Evoland
LAND MONITORING EVOLUTION

D5.10 EvoLand results portal – final version

Work Package 5 - Communication, Dissemination and Exploitation

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1 Introduction

The EvoLand project ("Evolution of the Copernicus Land Service portfolio") aims to expand and modernize the Copernicus Land Monitoring Service (CLMS) by integrating novel Earth Observation (EO) data sources and the latest machine learning algorithms to enable continuous monitoring of the status, dynamics, and biomass of the land surface across Europe and beyond. Within this context, Deliverable D5.11 – EvoLand Results Portal (Final Version) presents the implementation and finalization of the project's results portal, a key component of Work Package 5 – Communication, Dissemination and Exploitation.

The EvoLand Results Portal serves as the main visualization and access platform for the project's prototype products. It provides an interactive environment through which users, stakeholders, and project partners can explore, analyse, and assess the outputs generated during the project's two development phases. The portal is built upon the Copernicus Data Space Ecosystem (CDSE), leveraging the "Bring Your Own COG" (BYOC) functionality of Sentinel Hub to ensure efficient access, visualization, and sharing of data stored on EvoLand's dedicated S3 infrastructure. By adopting this approach, EvoLand demonstrates how existing Copernicus services and infrastructures can be effectively utilized to enhance the visibility, usability, and sustainability of research outputs.

This deliverable describes the final version of the EvoLand Results Portal, including the methodology, technical implementation, and user access instructions. Chapter 2 provides an overview of the prototype viewer, outlining its functionality, architecture, and examples of visualization workflows. Chapter 3 explains how to access and interact with the prototypes via the Copernicus Browser. Finally, Annex I offers detailed descriptions of each prototype, covering their objectives, data inputs, specifications, and examples.

Overall, the EvoLand Results Portal represents a tangible step toward improving transparency, accessibility, and reusability of Copernicus research results. It provides a practical demonstration of how innovative EO-based services can be disseminated and evaluated in a collaborative and interoperable way, paving the path for their potential integration into the future Copernicus 3.0 CLMS portfolio.

2 Description of the prototype viewer

The EvoLand Results Portal is designed to offer easy access to the project results. This does not only allow data producers (in our case, prototype developers) to gain different insights into their results but it is also intended for dissemination to the public and reporting to project officers and reviewers. A picture is worth a thousand words and an interactive visualization even more (**Error! Reference source not found.**): it also provides a more concrete and comprehensible representation of the work done that can be explored and compared to other sources of information.

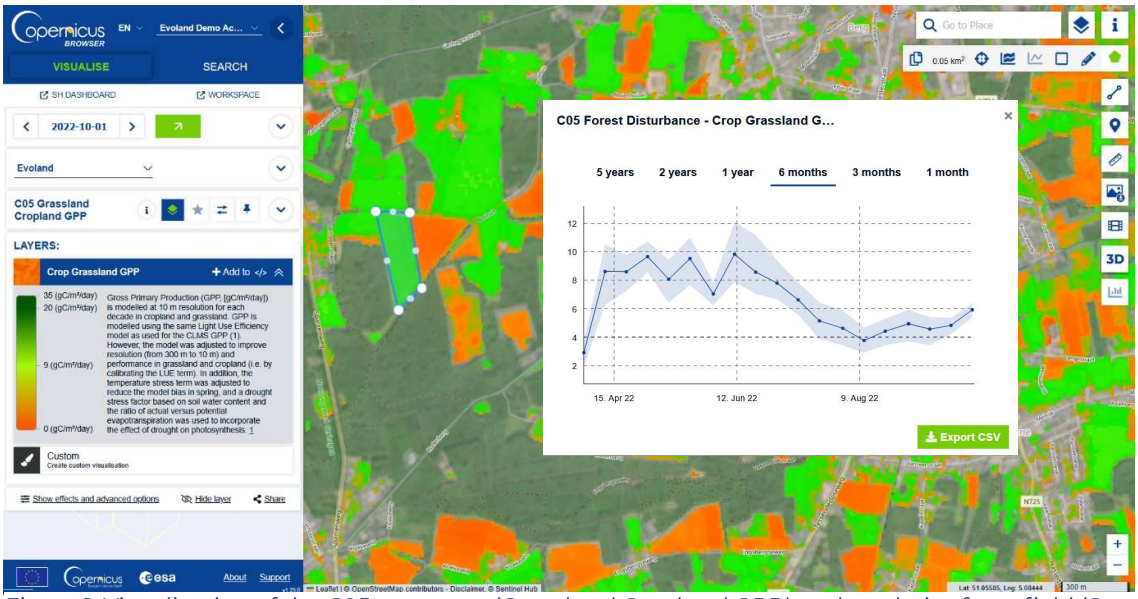


Figure 1: Visualization of the C05 prototype (Grassland Cropland GPP) and analysis of one field (6-months gross primary production) using Copernicus Browser.

The prototypes are hosted on a dedicated EvoLand S3 bucket provided by CloudFerro, which allows for easy and collaborative access. We explored solutions that could directly access and use this type of data storage, avoiding the need to duplicate the data elsewhere. We selected the Copernicus Data Space Ecosystem[1] (CDSE) because:

- having ability to directly access the data from an S3 bucket,
- providing a straightforward way to reference/prepare the data for visualization, and
- Offering an interactive way to visualize and explore the data using Copernicus Browser.

[1] https://dataspace.copernicus.eu/

To get the data into Copernicus Browser we utilized the "Bring your own COG" (BYOC) functionality offered by Sentinel Hub within the CDSE. Since the prototype results were prepared in the GeoTIFF format, all we had to do was:

- Transform the GeoTIFFs into Cloud Optimized GeoTIFFs (COGs),
- Set the correct access rights to the S3 bucket so the Ecosystem could access/read the data
- Ingest the tiles (reference them in the CDSE catalogue).

We followed the instructions as described here.

