| Systematic Biophysical Monitoring | Snow and Ice           | FSC   | 20 m - 100 m (TBD)                  | continuous, starting with 2018 (TBD)                  | production start Q4-2018                    |
|                                   |                        | Permanent Snow line                                       | based on FSC                        | yearly, starting with 2018                            | production start Q4-2018                    |
|                                   |                        | River/Lake Ice  | 20 m - 100 m (TBD)                  | continuous, starting with 2018 (TBD)                  | production start Q4-2018                    |
|                                   | Phenology              | various phenological indicators and seasonal trajectories | 10 m - 30 m                         | continuous, starting with 2017                        | production start Q4-2018                    |
| Land Cover & Land Use Mapping     | CLC                    | LCLU Status and change                                    | 25 ha and 5 ha MMU                  | 1990/2000/2006/2012/2018                              | production 2018 ongoing                     |
|                                   | CLC+                   | CLC-backbone  | 0.5 ha - 1 ha MMU range (TBD)       | 2018  | production from 2019 onwards                |
|                                   |                        | CLC-core grid DB  |                                     |   | TBD   |
|                                   |                        | CLC+ instances (tailored)                                 |                                     |   | TBD   |
|                                   | High Resolution Layers | Imperviousness  | 20 m and 100 m                      | 2006/2009/2012/2015/2018                              | production 2018 start Q4-2018               |
|                                   |                        | Forest  | 20 m and 100 m                      | 2012/2015/2018  | production 2018 start Q4-2018               |
|                                   |                        | Grassland   | 20 m and 100 m                      | 2015/2018   | production 2018 start Q4-2018               |
| Wetness & Water                   |                        | 20 m and 100 m  | 2015/2018                           | production 2018 start Q4-2018                         |   |
| Small Woody Features              |                        | 0.02 MMU  | 2015/2018                           | production 2015 ongoing, 2018 TBD                     |   |
| Thematic Hotspot Mapping          | Urban Atlas            | LCLU Status and change                                    | class dependent MMU 0.25 ha or 1 ha | 2006/2012/2018  | production 2018 start Q1-2019               |
|                                   | Riparian Zones         | LCLU Status and change                                    | 0.5 ha MMU                          | 2012/2018   | production 2018 start Q1-2019               |
|                                   | Natura2000             | LCLU Status and change                                    | 0.5 ha MMU                          | 2006/2012   |   |
|                                   | Coastal Zones          | LCLU Status and change                                    | 0.5 ha MMU                          | 2012/2018   | production start Q4-2018                    |
| Reference Data                    | EU-DEM                 | EU-DEM  | 25 m                                | 2012  | revision ongoing                            |
|                                   |                        | Slope   | 25 m                                | 2012  |   |
|                                   |                        | Aspect  | 25 m                                | 2012  |   |
|                                   |                        | Hillshade   | 25 m                                | 2012  |   |
|                                   |                        |   |                                     |   |   |
|                                   | EU-Hydro               | Rivers (centerline and outline)                           | based on 2.5 m                      | 2012  | revision ongoing                            |
|                                   |                        | Inland waters   | based on 2.5 m                      | 2012  | revision ongoing                            |
|                                   |                        | Coastline   | based on 2.5 m                      | 2012  | revision ongoing                            |
|                                   |                        | Drainage network  | based on EU-DEM                     | 2012  | revision ongoing                            |
|                                   | Image Mosaics          | VHR   | 2.5 m                               | 2012/2015/2018  | production 2015 ongoing, 2018 start Q1-2019 |
| HR                                |                        | 20 m  | 2006/2009/2012/2015/2018            | production 2018 start Q1-2019                         |   |





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CLC time series: 1990 – 2000 – 2006 – 2012 – 2018



**Main use:** support to  
harmonised  
development of  
various EU policies



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# Imperviousness (IMP)

## Products:

- Built-up area & Imperviousness Degrees 2018 (10m)
- Reprocessing of 2012-2009-2006 (20m)
- Imperviousness (classified) change
- Imperviousness reference database

