# D1.2 Service Requirements Report – Final version

Work Package 1 - Requirements Analysis

**Authors:** Phillip Harwood (Evenflow)

Date: 31.01.2025

Funded by the European Union

| | | | | |
|---|---|---|---|---|
| **Full Title** | **D1.2 Service requirements report - final version** | | | |
| **Project number** | 101082130 | | **Acronym** | EVOLAND |
| **Start date** | 01.01.2023 | | **Duration** | 36 months |
| **Granting authority** | European Health and Digital Executive Agency (HaDEA) | | | |
| **Project Coordinator** | Vlaamse Instelling voor Technologisch Onderzoek N.V. (VITO) | | | |
| **Date of delivery** | **Contractual** | M22 | **Actual** | M25 |
| **Type** | R - Document, report | | **Dissemination level** | PU - Public |
| **Lead beneficiary** | Evenflow | | | |
| **Lead author** | Phillip Harwood | | **Email** | phil@evenflow.eu |
| **Other authors** | Tim Ng (VITO) | | | |
| **Reviewer(s)** | Ruuta Skujina (EVF), Ruben Van De Kerchove (VITO) | | | |
| **Keywords** | Service Requirements, User Domains, Policy Areas | | | |

| **Document Revision History** | | | | |
|---|---|---|---|---|
| **Version** | **Issue date** | **Stage** | **Changes** | **Contributor** |
| 0.1 | 11.11.2024 | Draft | Review of interim version | Evenflow |
| 0.2 | 29.01.2025 | Draft | Review and minor edits | VITO |
| **1.0** | 31.01.2025 | Final | Final edits and proofreading | Evenflow |

***Disclaimer***

*Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.*

# Acronyms

| Acronym | Description |
|---|---|
| AI | Artificial Intelligence |
| CAP | Common Agricultural Policy |
| CBD | Convention of Biological Diversity |
| CLMS | Copernicus Land Monitoring Service |
| EC | European Commission |
| ECV | Essential Climate Variable |
| EEA | European Environment Agency |
| EO | Earth Observation |
| EU | European Union |
| EUNIS | European Nature Information System |
| FAO | Food and Agriculture Organization |
| FISE | Forest Information System for Europe |
| FLEGT | Forest Law Enforcement, Governance and Trade Action Plan |
| GCOS | Global Climate Observing System |
| GHG | Green House Gass |
| GHSL | Global Human Settlement Laye |
| GPP | Gross Primary Production |
| HRL | High Resolution Layers |
| JRC | Joint Research Centre |
| LUCAS | Land Use/Cover Area frame statistical Survey |
| LULUCF | Land Use, Land Use Change and Forestry |
| MARS | Monitoring Agricultural Resources |
| NRT | Near Real Time |
| UN COP | United Nations Conference of the Parties |
| UR | User Requirement |
| VLCC | Vegetated Land Cover Characteristics |
| WFD | Water Framework Directive |

# Contents

# Table of Tables



# Table of Figures

# Executive Summary

The Copernicus Land Monitoring Service (CLMS) provides geospatial information on environmental terrestrial applications, including land cover and changes, land use, vegetation state, water cycle and Earth's surface energy variables, to a wide range of European and worldwide users. EvoLand is a Horizon Europe project that will develop, test and roll out eleven innovative new candidate prototypes, integrating novel Earth Observation, in-situ data and the latest Machine Learning techniques, which could support the evolution of the Copernicus Land Monitoring Service to better meet key user needs and policy objectives.

There are many potential uses for such improved CLMS services, but in this document, we focus on the use of such products to support key European Commission (EC) policies, in particular those centred on the European Green Deal. These include key policies for greenhouse gas emissions from Land Use, Land Use Change and Forestry (LULUCF); preservation and restoration of key ecosystems supporting enhanced biodiversity; improved food systems supporting food security and sustainable agriculture; enhanced soil management across Europe; better management of water resources and restoration of waterways. It can also be expected that any services derived to support these policies will be of interest to additional users.

This document combines desktop research (literature review) and targeted interviews to identify the key geospatial needs for supporting the implementation and monitoring of these policies. These needs are then translated into user requirements for the prototypes developed in EvoLand. In some cases, user requirements are well-defined, while in others, the focus is on exploring potential solutions and providing stakeholders with informed recommendations.

The user requirements have been analysed by the teams developing each of the prototype services, who derived service specifications accordingly. These specifications do not necessarily fully reflect the user requirements, as technical feasibility also needs to be considered. After demonstrating the initial prototype versions, further iterations were conducted with users to refine and clarify specific requirements.

# 1 Introduction

## 1.1 About this document

This document is the **final version** (D1.2) of the **Service Requirements Report** for the EvoLand project. It aims to collect stakeholder and user requirements for the evolution of the CLMS, and to translate these into user requirements for the prototype services to be developed within this project. These have then been further analysed within WP2 to create the Technical Specifications for each product. In particular, the aim is to look at the requirements for how future CLMS services can better support current and future EU policy reporting requirements across a range of domains.

In the process of collecting the requirements for EvoLand, the project team has also been given general feedback on the current CLMS services and delivery, and this is also recorded in this document for future reference.

The document is structured as follows:

- Section 1 (this section) introduces the document and the EvoLand project.
- Section 2 describes the methodology and sources for the analysis performed.
- Section 3 looks at the requirements according to different key policy areas.
- Section 4 gives the key user requirements for the services to be prototyped.
- Section 5 contains additional user feedback on CLMS, not directly related to the services being developed.

Following this deliverable further iteration with users will be performed in the framework of EvoLand's WP4.

## 1.2 About EvoLand

EvoLand is a Horizon Europe project that will develop, test and roll out eleven innovative new candidate prototypes to support the evolution of the Copernicus Land Monitoring Service. The project will integrate novel Earth Observation, in-situ data and the latest Machine Learning techniques to continuously monitor the status, dynamics and biomass of the land surface.

The project focuses on five key thematic sectors: agriculture, forest, water, urban, and general land cover.

EvoLand brings together a consortium of 10 partners from 5 European countries. Led by VITO Remote Sensing, an independent research organization from Belgium, it involves also CESBIO (France), CLS (France), CNES (France) DLR (Germany), Evenflow (Belgium), GAF AG (Germany), IIASA (Austria), Joanneum Research (Austria) and Sinergise (Slovenia). The EvoLand consortium includes CLMS specialists, key CLMS service providers, and leading research institutes in all methodological developments. The team also involves partners experienced in supporting the Copernicus in-situ component, driving innovative in-situ data collection, cloud infrastructure, and mass data processing, as well as effectively engaging stakeholders.