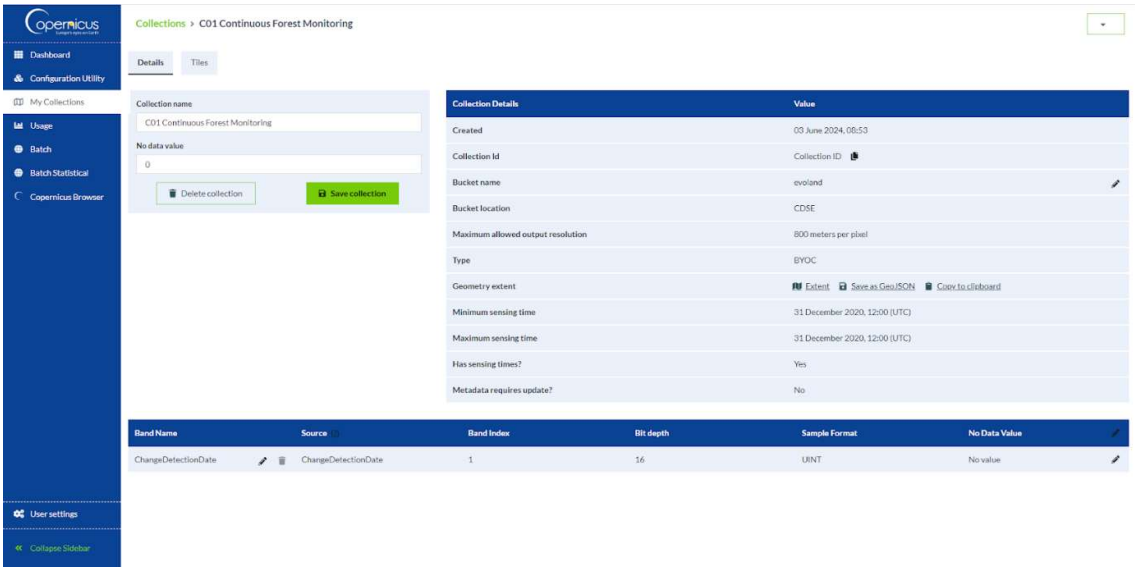


Figure 2: C01 Continuous Forest Monitoring collection as ingested into the Copernicus Data Space Ecosystem (dashboard visualization).

Once the data was ingested into Sentinel Hub, the final step was visualizing it through Copernicus Browser. For this we created a dedicated test account (to restrict the data access to this account – only relevant for the interim version of the Results Portal) and prepared nice visualization options utilizing Sentinel Hub's Evalscripts[2], including custom legends for each of the prototypes. Adding legends is natively supported by the Browser, we simply had to define the colour per label/class. A guide on how to set up custom visualizations in Copernicus Browser can be found here.

With all the data available within the CDSE, we closely examined and analysed the data using the Browser's built-in functionalities.

With just a few clicks, we were able to:

- Navigate the data on a map and compare it with different background layers (e.g., OpenStreetMap, Sentinel-2 mosaics)

[2] https://documentation.dataspace.copernicus.eu/APIs/SentinelHub/Evalscript.html

- Create nice timelapse animations (C10 Land surface characteristics example below),
- Use the compare functionality to compare different dates and collections in the same view (e.g., gross primary grassland production with the corresponding Sentinel-2 image),
- Calculate data statistics (time series, histograms),
- Download the data (visualization or raw data) for further use.

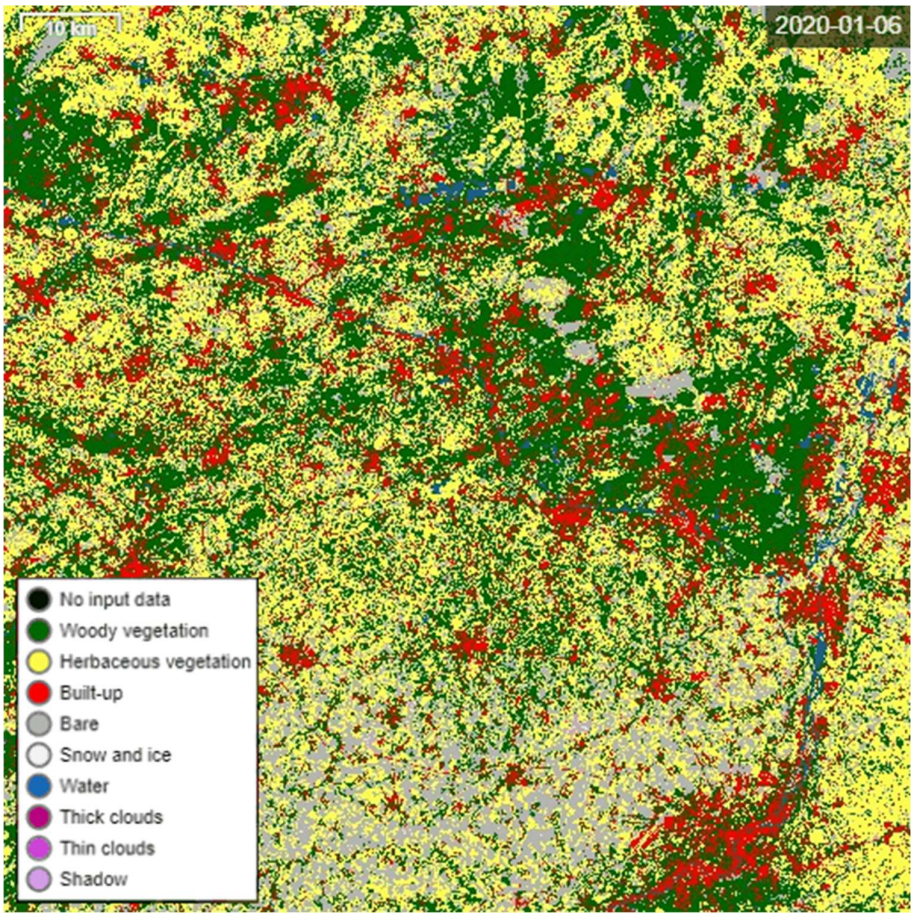


Figure 3. Land surface prediction (C10 Land Surface Characteristics)

Using the CDSE as a service within our project, we were also able to give some valuable feedback to the developers, some of which was immediately implemented. This not only improved our data presentation but also contributed to a better experience for similar use cases in the future.

We believe this use case is a great example of how leveraging existing tools and functionality can create synergies, and we hope to see more of such cross-European project efforts in the future.

Utilizing Copernicus Browser for visualizing the EvoLand intermediate results not only provided the CDSE with another use case and valuable feedback but also enabled the EvoLand project to focus on value creation (improving algorithms, testing, etc.) rather than reinventing the wheel.