## Input Data:

- Multi-temporal optical HR composites (Sentinel-2, Landsat, SPOT-4 & -5, IRS-P6, ResourceSat-2) for 2018 +/-1 year plus HR IMAGE 2012/2009/2006
- VHR images & in-situ data (via CORDA)

## Main use:

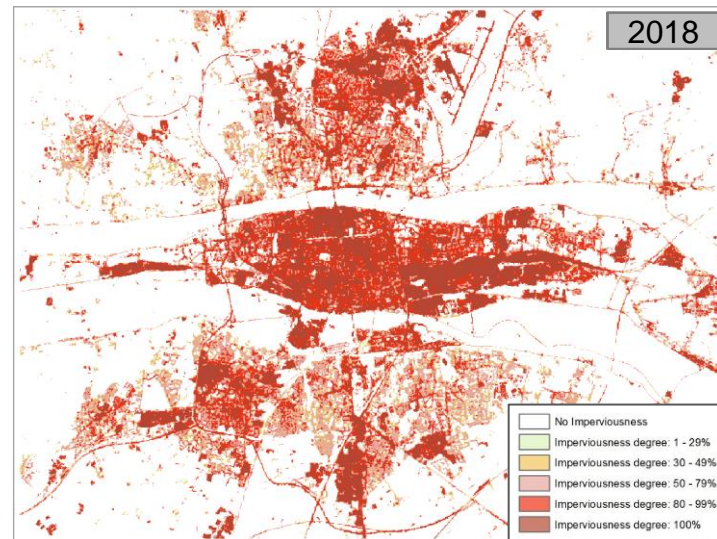
- support to harmonised monitoring of urban-industrial sprawl

GeoVille  
Information Systems



## Highlights:

High-quality information on  
imperviousness change in Europe  
(2006/2009/2012/2015).





## Products:

- Dominant Leaf Type (DLT) (20m)
- Tree Cover Density (TCD) (20m)
- DLT Change (20m)
- TCD Change (100m)
- Forest reference database

## Input Data:

- Sentinel-2, Landsat 8, HR Image 2015 (2015+/-1)
- HR IMAGE 2012, Landsat-8
- VHR IMAGE 2012 & 2015

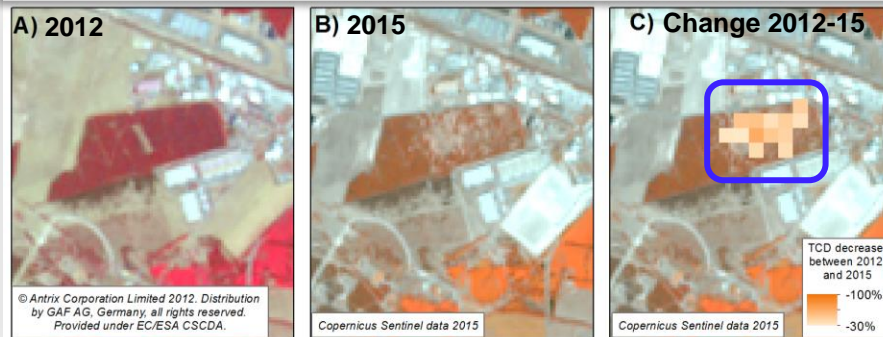
## Main use:

- Support to harmonised monitoring of forests

## Highlights:

Very high thematic accuracy, including change products (overall accuracy > 90%).  
Change products 2012-2015 with up to 14 thematic classes.

### Tree Cover Density Change Layer 2012-2015 (100m)







## Products:

- Permanent Grassland Mask (20m)
- Grass Vegetation Probability Index (*additional product for expert users, 20 m*)
- Ploughing Indicator (*additional product for expert users, 20m*)

## Input Data:

- Sentinel-1: (2015+/-1: 30 amplitude & short-term coherence images)
- Sentinel-2/Landsat8 (2015+/-1)
- Landsat 5-8/HR IMAGE 2012 (2008-2013)