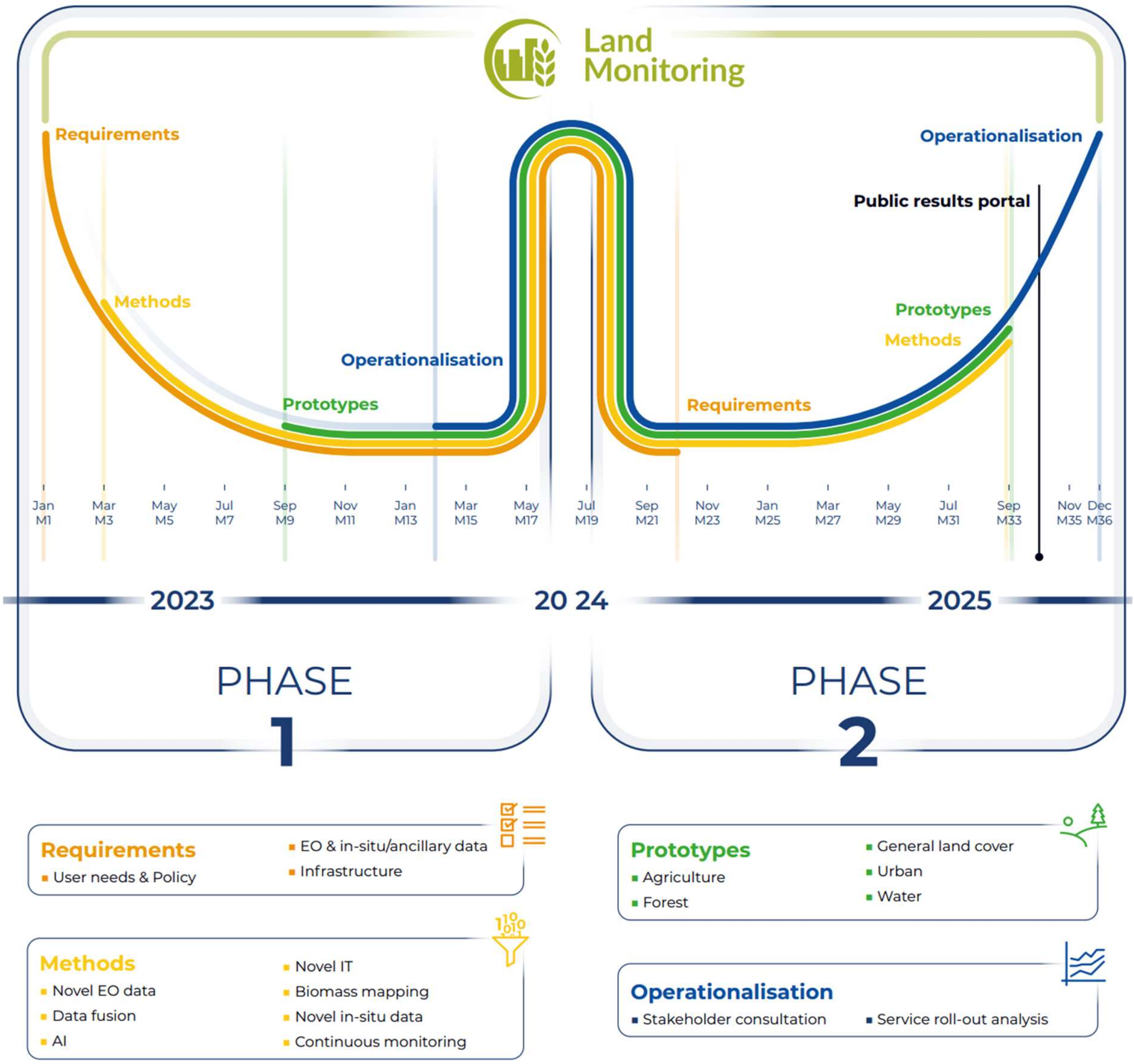


*Figure 1. The EvoLand Concept.*

## 1.3 Prototype Services

EvoLand will develop eleven next-generation CLMS product candidates, using innovative approaches in data fusion, continuous monitoring, AI, and biomass mapping, as well as by integrating novel Earth Observation (EO) and in-situ data. At the end of the project there will thus be up to eleven operationally benchmarked and qualified candidate CLMS services with a TRL5-7, which will have the potential to be taken up and integrated into CLMS by the Entrusted Entities from 2025 onwards.

The table below lists the prototypes to be developed in this project. Additional descriptions can be found on the project website using the links given.

*Table 1. Prototype services to be developed.*

| ID | Domain | Title | Description |
|---|---|---|---|
| C1 | Forestry | Continuous forest monitoring | Improve the HRL products for Forest Monitoring by providing near real-time information (e.g., weekly, monthly, quarterly, yearly) at a target 10m spatial resolution. More details. |
| C2 | Forestry | Forest disturbance mapping | Map forest disturbances continuously. to identify potential main disturbance agents at sites of identified forest change. More details. |
| C3 | Forestry | Forest biomass mapping | Complement the HRL VLCC portfolio with spatiotemporally consistent estimates of above-ground woody biomass and forest canopy height. More details. |
| C4 | Agriculture | Cover crop type mapping | The aim of this candidate is therefore to develop a prototype service to map and identify cover crop types at 10m resolution. More details. |
| C5 | Agriculture | Cropland/Grassland GPP mapping | Develop high-resolution GPP data (10-daily, 10m) for grassland and cropland, currently non-existing over Europe. More details. |
| C6 | Agriculture | Small landscape features mapping | Improve on the existing CLMS Small Woody Features product, in particular looking at small linear features such as stone walls and diches. More details. |
| C7 | Water | Improved water bodies mapping | Map water bodies extent and water network at a finest resolution (<10m) to better characterize water resource and water dynamics in different kind of landscapes. More details. |
| C8 | Urban | Continuous imperviousness mapping | Demonstrate the potential for continuous monitoring of soil sealing and imperviousness. More details. |
| C9 | Urban | Automated land use mapping of urban dynamics | Improve on the current Urban Atlas data with automatically generated Land Use Land Cover maps. More details. |
| C10 | General | Continuous mapping of land surface characteristics | Develop continuous mapping of key land surface characteristics at 10m resolution. More details. |
| C11 | General | On-demand land cover mapping | Demonstrate an on-demand service showcasing a number of tailored Land Cover products with customised classes (at different spatial resolutions. More details. |

# 2 Methodology

## 2.1 Overview

The aim of this document is to derive key user requirements for the proposed EvoLand services. It is noted that the portfolio of services to be prototyped was already defined at the proposal stage of EvoLand and so is not being driven by the current user requirements exercise[1], though some changes to the scope of the services was foreseen.

There are many potential uses for improved CLMS services, but for the purpose of this document we focus on the use of such products to support key EC policies, in particular those centred on the European Green Deal. It can be expected that any services derived to support these policies will be of interest to additional users.

The overall methodology used for identifying the user requirements for the proposed EvoLand prototype services:

1. Identify the key policy needs and trends which are driving the requirements for CLMS evolution.
2. Perform an in-depth document review for these fields to capture key unmet needs and requirements for CLMS.
3. Supplement this review by performing interviews with key experts (identified as core users) in the selected fields.
4. Using the inputs acquired, consolidate the key needs for improved CLMS services arising from each policy driver.
5. Map these needs into user requirements for each of the proposed prototype services.

The user requirements were then analysed by the teams developing each of the prototype services, who derived service specifications accordingly. These specifications do not necessarily fully reflect the user requirements, as technical feasibility also needs to be taken into account.

Once initial versions of the prototypes are available, these were presented to users at a series of webinars held in December 2024. These webinars were open for anyone to attend, so included both the core users previously identified but also new potential users. The aim here was to both validate the requirements baseline with a wider audience, and to see if there were any new requirements that should be included, using the initial prototypes as the basis for discussion. The results of this feedback have been included in this version of the deliverable.

[1] For completeness users were also asked to give their feedback on the service portfolio as a whole.

## 2.2 Documentation Review

There is a large amount of material already available looking at how Copernicus data in general, and CLMS in particular, can be used for achieving policy goals. Similarly, there are many existing sources capturing gaps in the current service provision, and documenting user needs and requirements to meet specific policy objectives.

Table 2 below lists the most relevant documents which have been consulted for the purpose of ascertaining service requirements. As a general rule, newer documents have been given preference over older ones, though this is not always followed consistently. Additional more specific references are cited as foot notes in the relevant section.