Update for the final version of the report: For the final data integration within the results portal, we followed the same data ingestion steps as outlined above with some optimisation on our data ingestion pipeline due to the much larger volume of data within phase 2. To accommodate some of the phase 2 improvements on the prototypes we had to update some of the custom scripts and legends to better represent the phase 2 results.

3 Accessing the prototypes

Within the final version of the Results Portal, we improved the ease of accessibility, and now everyone can visualize the 12 prototypes without needing an account or login.

To visualize the data please following these steps:

1. Go to: https://browser.dataspace.copernicus.eu/?zoom=5&lat=50.16282&lng=20.78613&themeId=EVOLAND-THEME&useEvoland=true
2. Select the prototype of your choice (C01 – C12).
3. Select a footprint on the map and click “show latest date” or zoom in to an area of your choice and click the “Show latest date” button

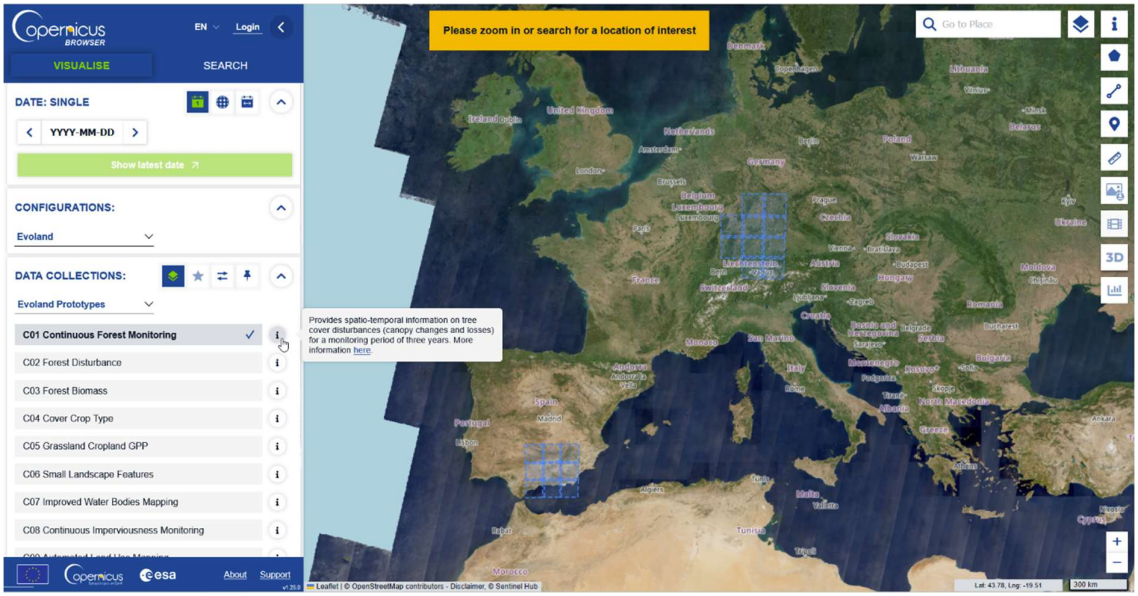


Figure 4: Evoland configuration integrated within Copernicus Browser

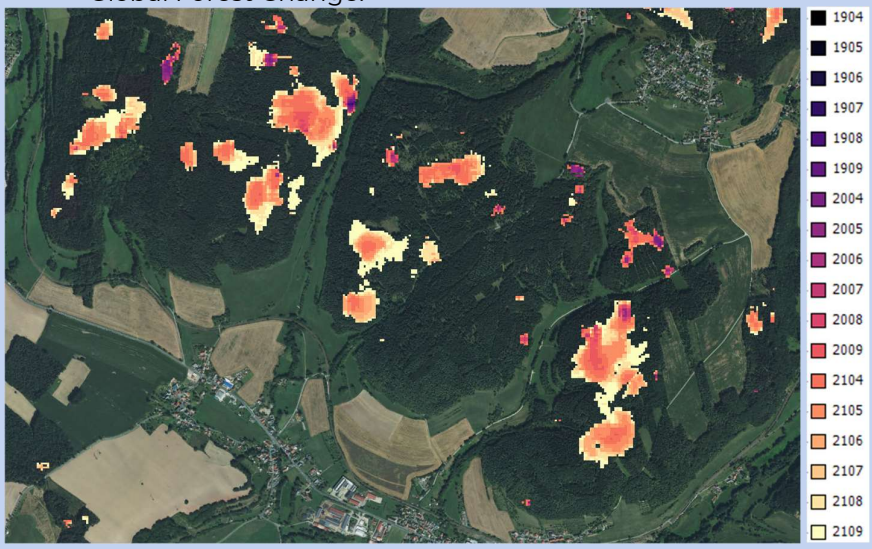
Note that some prototypes have several visualization options (e.g., C10 with the prediction and the different probabilities), while others include time series with multiple dates (e.g. C07)

Feel free to explore and play around with all functionalities. If you want to learn more about the Results Portal we recommend looking at the Results Portal subpage within our EvoLand website here.

For general questions around the different features within the Browser you can take a look at the Copernicus Browser documentation here.