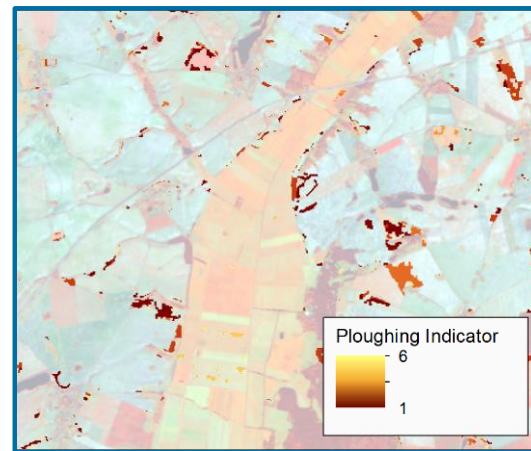
## Main use:

- Support to harmonised monitoring of grasslands

## Highlights:

- First high-resolution retrieval of both managed and (semi-)natural grasslands on continental scale.
- Optical-SAR multi-temp/multi-seasonal evaluation.
- New multi-year product (ploughing indicator).

## First Results:





## Products:

- Classified Water & Wetness product (20m)
- Water Wetness Probability Index from...  
...2009 to 2015 (20m)  
*(additional product for expert users, 20m)*

## Input Data:

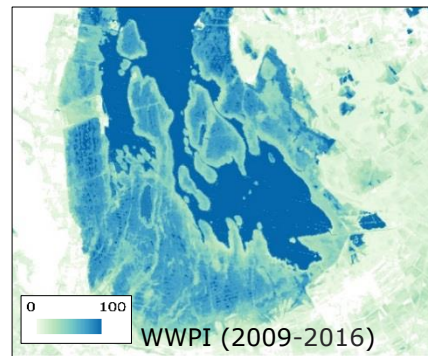
- Multi-temporal optical HR composites: SPOT, ResourceSat, Sentinel-2, Landsat (2009-15)
- Multi-temporal SAR data: Sentinel-1 (since 2014), ENVISAT-ASAR, METOP-Ascat (since 2004)
- Soil moisture calibration database
- VHR images & in-situ data (via CORDA)

## Main use:

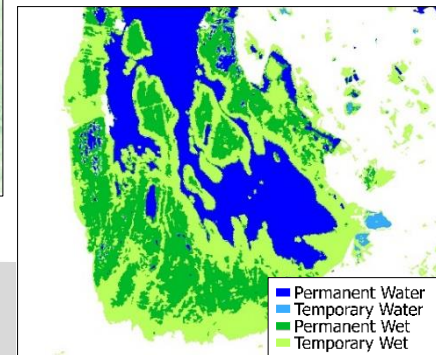
- Support to harmonised monitoring of water bodies

## Highlights:

New high-quality information on water & wetness presence in Europe on HR scale (2009-2016 multi-year products)



Water Wetness  
Probability Index



Water & Wetness  
(classified product)





# Small Woody Features (SWF) 2015

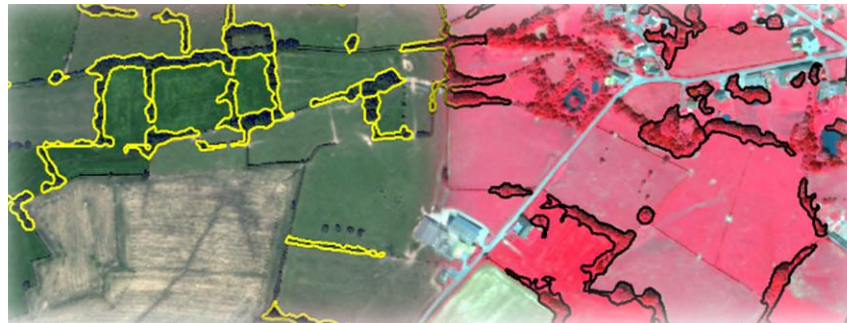
Available at <https://land.copernicus.eu/pan-european/high-resolution-layers/small-woody-features/small-woody-features-2015>

## Product

- SWF 2015 includes
  - Linear hedgerows and scrubs
  - Tree rows
  - Isolated patches of trees
- *Elements to be excluded*
  - *Stone walls*
  - *Drainages ditches*
  - *Grass margins, field boundaries without trees or hedges*
  - *“Grey infrastructure”*
  - *Artificial tree rows like olive tree plantations*