*Table 2. Key Documentary Sources of Requirements.*

| Acronym | Title | Reference | Availability |
|---|---|---|---|
| EOEU | Copernicus and Earth Observation in Support of EU Policies | JRC18879 | Online |
| SWD | Commission Staff Working Document: Expression of User Needs for the Copernicus Programme | SWD (2019) 394 Final | Online |
| NxS | NextSpace database for user requirements | Not given | Online |
| CLUE | Presentations given at the Copernicus Land User Event (November 2022) | N/A | Online |
| DDB | Earth Observation in support of EU policies for biodiversity - A deep-dive assessment of the Knowledge Centre on Earth Observation | JRC132908 | Online |
| ISM | Potential of Earth Observation for improved soil monitoring | 07.0201/2016/ 742739/SER/ENV.D.I | Online |
| JLVW | JRC LULUCF Virtual Workshop Report2021 | Not given | Online |
| CCH | Report on the user requirements in the Copernicus domain to support Cultural Heritage management, conservation and protection | CC-2020-37 | Online |
| AHP | Atlas of the Human Planet 2020 | JRC122364 | Online |
| WCL | Workshop summary: Using CLMS to support the LULUCF regulation | N/A | Online |
| CCAP | Workshop: Copernicus and the Common Agricultural Policy | N/A | Online |
| CGD | Workshop: Copernicus for the Green Deal | N/A | Online |
| CMW | Workshop: Copernicus for Water Management | N/A | Online |
| CPW | Copernicus Polar Workshop | N/A | Online |

## 2.3 Initial Stakeholder Interviews

In order to supplement the document review, we performed a series of stakeholder interviews. Since the focus at this stage was to collect requirements for supporting key EU policies, the interviewees were key staff from the agencies most involved in collecting data to monitor and support these policies, i.e. EEA and JRC. These were expected to be key users of the new services.

The key notes from the stakeholder interviews are provided in Annex 1.

## 2.4 Prototype Demonstration and Feedback

In order to validate the requirements, the baseline for each prototype and the proposed way forward were presented to key stakeholders within the CLMS in June 2024. They were then validated with a wider audience later that year.

During December 2024 a series of webinars was organised by the EvoLand project. The aim of these webinars was to showcase the progress made to date by demonstrating the initial results from each prototype, to collect feedback on the usefulness of these prototypes, and to use these to fine tune the requirements for the next phase of the project. As such the outcomes of these webinars are relevant both for this document, but also for the upcoming deliverable D4.3 (Stakeholder Consultation Report).

There were two webinars held:

- Webinar 1: (Monday 2nd of December 2024) presented the prototypes in the domains of forestry and agriculture.
- Webinar 2: (Wednesday 4th of December 2024) presented the prototypes in the domains of water, urban and general land cover.

Recordings of these webinars are available online via the EvoLand website[2].

Within these webinars the requirements for each prototype were described to the participants, with feedback strongly encouraged. Following the webinars an online survey was distributed to attendees. The survey was also advertised through the project's website and social media channels (and directly by email to selected target users) to encourage feedback from additional users who may not have been able to join the webinars.

The full feedback from the webinars is presented in the Stakeholder Consultation Report (Deliverable 4.3).

[2] https://www.evo-land.eu/last-chance-to-have-your-say-on-evoland-prototypes/

# 3 Analysis by User Domains and Policy Areas

## 3.1 Overview

One of the key objectives of EvoLand is to enhance the quality and efficiency of the service in responding to policy and user requirements. Within Europe, the key policy framework that must be addressed is the European Green Deal[3], a set of linked policies aiming to transform the European economy to better address the threats of climate change and environmental degradation. The key pillars of the European Green Deal are shown in the figure below.


*Figure 2. Key Components of the European Green Deal.*

This chapter looks at key elements of the European Green Deal for which CLMS data are relevant, assessing the key user requirements coming from each policy element. In practice many of these different elements are interlinked and so have very similar requirements. While CLMS is not solely focused on addressing Green Deal needs, its broad framework encompasses most key use cases in practice. Some additional policy drivers are set out in the final section of this chapter.

3 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

## 3.2 LULUCF

### 3.2.1 Background

The LULUCF regulation[4] (Regulation (EU) 2018/841) sets out the regulations for Green House Gass (GHG) emissions from the land use sector, specifically from land use, land use change and forestry (LULUCF). It requires each Member State to ensure that accounted GHG emissions from the land use sector are compensated for by an equivalent removal elsewhere. The regulation also establishes an accounting framework and governance process for ensuring accurate reporting of carbon budgets from the LULUCF sector. This regulation is a key part of the EU's strategy for becoming climate neutral by 2050, a key pillar of the EU Green Deal.

The EU regulations are designed to codify commitments made by Member States under the United Nations Conference of the Parties (UN COP), for example aligning the reporting requirements[5]. These regulations also impact the Common Agricultural Policy[6], the EU Forest Strategy for 2030[7], and other EU initiatives relating to different types of land use.

With the adoption of this regulation, greenhouse gas emissions and carbon dioxide removals from land use, land use change and forestry (LULUCF) have become part of the 2030 Climate and Energy targets, such that greenhouse emissions do not exceed removals in all of the land accounting categories in the period 2021 to 2030. This "no net debit" obligation will be assessed for the period 2021-2025 and 2026-2030 and a land-based accounting framework has been established.

EU Member States are obliged to submit annual assessments of the net GHG emissions for the land use sector. Accounting for LULUCF carbon budgets from requires a clear understanding of patterns of land use over time. It is recognised that this is difficult to implement, and there are still many questions around the accuracy of existing estimates.

### 3.2.2 Current Use of CLMS

Despite high interest, CLMS products are not yet widely used to support LULUCF reporting obligations. There are several reasons for this, of which the most important is the lack of familiarity with, or confidence in, the use of such products by the national agencies responsible for producing the LULUCF budgets, as well as difficulties in adapting established systems to take account of new data sources.

---

[4] https://climate.ec.europa.eu/eu-action/forests-and-agriculture/land-use-and-forestry-regulation-2021-2030_en
[5] https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/reporting-requirements
[6] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/new-cap-2023-27_en
[7] https://ec.europa.eu/environment/strategy/forest-strategy_en

In addition, several technical limitations of the products are cited, including[8],

- Infrequent updates instead of annual products.
- Mismatches between CLMS approach and the various national LULUCF classifications.
- Insufficient spatial detail for capturing key needs.

Many of these points are already being addressed in the ongoing improvements to the Copernicus Land Services.

### 3.2.3 Key Needs for CLMS evolution

The key needs from CLMS for LULUCF users are:

- The availability of annual updates, produced with sufficient timeliness to be used in national level reporting.
- The availability of consistent long term time series (20-30) years for monitoring overall trends in land use[9].
- Flexibility of classification to allow for adaptation to national reporting frameworks.
- The ability to monitor parcel sizes of 1 hectare or lower.

In addition to these technical points, a better emphasis on user engagement and training is needed to support member states.

## 3.3 Ecosystems and Biodiversity

### 3.3.1 Background

As part of the European Green Deal, the EC has proposed a strategy for the protection and restoration of key natural ecosystems and the preservation of biodiversity[10]. This aims to put Europe's ecosystems on a path to long term recovery and sustainability, through a range of actions and commitments at national and member state level. It aims to promote the adoption of a global biodiversity framework which addresses the commitments made under the Convention of Biological Diversity[11] (CBD) and the achievement of targets for biodiversity under the Sustainable Development Goals (SDG) 14 and 15.

### 3.3.2 Current Use of CLMS

The Copernicus Services, including the CLMS, play an increasingly important role in supporting biodiversity conservation and restoration. A detailed review of the

[8] https://land.copernicus.eu/user-corner/events/using-copernicus-land-monitoring-services-clms-to-support-the-land-use-land-use-change-and-forestry-lulucf-regulation/public/post-workshop-summary/view
[9] Note that CLMS generally provide data on land cover and not land use.
[10] https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en
[11] https://www.cbd.int

current uses of CLMS to support EU Biodiversity policies has been performed by the JRC. This analyses to what extent the existing EO products and services meet the identified policy needs, highlighting existing gaps and providing recommendations for future evolution.