Annex I: Prototype descriptions

C1 Continuous forest monitoring

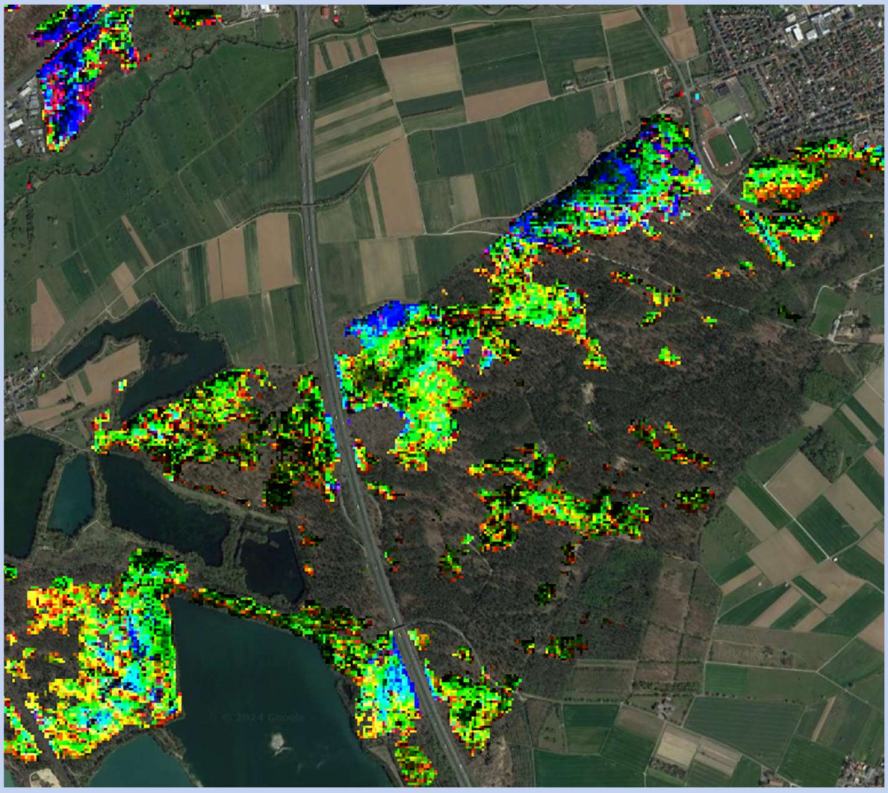
	Description
Pin ID	C01 Continuous Forest Monitoring
Aim	The candidate prototype C1 - Continuous Forest Monitoring aims at extending the portfolio and scope of the Forestry products, mainly the current HRL Vegetated Land Cover Characteristics (VLCC) Forest products, by improving the update frequency of the forest mask in order to depict the change dynamics within tree covered areas and also to serve as an input to the forest disturbance agent classifier (C2).
Improvements	- Pan-European prototype on forest dynamics at high temporal frequency = new prototype not yet part of CLMS portfolio - Improvement of temporal resolution with respect to HRL Forest and VLCC: from 3-yearly to yearly with monthly resolution - Improvement of the spatial resolution for tree cover changes from 20m to 10m
Input data	- Sentinel-2 time series (monthly median features) - HRL DLT for the derivation of a tree cover mask
Specifications	- Content: detection of tree cover canopy change/loss (date, extent) - Test sites: Central Europe, Spain, Sweden - Spatial resolution: 10m - Temporal resolution: yearly products with monthly resolved change information - Raster format in ETRS LAEA projection - Validation: reference dataset created from: multitemporal VHR, Sentinel-2 time series, Remote sensing based National Detection System for Forest Damages (FNEWSs), European Forest Fire Information System (EFFIS), Tree Cover Disturbance Monitoring (TCDM), European Forest Disturbance Atlas (EFDA), Global Forest Change.
Example	

C1 Prototype: Forest change date and extent detection in Germany on a monthly basis for the years 2019 to 2021.

C2 Forest disturbance mapping

	Description
Pin ID	C02 Forest Disturbance Mapping
Aim	The candidate prototype C2-Forest Disturbance Mapping aims at deriving the cause (i.e. the driver) of a forest disturbance event. The following disturbance agents are defined in the EvoLand project: (i) insect infestation (focus on bark beetle), (ii) clear cut and thinning activities, (iii) healthy forest, events of (iv) subsequent human-induced forest clearing to prevent further damage or spread of pest (i.e. salvage logging), (v) wildfire and vi) wind throw/storm damage.
Improvement	- Pan-European prototype on forest disturbance agent classification = new prototype not yet part of CLMS portfolio
Input data	- Sentinel-2 time series - Monthly forest change detection results from prototype C1
Specifications	- Content: Forest disturbance agent classification on probability basis - Test sites: Central Europe, Spain, Sweden - Spatial resolution: 10m - Temporal resolution: scene-based, merged with monthly forest changes (example in viewer covers time scale of 2019-2020) - Raster format in ETRS LAEA projection - Validation: reference dataset created from: multitemporal VHR, Sentinel-2 time series, Remote sensing based National Detection System for Forest Damages (FNEWSs), European Forest Fire Information System (EFFIS), Tree Cover Disturbance Monitoring (TCDM).