## Main use:

- Support to monitoring of high nature value in farming areas



## Geometric specifications of SWF

|                    | Linear Structures | Patchy Structures                             |
|--------------------|-------------------|---|
| <b>Width</b>       | ≤20m              | n/a   |
| <b>Length</b>      | ≥50m              | n/a   |
| <b>Compactness</b> | ≤ 0.65            | > 0.65  |
| <b>Area</b>        | n/a               | 200m <sup>2</sup> ≤ area ≤ 5000m <sup>2</sup> |



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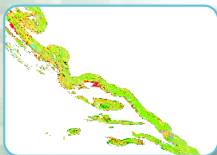
## Local Component-Overview

- Vector based Very High Resolution Land Cover & Land Use mapping of hotspot areas
- Minimum Mapping Unit between 0.25ha - 1ha
- Tailored nomenclature based on CORINE
- 6 year cycles: status and change mapping
- Urban Atlas (UA), Riparian Zones (RZ), Natura 2000 (N2K) and Coastal Zones (CZ)

UA  
2006-12-18



CZ 2018



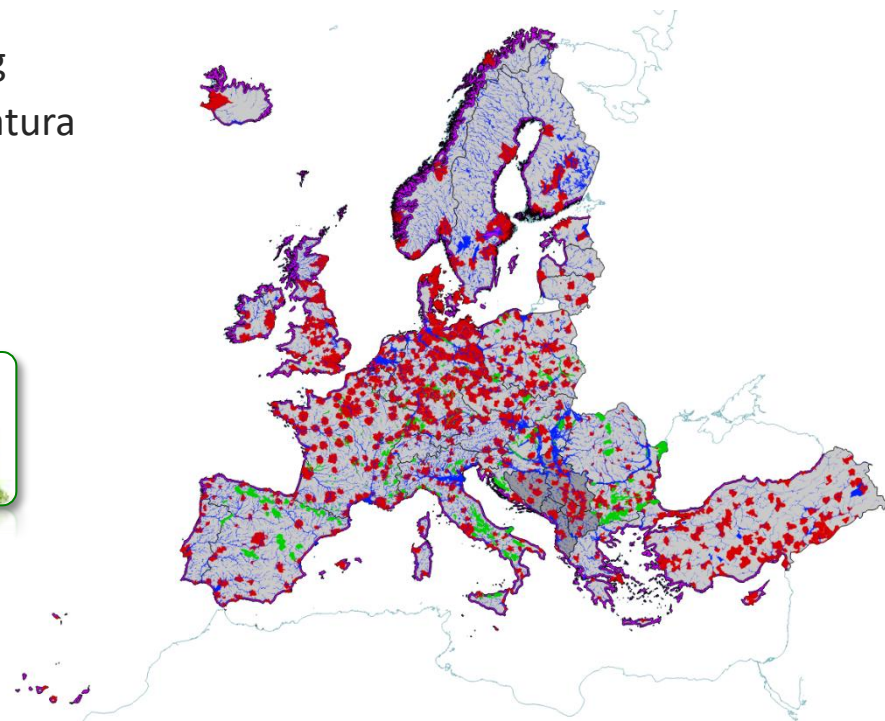
RZ  
2012-18



Snow & Ice



N2K  
2006-12

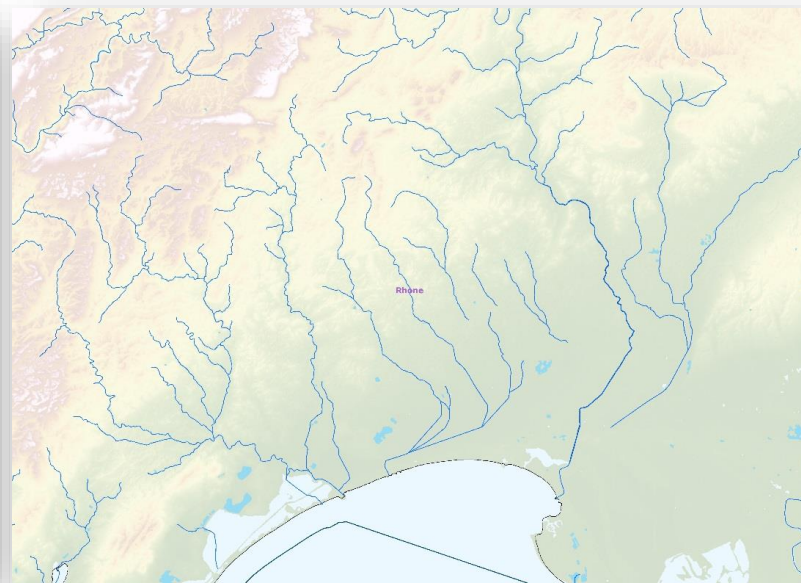




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## Reference data: EU-DEM & EU-Hydro

- EU-DEM: Digital Elevation Model with 30 metre spatial resolution. It is a hybrid product based on SRTM and ASTER GDEM data. Upgrade on-going
- EU-Hydro: river network and a drainage model with catchments and drainage lines derived from EU-DEM





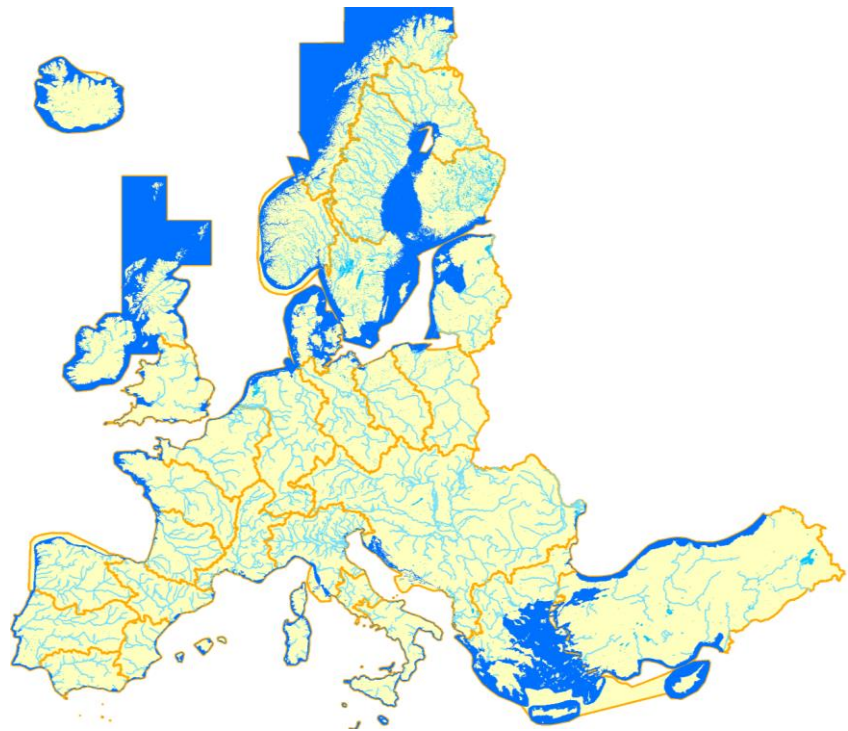


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## EU-Hydro

**EU-HYDRO is a database for all EEA39 countries providing:**

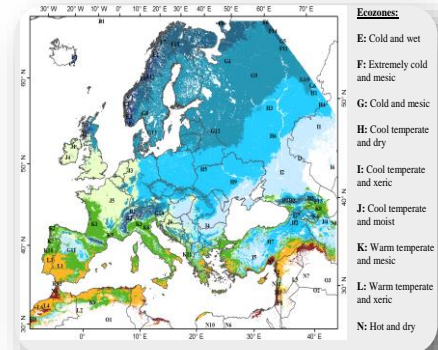
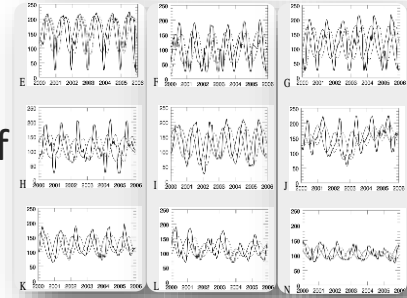
- **Photo-interpreted river network** derived from VHR data
  - Water bodies and wide rivers
- **Drainage Model** derived from EU-DEM
  - Catchments and drainage lines and nodes.
- **Update with improvements and error corrections in late 2018**