Some key conclusions from this report, backed up by other inputs, are that although the data sets currently available from CLMS are relevant and valuable, their uptake is limited by several factors. Insufficient refresh time and a high latency of product availability are two key factors. Another key issue is that the thematic detail of land cover maps is not sufficiently detailed for many key applications around biodiversity, for example better ecosystem typologies should be applied. Better collection of related in-situ data is also needed to get full value from the available EO-based products. In addition, potential users also reported issues in navigating and using the wide range of products available, though this is not an issue unique to this field.

### 3.3.3 Key Needs for CLMS evolution

The key needs for CLMS for assessment of ecosystems are as follows:

- Long term monitoring following a consistent baseline is required to establish trends,
- Annual updates are required for most purposes.
- Weekly assessments are needed for monitoring of fragile or vulnerable areas.
- Spatial resolution and thematic detail are more important than temporal revisit times.
- The spatial resolution of existing Copernicus products (10m) is generally considered adequate.
- Mapping of small features, such as hedgerows and grass verges, is needed as these are key markers of biodiversity.
- A significant improvement is needed in the timeliness of product delivery, with products for a given reference year available in the following year at the latest.
- Better reference ecosystem typologies should be applied to land use products.
- Better mapping of wetlands and wetland connectivity is particularly needed.

In addition, it is noted that users in this field have difficulties in navigating and using existing product interfaces. As in the case of LULUCF, many of these issues are already being addressed within the framework of ongoing CLMS evolution.

## 3.4 Forest Management

### 3.4.1 Background

The European Green Deal commits the EU to improving its forested area, both in quality and quantity, and to fighting global deforestation linked to the EU's footprint. These aims are further reflected in the new Forest Strategy 2030[12]. This sets the ground for a series of actions including the development of the EU observatory on deforestation, forest degradation, changes in the world's forest cover, and associated drivers which will build Earth-Observation-based monitoring tools for forests that may be operationalized by Copernicus and taken up by the Forest Information System for Europe (FISE) as part of the integrated forest monitoring system.

The Forestry Strategy underlines the strong link with biodiversity, explaining that forest management plans should include forest-related risk assessment and management, as well as better integrate biodiversity-related data.

This is further covered in the new EU Biodiversity Strategy for 2030, which requires the EU to increase its forests in quantity and improve their health and resilience. Several other EU policies or communications pinpoint specific forest-related topics, including the Common Agricultural Policy, the Habitats and Birds Directives, the European Union Forest Law Enforcement, Governance and Trade Action Plan (FLEGT), the Timber regulation, and more.

### 3.4.2 Current Use of CLMS

Remote sensing techniques are being increasingly used for the provision of timely and accurate data on several aspects related to forest monitoring and management. In Europe, Copernicus Sentinels data and products under the CLMS have been supporting forest-related applications for several years now. The combination of satellite imagery with in-situ and other data allows the continuous monitoring of forested areas and the extraction of valuable information that can allow for the detection and monitoring of forest degradation, deforestation and illegal forest operations. In this context, the ability of satellites to gather information on tree and plant health as well as forest canopy coverage over large areas and with a high revisit frequency, is leveraged in multiple applications. These include forest biomass monitoring, forest inventory monitoring, forest vegetation health assessment, illegal logging monitoring, deforestation/forest degradation monitoring and land cover analysis.

### 3.4.3 Key Needs for CLMS evolution

The key requirements for improved CLMS products are:

- Annual production of forest maps.
- Flexible definition of what constitutes a forest, to allow matching with different national reporting methods.
- Near real time analysis of disturbances and other events.

[12] https://environment.ec.europa.eu/strategy/forest-strategy_en

# 3.5 Agriculture and Farm to Fork

## 3.5.1 Background

The Farm to Fork strategy[13] aims to support the objectives of the European Green Deal by making food systems sustainable and environmentally friendly. Among other things it includes a set of policies for reducing the environmental and carbon footprint of European food systems while also ensuring Europe's food security in the face of a changing climate.

Other key policies, in particular the revised Common Agricultural Policy[14] (CAP), have been aligned with the objectives of the Farm to Fork strategy, and there are close links between the farm to fork and biodiversity strategies. There is also a clear connection between agriculture and the LULUCF regulation.

## 3.5.2 Current Use of CLMS

There are many current uses of CLMS to support the Farm to Fork strategy in general and the Common Agricultural Policy in particular. Because of the complementarity with other strategies within the framework of the European Green deal these overlap significantly with other themes in this chapter.

In the case of the CAP, satellite Earth Observation is taking up an increasing role in compliance monitoring. Currently this is mainly based on data from Sentinels (and other satellites) rather than on the use of CLMS. This is mainly due to the infrequent update of key layers, but there is also an issue that CAP compliance is primarily dealt with at a national level and so should be flexible enough to support different definitions used.

CLMS data are also used as inputs to crop yield prediction systems such as the Monitoring Agricultural Resources (MARS) service[15], thus supporting food security. These do not currently take full advantage of the available resolution from Sentinels as this requires a redesign of the relevant processing chains. CLMS data are also used by commercial companies as part of their input data portfolio.

The CLMS data can be a key tool in assessing the environmental impacts of agriculture, both for climate and biodiversity. It can be used to support actions such as the provision of carbon credits, or to monitor requirements such as the setting aside of areas for biodiversity.

## 3.5.3 Key Needs for CLMS Evolution

The key needs for increased uptake of CLMS in supporting the Farm to Fork strategy (excluding those discussed elsewhere) are:

---

[13] https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en
[14] https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance_en
[15] https://joint-research-centre.ec.europa.eu/monitoring-agricultural-resources-mars_en

- Detection of crop types (primary and cover crops) at a field-scale seasonally or annually.
- Detection of non-productive areas (field borders, hedgerows, anti-erosion strips) and other linear features, of width 3-30m, at least annually.
- Detection of key farm management events such as mowing, mulching or start of grazing.
- Annual assessment of land use and land cover, with products flexible enough to support different national definitions used in this field.
- Long term time series for the assessment of key trends.
- Near real time assessment of key biophysical variables.
- Measurement of crop biomass and crop residues for supporting assessment of environmental impacts.
- Stable and reliable data streams are required if the data are to be included into operational processing chains.
- Consistency between all products and with related products such as the Land Use/Cover Area frame statistical Survey (LUCAS).

Users in this field also emphasised the need for simplified access to all products, including suitable processing platforms and tools, as well as for suitable support and training.

# 3.6 Soils

## 3.6.1 Background

Soil health is of increasing concern in Europe, as a combination of climate change and intensive human activities places increasing pressure on soils. Soil degradation manifests in various ways, including soil sealing, erosion, desertification, and reduction in soil organic carbon.

Soil protection is not regulated at European level and Member States can individually develop specific policies for the sustainable exploitation and conservation of their soil. However, given the importance of soil health, the EU has developed a soil strategy for 2030[16], which describes actions that the EC will take around soil health.

The strategy integrates the objectives of the European Green Deal with other strategies and policies, including Farm to Fork, the Zero Pollution Action Plan, the Biodiversity Strategy and the new CAP. Within the CAP, sustainable management of soil will be a crucial component of several objectives, in particular those focused on landscapes and biodiversity, natural resources, and climate action.

## 3.6.2 Current Use of CLMS

The most mature use of CLMS for soil health is in monitoring soil sealing by means of the HRL for imperviousness. Existing CLMS products can also be used for

[16] https://ec.europa.eu/environment/publications/eu-soil-strategy-2030_en

assessing soil water, soil surface moisture, vegetation cover, landscape heterogeneity and forest cover, all parameters that are relevant for proposed soil health indicators. Soil erosion can also be monitored directly from earth observation data.

There is also the potential[17] for CLMS products to be used to assess soil organic carbon, via models, or to look for factors indicating soil pollutants, *e.g.* by using vegetation states as a proxy. These are not yet considered operational, though there is high interest. In many cases EO-based products can support determination, but there is a need for more relevant in-situ data to make the services operational.