Example

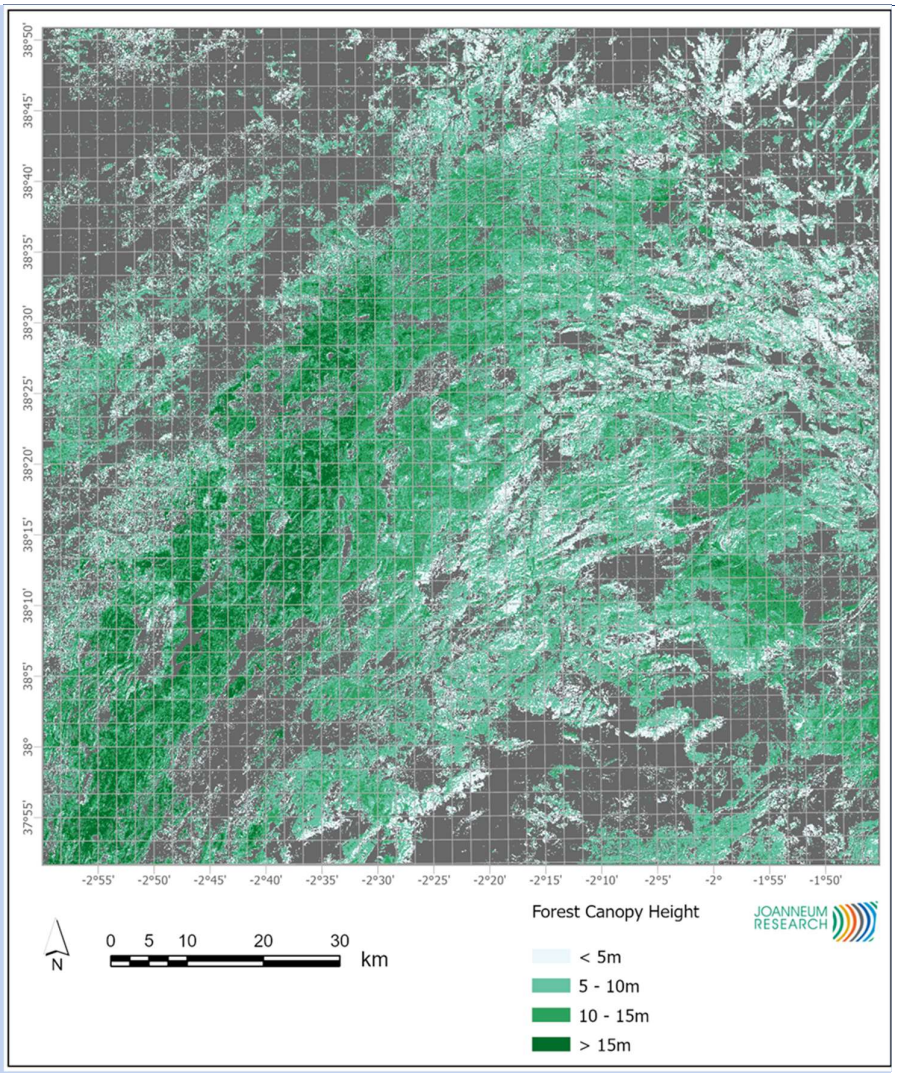


C2 Prototype: RGB colour composite of the probabilities for the disturbance agent classes: bark beetle infestation (displayed in red), wind throw (displayed in green), and clearing/clear cut (displayed in blue), for every pixel at its time of disturbance detection (= C1 prototype) for a wind throw event followed by forest clearing in Germany.

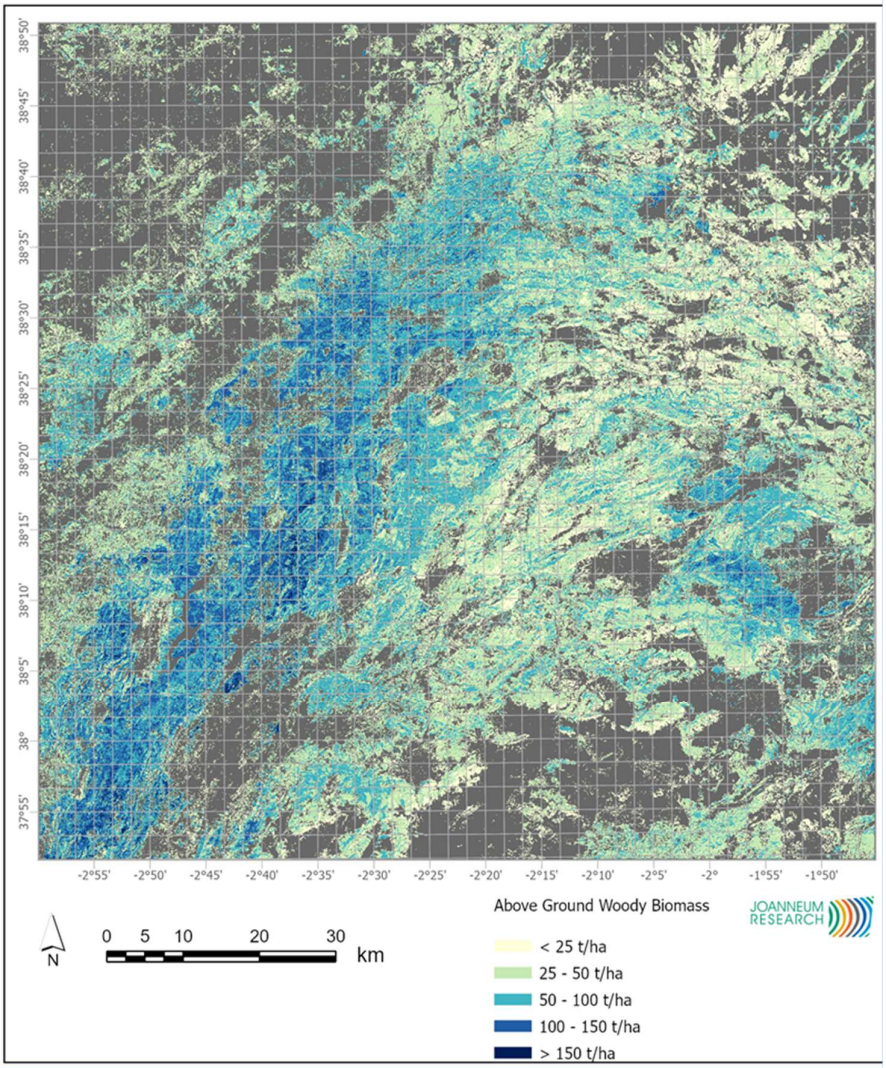
C3 Forest biomass mapping

	Description
Pin ID	C03 Forest Biomass Mapping
Aim	The candidate prototype C3-Biomass consists of two main products: Forest (or Tree Cover) Canopy Height (FCH) and Above-ground biomass (AGB), targeting woody biomass.
Improvements	- Pan-European prototype on Above-Ground Woody Biomass (AGB) and Forest Canopy Height (FCH) = new prototype not yet part of CLMS portfolio.
Input data	- ALOS PALSAR - Sentinel-2 time series - Sentinel-1 time series - Copernicus DEM - Training data: NFI in-situ data, GEDI (spaceborne LiDAR), airborne LiDAR, other existing products
Specifications	- Content: Above-Ground Woody Biomass (AGB) in Mg/ha; Forest Canopy Height (FCH) in meters - Test site: Sweden, Spain - Spatial resolution: 10m (Phase 1 products with MMU 0.5 ha) - Temporal resolution: yearly - Raster format in ETSR LAEA projection - Validation: NFI in-situ data, GEDI (spaceborne LiDAR), airborne LiDAR, other existing products.

Example



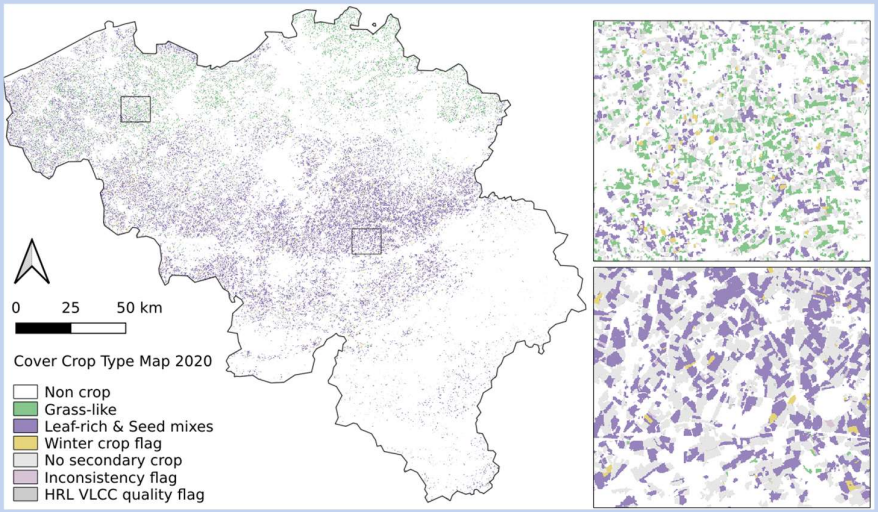
C3 Prototype: Forest Canopy Height (FCH) in meters, displayed for the prototype site in Spain (FCH increases from light green to dark green colours)



C3 Prototype: Above-Ground Woody Biomass (AGB) in Mg/ha, displayed for the prototype site in Spain (light yellow and green colours depict lower ABG, blue to dark blue colours higher ABG).