## High Resolution Phenology product (production ongoing)

- Based on Sentinel-2 time series, 10m spatial resolution
- Two main products:
  - **Phenology parameters:** Dates and values at Start of Season (SOS), End of Season (EOS) and seasonal maximum. Length of the growing season (LOS), amplitude, base value, and seasonal integral values.
  - **Seasonal trajectories:** The reconstructed vegetation index time-series, which are input to the phenology detection. e.g. daily, 10-day, monthly, and yearly upon user's request.
- Possible Use:
  - Agriculture (crop types, management intensity)
  - CC impact assessment (changes in growing season, impacts of droughts, forest fires, floods etc)
  - Improvement of production of other CLMS products and LU/LC mapping in general





# Current update frequency for various products

| Product                           | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|-----------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Imperviousness                    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Forest, Water, Wetland, Grassland |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| CLC                               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Urban Atlas                       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Riparian zones                    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| State of Environment Report       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |





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# Evolution of the service

challenges and opportunities  
(Future of Copernicus)





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## Copernicus land monitoring – service evolution

### New and existing demands:

- LULUCF (Land Use, Land Use Change and Forestry) monitoring, reporting and verification - Climate and Energy 2020-2030 framework
- Monitoring agri-environment-climate measures – CAP (Common Agriculture Policy) reform
- Sustainable Development Goals – Agenda 2030
- Use in ecosystem accounting, and increased use in EEA assessment work in general

### Known gaps and ongoing improvements:

- Annual/more frequent update frequency of selected products
- Some products more and some less mature. Change data not available (yet) for all products
- Crop type products missing
- Gap: more land use information, and products dealing with qualitative changes / intensity of use changes (including rates and trajectories of change)
- Ongoing: Increased use of CLMS (Copernicus Land Monitoring Service) products in indicators and through web-map services to facilitate use in assessments and reports across EEA (Integrated Data Platform data viewer, and contextual data inventory)



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## Requirements summary: driver for new concept for CLC+

- Summary of requirements review
  - MMU 0.5 to 5 ha, 0.5 to 1 ha for LULUCF
  - Change layer MMU = status layer MMU
  - Revised thematic content (more classes, increased characterisation)
  - 3 year to yearly update cycle
  - Pan-European coverage (EEA-39)
- Aspects of ....
  - Current CLC
  - Local Components
  - HRLs
  - EAGLE Group developments







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## CLC+ Backbone

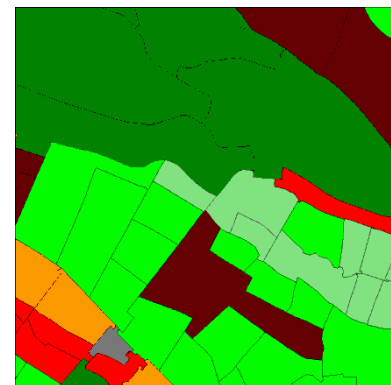
CLC-Backbone

CLC-Core

CLC+

CLC-Legacy

- Basic land cover inventory
- Wall-to-wall coverage (EEA-39)
- Complete the picture started by the LoCo which cover one third of EEA-39
- Spatially detailed, large scale
- Vector format
- Based on digital cartography and EO
- **Geometric backbone – high quality**
- **thematic detail – limited, but robust**
- Framework to build other products
- Production ongoing (to be finalised mid-2021)