### 3.6.3 Key Needs for CLMS evolution

Many of the needs for soil monitoring overlaps with those for agriculture or LULUCF. For example, crop monitoring is needed to support the modelling of soil organic carbon, while land use changes are needed for monitoring erosion.

The key requirements for CLMS to support the soil strategy are:

- Mapping of land cover changes, at least annually.
- Mapping of crop types (including primary and cover crops), covering at least the 10 most important types in each country or region, at least annually and ideally seasonally.
- Maps of soil sealing and de-sealing is needed, as is data on the trajectories (i.e. what land was/is used for before/after being sealed).
- Data allowing detection of crop / tillage management practices are of interest.
- All products are required at least annually, with products for a given reference year ideally available within the following year, at most with a 2-year delay.
- Continuity of products is important for developing service chains and for monitoring long term trends.
- All products should be at least for the EU27, though there is some interest in other EEA countries and in Africa and other regions.

In addition, there is an interest in obtaining thermal data at a 20m resolution for monitoring water stress in plants, and hence droughts.

In general, currently available forestry products from CLMS are considered sufficient for the purposes of soil monitoring.

[17] https://www.copernicus.eu/system/files/2020-12/NT%2025nov%20-%20The%20Horizon%20Europe%20Missions%20-%20Challenges%20and%20opportunities%20for%20Copernicus_0.pdf

# 3.7 Urban Monitoring

## 3.7.1 Background

An ever-increasing proportion of the world population lives in cities and other urban areas and making these areas sustainable[18] is key to addressing climate resilience. As a first step it is important to understand the population and ecological dynamics in areas which can change on a relatively fast timescale.

At European level, the Regional Policy[19] supports development across the different regions and cities of the EU, while the Urban Agenda[20] supports cooperation between cities, countries and other actors.

## 3.7.2 Current Use of CLMS

The CLMS Urban Atlas provides harmonised land cover and land use maps over several hundred cities. These maps support various applications, including the regional policy framework (DG REGIO) and the Urban Audit[21] performed by Eurostat. This can be used to support evidence-based policymaking around urban planning, for example looking at the relation between population distribution and transport networks over time or measuring quality of life indicators such as access to (and quality of) urban green areas.

Although not strictly part of CLMS, it is also worth highlighting the Global Human Settlement Layer[22] (GHSL) produced in the framework of the Copernicus Emergency Management Service.

## 3.7.3 Key Needs for CLMS evolution

The key additional needs for urban monitoring from CLMS are:

- More frequent updates of the existing Urban Atlas products in Europe, at least annually, and with a product accuracy of 1 year.
- Extension of these products to cover all urban and suburban areas with increased resolution.
- Precise products (i.e. minimisation of random errors) for detection of changes, together with an accuracy of at least 85%.
- Better characterisation of urban ecosystems, following the European Nature Information System (EUNIS) classification.

[18] https://sdgs.un.org/topics/sustainable-cities-and-human-settlements
[19] https://ec.europa.eu/regional_policy/home_en
[20] https://www.urbanagenda.urban-initiative.eu/urban-agenda-eu
[21] https://ec.europa.eu/eurostat/web/cities/background
[22] https://ghsl.jrc.ec.europa.eu/about.php

# 3.8 Water Management

## 3.8.1 Background

Water bodies are an Essential Climate Variable (ECV) of the Global Climate Observing System (GCOS). Mapping these bodies supports hydrological modelling, as well as being used for other purposes such as assessing flood risk.

In Europe, the Water Framework Directive (WFD) aims to ensure long-term sustainable water management based on a high level of protection of the aquatic environment. The WFD fosters a holistic approach to protecting all surface and ground water bodies, including transitional waters and coastal waters, covering all pressures and impacts on waters. For each river basin district, a "river basin management plan" has to be established and updated every six years.

## 3.8.2 Current Use of CLMS

Several CLMS products are relevant to water management, including Water and Wetness, Snow Water Equivalent, Riparian Zone Mapping, and Soil Surface Moisture. Information on crop types and agricultural practices, as well as other land use information, is also relevant for estimating water usage.

## 3.8.3 Key Needs for CLMS evolution

The key needs for CLMS relevant to EvoLand are around better mapping of surface water bodies:

- Mapping of global water bodies on at least a monthly basis, more frequently if possible.
- Inclusion of smaller water bodies in Europe below the currently available 100m resolution.
- Long term time series for assessment of trends.
- Estimation of water volume as well as water extent.
- Detection of new water bodies.

# 3.9 Others

The sections above summarise the key areas in which there are clearly identified policy drivers for improved CLMS services. However, these are not the only potential areas of CLMS services. For example, the preservation of cultural heritage sites calls for monitoring of vegetation encroachment, for which it may well be possible to use CLMS products if they were available at sufficient resolution and timeliness.

For the purpose of EvoLand we have used the main policy drivers to derive the service requirements, as outlined in the next section, but we can confidently expect that once available there will be many other fields of application for these products.

# 4 User Requirements for the EvoLand Prototype Services

## 4.1 Overview

This section maps the user needs for the different policies assessed in the previous section into requirements for the specific prototype services to be developed by EvoLand.

Although the portfolio of services was defined at proposal stage, before the current requirements gathering activity, the users surveyed felt that the set of services was broadly correct for their needs[23]. This does not mean that there is no scope for additional services within CLMS, only that the selected services are well chosen to meet the policy needs which are in focus.

The table below gives an indication of which services are relevant for specific policies.

*Table 3. Relevance of EvoLand prototypes to key policies.*

| EvoLand service: / Policy theme | C1: Continuous Forest Monitoring | C2: Forest Disturbance Mapping | C3: Forest Biomass Mapping | 5C4: cover crop type mapping | C5: Cropland / Grassland GPP Monitoring | C6: Small Landscape Features Mapping | C7: Improved Water Body Mapping | C8: Continuous Imperviousness Mapping | C9: Automated LU mapping of urban dynamics | C10: Continuous Mapping of LSL | C11: On Demand Land Cover Mapping |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LULUCF | X | X | X | | X | | | | X | | X |
| Biodiversity | X | X | X | | | X | X | | X | | X |
| Forestry | X | X | X | | | | | | | | |
| Agriculture | | X | | X | X | X | | | | X | X |
| Soil | x | | | | X | X | X | X | X | X | x |
| Urban | | | | | | | X | | X | | |
| Water | | | | | | | X | X | | | |

[23] With a possible exception regarding wetlands, for which more information was required, as the users in question had not yet been able to fully assess the existing CLMS layers, e.g. water and wetness, that might have been relevant.

## 4.2 Common Requirements

The following user requirements (UR) were highlighted as being applicable to all of the EvoLand prototypes.

**UR-Common-01:** All products generated should be backwards compatible with existing CLMS products.

- Many users need to analyse changes over long periods (up to 30 years) to determine progress towards some objective. Any products intended to replace existing CLMS products must either directly align or else should allow for an intercomparison exercise to be performed.
- This has been highlighted by multiple end users.

**UR-Common-02:** All products generated should be consistent with each other to allow for understanding of changes between land use types.

- There are many use cases where it is not enough just to see the change of a parameter but to understand what is driving the change. For example, in the case of forests it is important not just to track loss of forest area but to see whether this is being lost to urbanisation, agriculture, etc. Since no single product contains all this information it is important to be able to overlay and compare them.

It is noted that there is a potential contradiction between these two common requirements, as if the products have not always been compatible in the past (implied by the second requirement) then aligning them will mean some changes with respect to past products.

## 4.3 Forestry

### 4.3.1 C1: Continuous Forest Monitoring

**UR-C1-01:** the product should apply the FAO definitions of what constitutes a forest.

- This is consistent with the existing CLMS HRL Forest.