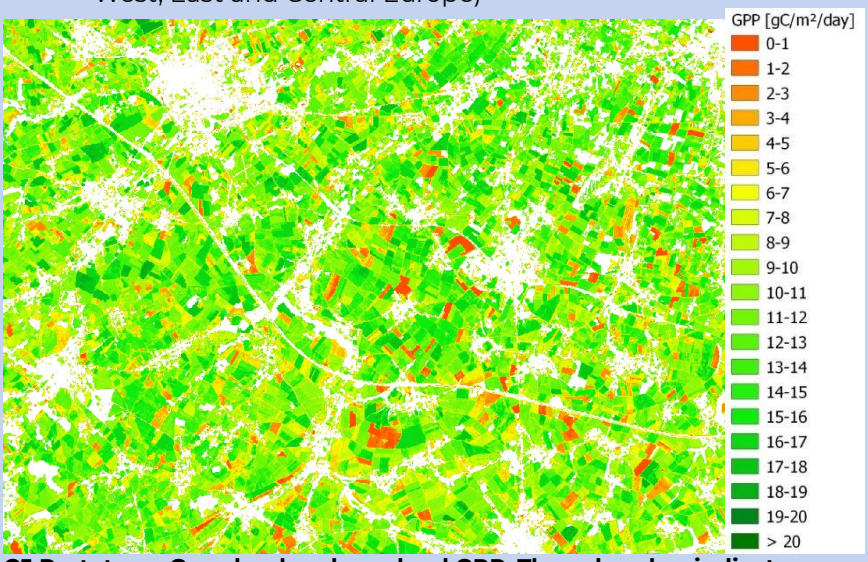
C4 Cover crop type mapping

	Description
Pin ID	C04 Cover Crop
Aim	The VLCC service aims already at providing information on when and where cover crops are being grown but doesn't distinguish between the cover crop type. The aim of this candidate is therefore to develop a prototype service to map cover crop types at 10m resolution.
Improvements	- Operational grouping achieved: two classes — grass-like (e.g., oats, rye) and leaf-rich & mix (e.g., mustard, rapeseed; seed mixes). - Validated across two seasons (2019, 2020) - Good temporal transferability season-to-season.
Input data	- HRL VLCC secondary crop products (Occurrence, emergence and duration) - Sentinel-2 bands and NDVI
Specifications	- Test site: Belgium (31UFS) - Spatial resolution: 10m - Temporal resolution: yearly, 2021 - Raster format in UTM projection - Validation: with LPIS (Flanders) secondary crop declarations - Performance: Overall accuracy = 81% (both 2019 & 2020); F1 = 0.73 (grass-like), 0.85 (leaf-rich & mix).
Example	



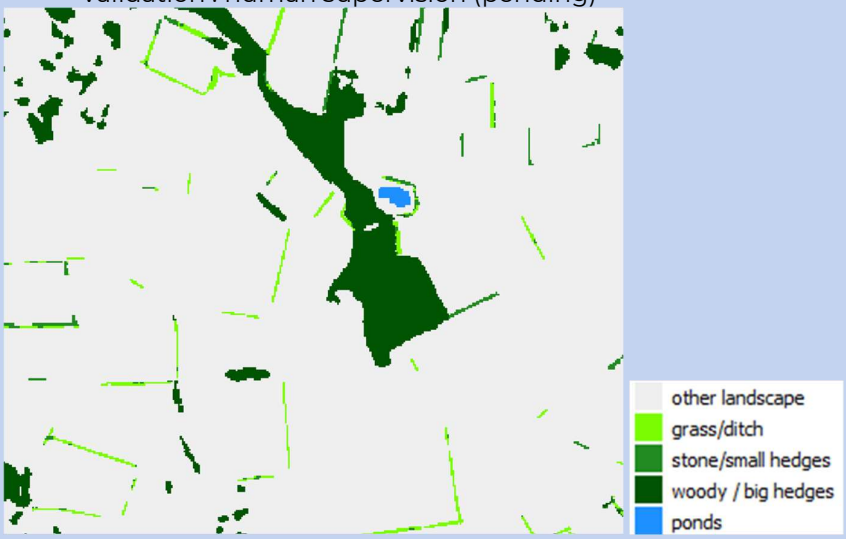
C4 Prototype: Cover crop classification with grass-like, leaf-rich and mixed, winter crop and no secondary crop classes.

C5 Cropland/grassland GPP monitoring

	Description
Pin ID	C05 Grassland Cropland GPP
Aim	Improve existing gross primary production estimations available on CGLS (300 m), with focus on crop and grassland.
Improvements	- Resolution improvement from 300 m to 10 m (using Sentinel-2) - Optimization for grass and cropland (i.e., calibration of maximum light use efficiency term of the GPP model) - Inclusion of drought stress factor directly in the GPP model - Adjustment of the temperature stress factor to improve model performance in early spring and winter.
Input data	- ERA-5 land (ECMWF): temperature, soil water content, ETact/pot and radiation information - Sentinel-2 FAPAR derivation - WorldCover (temporarily): crop and grassland locations.
Specifications	- Indicator: gC/m²/day - Test sites: Belgium (31UFS) - Spatial resolution: 10 m - Temporal resolution: 10-daily, 2022 (currently) - Thematic accuracy: different parameters for crop/grassland - Raster format in LAEA (or UTM) projection - Validation: with ICOS data (data from 21 towers were used) & CGLS 300m GPP (150 random test samples for 2018, 2021 in West, East and Central Europe)
Example	