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## CLC+ Core

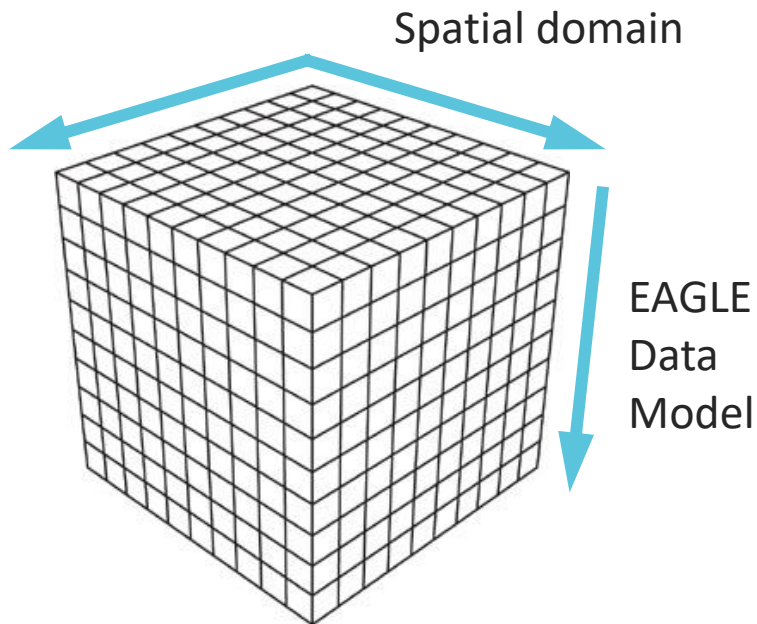
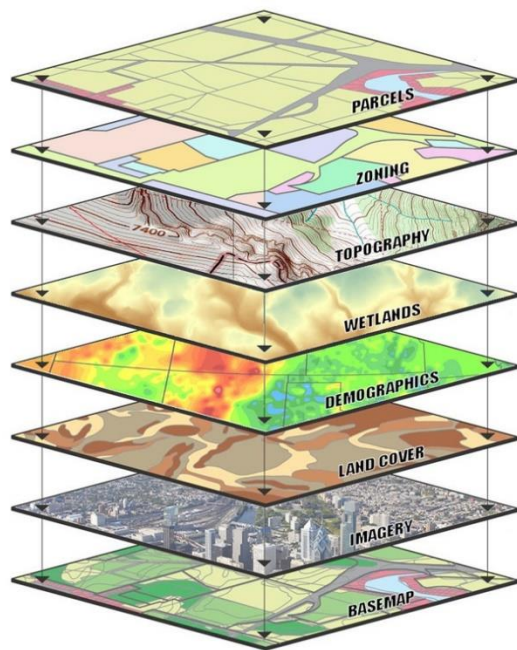
CLC-Backbone

CLC-Core

CLC+

CLC-Legacy

CLC+ Core is a consistent multi-use grid database repository for environmental land monitoring information populated with a broad range of land cover (including but not limited to CLC+ Backbone), land use and ancillary data from the CLMS and other sources, forming the information engine to deliver and support tailored thematic information requirements.



Source: CSU,  
<http://heleneloyan.cikeys.com/update/gis-layers/>



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## CLC+ Instance

CLC-Backbone

CLC-Core

CLC+

CLC-Legacy

- Tailored instances:
  - An improved LULC monitoring product relative to CLC
  - Multi-functional geospatial dataset
  - Addressing a broad range of requirements at European, national and regional scales
  - Based on CLC+ Backbone and CLC+ Core, along with the hotspot components and HRLs
  - Expand the mapping philosophy away from single attribute thematic classification



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## Existing and planned EEA indicators based (partly) on Copernicus data

- Land take (based on CLC): existing
- Imperviousness and imperviousness change
  - (existing for 2009-2012-2015, update for 2006-209-2012-2018 in preparation)
- Urban sprawl ‘indicator’ (developed and published, but not implemented)
- Land recycling ‘indicator’: existing
  - Based on Corine LC and Urban Atlas LC change flows 2006-2012
  - Set of 13 (sub)indicators
- Landscape fragmentation published end 2017
  - Based on HRL Imperviousness 2012 with corresponding Open Street Map (OSM) transport networks
- Forest indicator(s) (in preparation 2018/2019)
  - Partly based on Copernicus forest products
- Grassland (in preparation)