**UR-C1-02:** the product should allow users to apply different definitions of what constitutes forest/not-forest.

- This is being driven by the fact that different countries apply different definitions of forest for reporting.
- This could be met by providing a measure of tree cover as a first step.

**UR-C1-03:** it is desirable that the product includes information on tree cover density.

- This is linked to the previous requirement.

**UR-C1-04:** the product should be available across all of Europe at a 10m resolution.

- In this case Europe means at least EU27, ideally EEA38.

**UR-C1-05:** the product should be available worldwide at a resolution of 200-300m.

- Note that this is not currently in scope of the project but could potentially be applied at a later phase.

**UR-C1-06:** the product should be updated at least annually.

- Annual updates are sufficient for most requirements, but with a significant subset of users' interest in higher frequency updates.
- Noted that the project will experiment with providing a higher cadence.

**UR-C1-07:** the product should be available with a maximum latency of 1 year.

- i.e. a product for a given reference year should be produced within the following year.

### 4.3.2 C2: Forest Disturbance Mapping

**UR-C2-01:** the service should systematically produce an annual product highlighting changes.

- This is the key need from users.

**UR-C2-02:** the service should support an additional product at higher cadence for assessing specific events.

- This could potentially be provided on demand.

**UR-C2-03:** the product should at a minimum identify changes due to droughts, infestations, wildfires and storms.

- Noted that these events occur on different scales (both time and area), for example a drought affects a wide area over a long time, while a wildfire affects a smaller area over a shorter timescale.

**UR-C2-04:** the product should distinguish between forest management and forest disturbances.

**UR-C2-05:** the product should be available across all of Europe at a 10m resolution.

- In this case Europe means at least EU27, ideally EEA38.

**UR-C2-06:** the product should be available worldwide at a resolution of 200-300m.

- Note that this is not currently in scope of the project but could potentially be applied at a later phase.

### 4.3.3 C3: Forest Biomass Mapping

**UR-C3-01:** the product should follow the definitions used in the ESA BIOMASS project.

- These can be found on the project webpage[24].

**UR-C3-02:** the service should provide forest canopy height as an intermediate product.

- The aim of this intermediate products is to facilitate estimations of the above ground biomass.

**UR-C3-03:** the service should provide forest canopy roughness as an intermediate product.

- The aim of this intermediate products is to facilitate estimations (taking the measurements together with in situ data) of tree age and type, which are required for assessing carbon fluxes.

**UR-C3-04:** the product should be available across Europe at a 10m resolution.

**UR-C3-05:** the product should be available worldwide at a resolution of 200-300m.

# 4.4 Agriculture

## 4.4.1 C4: Cover Crop Mapping

**UR-C4-01:** the product should provide a simple flag of whether or not cover crops are present.

- This aligns with current VLCC service and is a first step towards defining the crop type.

**UR-C4-02:** the product should at a minimum identify the 10 most important cover crops in each country or region.

- This is sufficient for most purpose, but identifying additional cover crops would also be useful.

**UR-C4-03:** the product should allow assessment of cover crops on a minimum unit of 1 hectare.

- Better resolution is obviously more desirable.

**UR-C4-04:** the product should at a minimum be available annually, with a target to be available seasonally.

- Annual updating is a minimum requirement, but seasonal updating would be useful if feasible and should be seen as a target.

**UR-C4-05:** the product should have an accuracy of greater than 85%.

- Note however that in this case precision is seen as a more important requirement than accuracy.

[24] https://climate.esa.int/en/projects/biomass/

**UR-C4-06:** the product should have the highest possible precision.

- No numerical requirement is given here.
- Precision means the minimisation of random errors, such that similar inputs always give similar output measurements, whereas accuracy refers to how close the measurement is to the underlying real value.

**UR-C4-07:** the product should cover the entire EU territory.

### 4.4.2 C5: Cropland/Grassland GPP Mapping

**UR-C5-01:** the product should allow determination of management practices for grasslands and harvesting events for crops.

**UR-C5-02:** the product should have a resolution of 10m.

**UR-C5-03:** the product should have an accuracy of greater than 85%.

- Note however that in this case precision is seen as a more important requirement than accuracy.

**UR-C5-04:** the product should have the highest possible precision.

- No numerical requirement is given here.
- Precision means the minimisation of random errors, such that similar inputs always give similar output measurements, whereas accuracy refers to how close the measurement is to the underlying real value.

**UR-C5-05:** the product should be updated no less than every 10 days.

**UR-C5-06:** the product should cover the entire EU territory.

### 4.4.3 C6: Small Landscape Features Mapping

**UR-C6-01:** the product should at a minimum identify the following features: grass margins, terraces, hedges, stone walls, plant residues.

**UR-C6-02:** the product should identify features at least down to a 3m resolution.

- Failing this, the best resolution possible.

**UR-C6-03:** the product should distinguish between linear dry features and water bodies.

**UR-C6-04:** the service should support quick identification of changes between subsequent products.

**UR-C6-05:** the product should align with other CLMS products and EvoLand prototypes.

- This is a general requirement on all services but is especially important for this one.

# 4.5 Water

## 4.5.1 C7: Improved Water Bodies Mapping

**UR-C7-01:** the product should capture ponds of under 1 hectare.

- These are currently not accounted for by the CLMS Water and Wetness layer.
- Ideally 0.1 ha (10m resolution) would be achieved.

**UR-C7-02** the product should distinguish between permanent and temporary water bodies.

**UR-C7-03** the product should provide maps on at least a monthly basis.

**UR-C7-04** the product should include information on the volume of water contained in the body.

- This implies some assessment of depth or bathymetry and may not be feasible in this prototype.

**UR-C7-05** the product should be available globally.

- However lower resolution outside Europe would be acceptable.

**UR-C7-06** the product should detect new water bodies and not just map existing ones.

# 4.6 Urban

## 4.6.1 C8: Continuous Imperviousness Mapping

**UR-C8-01:** the product should highlight changes in imperviousness.

**UR-C8-02:** the product should allow assessment of both of sealing and of de-sealing.

- i.e. it should map both where open soil is lost and where it is restored.

**UR-C8-03** the product should support analysis of what land is being lost to soil sealing.

- i.e. what was the land being used for prior to being sealed? This could be done directly in the product or else through comparison of different layers.

**UR-C8-04** the product should be available in at least the EU27 and ideally the EEA28.

- There is additional interest in worldwide coverage, but this is not considered a priority.

**UR-C8-05** the product should be updated on a 6-monthly basis.

**UR-C4-05:** the product should have the highest possible accuracy.

- No numerical figure is given here.

### 4.6.2 C9: Automated Land Use Mapping of Urban Dynamics

**UR-C9-01:** the product should retain consistency with existing urban atlas products.

- This is a general requirement but is emphasised in this case.

**UR-C9-02:** the product should be updated at least annually.

**UR-C9-03:** the product should have a latency of no more than 1 year.

- i.e. products for a given reference year should be available before the end of the following year.

**UR-C9-04:** the product should highlight changes with respect to the previous measurement cycle.

- Ideally it would also show what type of land is being lost to urbanisation.

**UR-C9-05:** the product should have spatial coverage including all cities, towns and suburbs.

**UR-C9-06:** the product should have resolution of 0.25ha in urban areas and 1ha in rural areas.

**UR-C9-07** the product should have an accuracy of at least 85%.

- Note however that in this case precision is seen as a more important requirement than accuracy.

**UR-C9-08:** the product should have the highest possible precision.

- No numerical requirement is given here.
- Precision means the minimisation of random errors, such that similar inputs always give similar output measurements, whereas accuracy refers to how close the measurement is to the underlying real value.