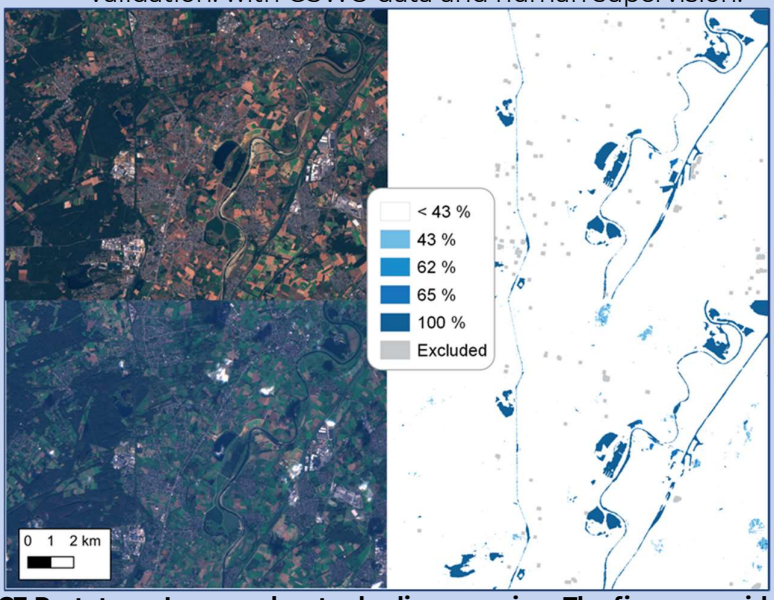
C5 Prototype: Grassland and cropland GPP. The colour bar indicates a range from sparse (red) to dense (dark green) GPP which is expressed in gC/m²/day.

C6 Small landscape features mapping

	Description
Pin ID	C06 Small landscape features mapping
Aim	Improve existing SWF product by adding new classes, and switch to 2.5m spatial resolution
Improvements	- Resolution improvement from 5m to 2.5m for woody classes using Pleiades imagery - Inclusion of “non productive agricultural features” class from Sentinel-2 super resolution data) - Sub-division of new class - Production at larger scale - Include 3D data
Input data Specifications	- Pleiades Sentinel-2 Super-resolution time series - Test site: Belgium, Spain, Eastern Europe - Spatial resolution: 5m - Temporal resolution: yearly (2020 and 2022 currently) - Thematic accuracy: target of 80% user/producer accuracy - Raster format in LAEA (or UTM) projection - Validation : human supervision (pending)
Example	

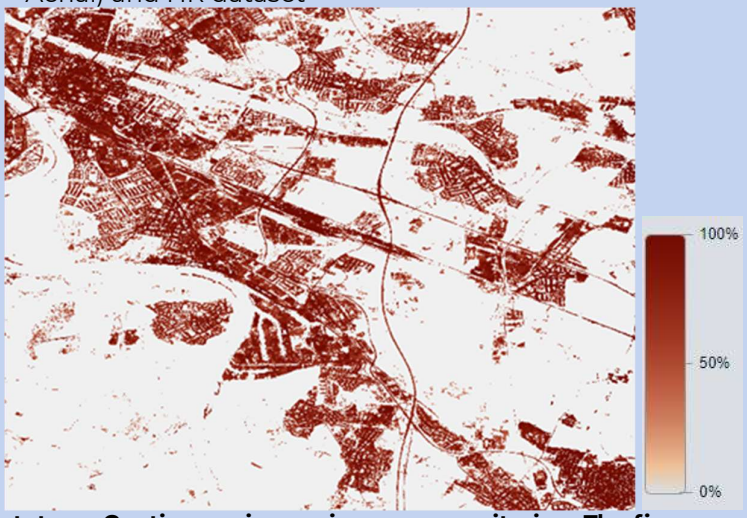
C6 Prototype: Small landscape features. The image shows a classificationof Small Landscape Features .

C7 Improved water bodies mapping

	Description
Pin ID	C07 Improved water bodies mapping
Aim	Enhance current CLMS products (Copernicus High-Resolution Layer Water and Wetness; Copernicus Global Land Monitoring Water Bodies) for water area delineation.
Improvements	- Resolution improvement from 100m to 10 m (using Sentinel-2). - 3-year / Monthly to daily. - Detection of new or ephemeral water bodies. - Global cover.
Input data	- Sentinel-2 L1C (S2L1C) - Copernicus GLO-30 DEM - Global Surface Water – maximum water extent (GSWE)
Specifications	- Indicator: Water likelihood (%) - Test sites: Belgium, Ivory Coast, Spain, Sweden - Spatial resolution: 10 m - Temporal resolution: daily (when acquired). - Thematic accuracy: Overall accuracy > 97% on the four test sites. - Raster format in UTM projection. - Validation: with GSWO data and human supervision.
Example	

C7 Prototype: Improved water bodies mapping. The figure provides a likelihood of water bodies ranging from white (likely no water body) to dark blue (very likely a water body).

C8 Continuous imperviousness monitoring

	Description
Pin ID	C08 Continuous imperviousness monitoring
Aim	Demonstrate the potential for continuous monitoring of imperviousness degree as an improvement from 3-yearly CLMS HRL Imperviousness products.
Improvements	- Upscale resolution to 5m using Sentinel-2 super-resolution - Improve timeliness on a 6-monthly basis - Use of Machine Learning and Geographic Object-Based Image Analysis - Reduction of the underestimation of the imperviousness degree as well as the commission errors (quality of training set, multi-temporal classification ...) - Change layers production
Input data	- Sentinel-2 Monthly synthesis L3A (super-resolution) - HRL NVLCC 2021: imperviousness degree and built-up map for training - HRL VLCC 2021: tree cover density, grassland and crop type maps for training - HRL SWF 2018: small woody features for training - Open Street Map for training
Specifications	- Indicator: percentage of sealed area [0-100%] - Test sites: Belgium, Southern France, Central Europe - Spatial resolution: 5m - Temporal resolution: 6-monthly (currently) 2020-2022 - Thematic accuracy: 90% User and Producer accuracy - Raster format in LAEA projection - Validation: with visually interpreted VHR (Google Earth or Bing Aerial) and HR dataset
Example	

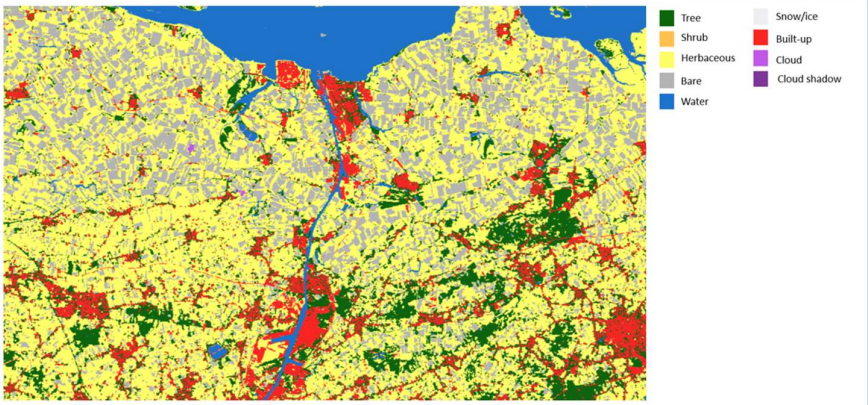
C8 Prototype: Continuous imperviousness monitoring. The figure provides a likelihood of a pixel being impervious ranging from grey (likely not impervious) to maroon (very likely impervious).

C9 Automated land use mapping of urban dynamics

	Description
Pin ID	C09 Automated land use mapping of urban dynamics
Aim	Production of a layer of urban changes and its characterization, both automatically
Improvements	- Layer produced by visual analysis (manually) => Layer produced automatically - 6-year or 3-year production timestep => 1-year production timestep
Input data	- Sentinel-2 L3A time series - CLC - Cadastral data - Open Street Map
Specifications	- 3 change classes: Renaturation (Urban to natural), urban renewal (intra-urban change), urban sprawl (Natural to urban)Test sites: Belgium, Ivory Coast, Central Europe, South of France - Spatial resolution: 5m - Temporal resolution: Yearly - Thematic accuracy: target of 85% user/producer accuracy - Raster format in UTM projection - Validation: human supervision
Example	

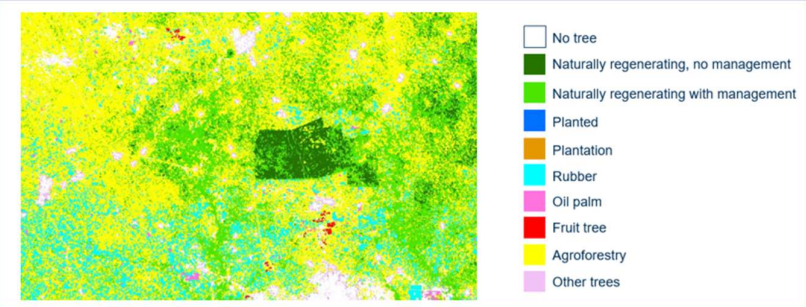
C9 Prototype: Automated land use mapping of urban dynamics. The figure displays the classes renaturation (green), urban renewal (red) and urban sprawl (blue).

C10 Continuous mapping of land surface categories

	Description
Pin ID	C10 Land Surface Categories
Aim	The aim of this prototype is to map near real time land surface categories (LSC), i.e. categories that capture basic, observable bio-geophysical properties of the Earth surface
Improvements	An EvoNet model that allows to map the classes tree, shrubs, herbaceous vegetation, built-up, bare, snow/ice, water, clouds, shadows, and no data over Sentinel-2 scenes.
Specifications	- Spatial resolution: 10m - Temporal resolution: one Sentinel-2 scene per month over the years 2020-2022 - Raster format in UTM projection - Training set automatically produced using rules and auxiliary information - Validation: derived from manually labelled annual land cover labels using a set of rules - Overall accuracy of 82%
Example	

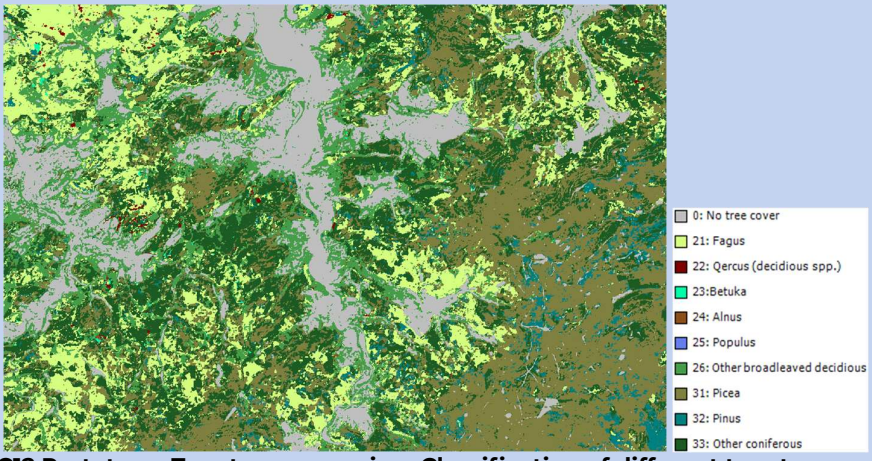
C10 Prototype: Land Surface Characteristics. Different layers per class of the probabilities are provided in the data viewer.

C11 On-demand land cover mapping

	Description
Pin ID	C11 On-demand land cover mapping
Aim	Demonstrate an on-demand cloud-based model inference pipeline on openEO
Improvements	- An openEO pipeline for model inference was implemented - The pipeline was tested for forest management type classification
Specifications	- Test sites: Belgium, Central Europe, Côte d'Ivoire, and French Guyana - Spatial resolution: 10m - Year 2020 - Raster format in UTM projection - Training set from manually collected labels - Validation: Agreement between the local and openEO inference
Example	

C11 Prototype: On-demand land cover mapping. Forest management type mapping

C12 Tree types mapping

	Description
Pin ID	C12 Tree Types Mapping
Aim	Assess the potential of deep learning approaches, specifically the TempCNN model, to classify dominant tree types on genus and species level using Sentinel-2 time series data.
Improvements	- Providing tree type information on a European scale - Extending the current CLMS Tree Cover & Forest portfolio, while being compatible to it
Input data	- Sentinel-2 time series data - Global Biodiversity Information Facility (GBIF) - TreeSat - HRL Dominant Leafe Type
Specifications	- Test sites: Central Europe – extended northwards to 25 Sentinel-2 tiles - Spatial resolution: 10m - Year 2021 - Raster format in LAEA projection - Validation: test set (not used for training)
Example	

C12 Prototype: Tree types mapping. Classification of different tree types on genus and species level.

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