**UR-C9-09:** the product should align with the EUNIS classification of urban ecosystems.

- For EUNIS refer to the EEA website[25]

**UR-C9-10** the product should be available in at least the EU27 and ideally the EEA28.

---

[25] https://www.eea.europa.eu/en/datahub/datahubitem-view/123d0c9a-a6fa-4f2d-b887-5d8e5468faed

- There is additional interest in worldwide coverage, but this is not considered a priority.

# 4.7 General Land Use

## 4.7.1 C10: Continuous Mapping of Land Surface Characteristics

**UR-C10-01:** the service should be possible to use worldwide.

- Note that a Europe only service would still bring considerable value.

**UR-C10-02:** the service should provide outputs in a format that can be used as an input to other services.

- This could be seen as providing analysis ready data to other services.

**UR-C10-03:** the service should support the mapping of wetlands and water extent.

**UR-C10-04:** the service should support the detection of harvesting and emergence events.

**UR-C10-05:** the service should provide data at a 10m resolution.

**UR-C10-06:** the service should provide data at a cadence of 3-10 days.

**UR-C10-07:** the service should provide data with minimum latency.

- No numerical requirement is given here, rather the aim is to give the best possible performance. For many users 1 year latency is sufficient, for others NRT is required.

**UR-C10-08** the product should have an accuracy of at least 85%.

**UR-C10-09:** the product should have the highest possible precision.

- No numerical requirement is given here.
- Precision means the minimisation of random errors, such that similar inputs always give similar output measurements, whereas accuracy refers to how close the measurement is to the underlying real value.

## 4.7.2 C11: On Demand Land Cover Mapping

**Note**: the general user feedback on this service was that they would be interested to see what was feasible, but did not have specific requirements. There were also some questions raised about how this service would be provided in practice, which although not strictly relevant for EvoLand should be seen as an open point for any future roadmap. With this in mind the requirements below should be seen as pointers to maximising the utility of such a service.

**UR-C11-01:** the service should be possible to use worldwide.

**UR-C11-02:** there should be an option to apply different resolutions from 10m to approximately 1km.

**UR-C11-03:** the service should support mapping of wetlands.

**UR-C11-04:** the service should support application of improved ecosystem typologies with respect to the current land use products.

- This implies use of the EUNIS classification[26].

[26] https://www.eea.europa.eu/en/datahub/datahubitem-view/123d0c9a-a6fa-4f2d-b887-5d8e5468faed

# 5 Additional User Feedback on CLMS Evolution

In addition to the feedback on the EvoLand prototypes, the stakeholders interviewed made some general comments about their perception of CLMS. These comments are also reflected in the desktop research performed. Although not strictly relevant for EvoLand they are recorded here for future reference.

- There is a concern over the proliferation of CLMS products, which are not always clearly differentiated. Having multiple products also increases the possibilities for misalignment, e.g. the pan-European and global layers may not actually be comparable.
- Many of the key use cases for CLMS involve long term time series, so it is important to always maintain consistency over time. (Or at least to have some means of performing an intercalibration.) If required previous years could be reprocessed to a new version to ensure compatibility with newer products.
- The question of trajectories of land use came up several times, particularly but not exclusively in the context of LULUCF. Where changes in land use occur, users would like to be easily assess these changes, for example to see how much forest is being lost to urbanisation, how much to agriculture, etc. There was a concern that the current CLMS layer do not easily lend themselves to this analysis.
- Several users emphasised the need for access to adequate processing resources to fully utilise CLMS products. Although CLMS products are available in the Copernicus Data Space Ecosystem (formerly DIAS) there is no formal connection between the services.
- In addition, the need for suitable help and support to new CLMS users was identified.

# ANNEX 1: Interview Outputs

## Agricultural Expert, JRC

| | |
|---|---|
| interviewee | Agricultural Expert, JRC |
| Main fields of focus | Agriculture, CAP |
| How have you used CLMS services before, and what is your feedback? | Looked at CLMS as part of implementation of CAP services. Copernicus services are good in the policy context and for validation of reporting, but not necessarily for implementation.<br>Separation of CLMS from processing solutions (DIAS/DAS) is not ideal as it reduces the options for users to play with the data to create a bespoke service. |
| What additional products /services would you like to see from CLMS? | Aim more to provide inputs to services, rather than services per se. Ideally CLMS would give a stream of ARD that local or European stakeholders could take up this would be in line with the recommendation for the ECA report to share processing burden with member states. |
| Which of the EVOLAND Services are of interest?<br>In each case, what specific requirements or suggestions do you have? | Services are useful but more at a policy level than for real reporting. General requirements applicable to all services:<br>• Precision is more important than accuracy in policy reporting. Don't change methods unless absolutely essential.<br>• Want parcel/field-based reporting and not pixel-based monitoring.<br>• Ensure high thematic resolution / coverage to allow for regional differences, e.g. in some areas grassland is important, in others it may be orchards. |
| Are there any other more general requirements that should be highlighted? | Want to support local projections and not try to make products fit Europe-wide. Ideally would allow users to fine tune the services according to their needs.<br>Need to provide adequate support to users in the service uptake. |
| Any other comments? | No |

## Ecosystem Accounting Expert, EEA

| | |
|---|---|
| interviewee | Ecosystem Accounting Expert, EEA |
| Main fields of focus | Ecosystem accounting |
| How have you used CLMS services before, and what is your feedback? | Has used many CLMS products.<br>Issue in past around CORINE spatial resolution. Change detection is also an issue, as it's not always possible to do a difference map with CLC.<br>The fact that individual services are user driven means that it is not always clear how to relate different services. |
| What additional products /services would you like to see from CLMS? | Product proliferation is an issue, suspect some redundancy of products within the CLMS portfolio. Would like to see a move towards an integrated land monitoring service. |
| Which of the EVOLAND Services are of interest?<br>In each case, what specific requirements or suggestions do you have? | **C1: Continuous forest monitoring**<br>Service as described is clearly useful and relevant.<br>10m resolution OK for most purposes within Europe.<br>Robust change detection is important. |

| | |
|---|---|
| | Need to be clear on definition of forest, as this is not straightforward. FAO definition is the nearest we have to a standard but is not uniformly used.<br>Start from the definition of tree cover but then keep flexible to allow users to shape this. Also account for edge effects.<br>**C2: forest disturbance mapping**<br>Service as described is clearly useful and relevant.<br>10m resolution OK for most purposes within Europe.<br>Don't limit to wildfires but cover as many sources of disturbance as possible.<br>**C3: forest biomass mapping**<br>Service as described is clearly useful and relevant.<br>Would like to get intermediary products, specifically canopy height and canopy roughness, as these are indicators of forest heterogeneity, useful for understanding the ecosystem.<br>Urban biomass also of interest.<br>**C6: small landscape feature mapping**<br>Start from the existing small woody features but extend it. Linear features (hedges, ditches, stone walls) are particularly of interest as they show ecosystem fragmentation. Need to differentiate between dry and water linear features.<br>Highlighting change detection is again key.<br>**C7: improved water body mapping**<br>Need for temporal dynamics of wetlands, seasonal or monthly.<br>**C10: Continuous mapping of land surface characteristics**<br>Proposed service is interesting but not clear how it relates to other services, e.g. water body mapping.<br>**C11: Continuous mapping of land surface characteristics**<br>How would this service be paid for by the user? |
| Are there any other more general requirements that should be highlighted? | Look at lessons learned from habitat mapping exercise; products need to support ecosystem accounting, with sufficient thematic definition.<br>Keep backwards compatibility, adding supplementary layers for higher resolution or other improvements.<br>Latency and timeliness of products needs to be improved. |
| Any other comments? | Often the key barrier for users is not access to data but to the processing power required to effectively utilise it. |

# LULUCF Expert, EEA

| | |
|---|---|
| interviewee | LULUCF Expert, EEA |
| Main fields of focus | LULUCF |
| How have you used CLMS services before, and what is your feedback? | Previously part of Copernicus group, so has experience both as user and producer.<br>CLMS generally works well, but several services deliver similar products with different geometry and resolution, which is confusing for users and reduces the ability to inter-compare products. |
| What additional products /services would you like to see from CLMS? | Need both lower-level products which can be post-processed by users, and higher-level products which can be used without changes.<br>Move toward one basic product with segmented layers would be welcomed. |
| Which of the EVOLAND Services are of interest? | **C1: Continuous forest monitoring**<br>The service is useful as described.<br>**C2: forest disturbance mapping** |

| | |
|---|---|
| In each case, what specific requirements or suggestions do you have? | Annual basis is necessary, with changes, with option for more frequent updates for assessing specific events.<br>Distinguish between biotic and abiotic events.<br>Important to cover both storms and drought.<br>**C3: forest biomass mapping**<br>Currently assessing the ESA BIOMASS product -would like to see this prototype follow these definitions. Needs to support the modelling of below ground biomass as well.<br>**C4: Cover crop type mapping**<br>For LULUCF there is only an obligation to follow main crops, not cover crops. But would still be interested to see how far we can take this.<br>**C5: Cropland/Grassland GPP**<br>Very relevant to get fluxes, also DGs AGRI & ENV want to assess grassland productivity.<br>Need all of Europe at 10m, can't work with 100m.<br>Need to know that it works in different regions, so important to have test sites across Europe.<br>**C11: On Demand Land Cover**<br>No strong opinion but would use it if it were available. |
| Are there any other more general requirements that should be highlighted? | Consistency between products is critical. See, for example, the changes in resolution in soil sealing between 2015 and 2018 as Sentinels came online. |
| Any other comments? | Need better support for users who want to use CLMS data.<br>Independent validation is important.<br>Need to think about the complete use case, so as well as product think about things like provision of data cubes and processing resources. |

# Soil Expert, JRC

| | |
|---|---|
| interviewee | Soil Expert, JRC |
| Main fields of focus | Soil Monitoring |
| How have you used CLMS services before, and what is your feedback? | Has used many different CLMS products, especially CLC. |
| What additional products /services would you like to see from CLMS? | Assessment of crop types, which is difficult to obtain. |
| Which of the EVOLAND Services are of interest?<br>In each case, what specific requirements or suggestions do you have? | **C1: Continuous Forest mapping**<br>Changes are of interest as they can show erosion. But generally, the existing CLMS forestry products are good enough for use in soil models.<br>**C4: Cover crop mapping**<br>All crop information is of interest, not just cover crops. Most requirements could be met by having maps of 10 most important crops in each country or region.<br>Need at least annual products, at a resolution of 10-20m, and with products available with delay no later than 2 year (ideally 1 year).<br>**C5: Cropland/Grassland GPP**<br>Also interesting for modelling soil carbon. Ideally would want to get 10 daily products-<br>**C6: small landscape features**<br>Would be interested in data on plant residues, grass margins, and terraces. |

| | |
|---|---|
| | **C7: improved water body mapping**<br>Of interest but of secondary importance. Considered quite difficult to use but would be interested in seeing what we can do.<br>**C8: Continuous Imperviousness Mapping**<br>Soil sealing maps are of key importance, but it is just as important to get maps of de-sealing, to show overall zero degradation. Need a clear identification of changes, and ideally information on what type of land has been lost to sealing, or what land is used for after de-sealing. Need this information over at least EU27, ideally also other areas such as EEA38 and North Africa. Annual products are desirable but not essential as sealing has a slower trend. Would want resolution of 10-20m, and with products available with delay no later than 2 year (ideally 1 year). |
| Are there any other more general requirements that should be highlighted? | Very important to keep continuity as it is necessary to identify long terms trends in sealing or soil carbon. |
| Any other comments? | Very interested to get products to assess. Also interested if we can identify datasets for validation. |

# LULUCF Expert, JRC

| | |
|---|---|
| interviewee | LULUCF Expert, JRC |
| Main fields of focus | LULUCF |
| How have you used CLMS services before, and what is your feedback? | Using CLMS to support member states in drawing up their LULUCF inventory.<br>Data are being used for this purpose for the first time, so many issue encountered. Some MSs are more advanced than others. |
| What additional products /services would you like to see from CLMS? | Need harmonised layers over last 20 years or so, in order to establish baselines.<br>Would like to create a transition of matrix showing changes in land use, would like to be able to easily use CLMS for this. |
| Which of the EVOLAND Services are of interest?<br>In each case, what specific requirements or suggestions do you have? | **C1: Continuous Forest mapping**<br>Keep a flexible definition of what is a forest, as MSs use their own definitions, and don't expect there to be convergence in the foreseeable future. Although main interest is in Europe this could also be used worldwide. Mapping area 0.05 to 1.0 hectare.<br>**C2: Forest disturbance monitoring**<br>Sector inventories mainly used burnt area mapping, but also interested in windstorms and infestations. How to map and account for forest management practices? Not clear how to account for increased logging as a means to counteract infestations.<br>**C3: Forest biomass mapping**<br>Important as determines the carbon budget of a given event. Capacity to absorb carbon is the key question. Also useful to get intermediate products of canopy height and tree crown cover. Forest age is also important but can't be determined directly by remote sensing.<br>**C5: Cropland/Grassland GPP mapping**<br>Not so important as for purposes of LULUCF this is assumed to be at balance.<br>**C7: Improved Water Body mapping** |

| | |
|---|---|
| | There is a need for better wetland mapping, so possibly this product could help here. |
| Are there any other more general requirements that should be highlighted? | For all products the requirements are:<br>• 10m resolution within Europe. If going worldwide could relax this to approx. 300m.<br>• Annual updates with products available as soon as possible.<br>• Harmonisation with data from previous years. |
| Any other comments? | There is a need for better wetland mapping, which may be an additional product that could be added to the portfolio.<br>Very interested to see results and to know what can be recommended to member states in the future. |

# Forest Expert, JRC

| | |
|---|---|
| interviewee | Forest Expert, JRC |
| Main fields of focus | Forestry, but with experience in LULUCF from a previous role |
| How have you used CLMS services before, and what is your feedback? | Used for monitoring forests and for LULUCF.<br>A three yearly update cycle is not enough, good that CLMS is moving to annual production.<br>For user uptake consistency is essential, booth over time and over different regions (e.g. between European and global datasets). If necessary, recompute earlier times for consistency, with suitable versioning. |
| What additional products /services would you like to see from CLMS? | |
| Which of the EVOLAND Services are of interest?<br>In each case, what specific requirements or suggestions do you have? | **C1: Continuous Forest mapping**<br>There are different definitions of forest used; the FAO definition should apply. Use tree cover density outputs to support alternative definitions. Note the difference between land use and land cover: harvested forest still counts as forest until under new use. Want to understand what is driving change (also worldwide) and where forests are being lost to.<br>**C2: Forest disturbance monitoring**<br>Get localised information on forest changes quickly. Characterisation of what is the disturbance type is very interesting, want to use this service to identify agents, including fires, bark beetle, storm and floods. Do not overlook slow degradation processes such as droughts.<br>**C3: Forest biomass mapping**<br>Biomass estimates used for many policy contexts, but the service is not enough by itself. Need also indicators of tree species, height, age, etc. For this specific case annual updates are not needed as they have too much noise. Also better to prioritise precision over accuracy as aim is to identify the trend. Need also to look at other sources of biomass for fuller picture, including below-ground and tree litter, but difficult to do with remote sensing.<br>**C5: Cropland/Grassland GPP mapping**<br>Want to be able to detect land management practices, e.g. number of mowing events per year, but should this be a downstream service rather than a CLMS service?<br>**C6: small landscape features**<br>Want to be able to identify ditches and to see whether they are in use or not. |

| | |
|---|---|
| Are there any other more general requirements that should be highlighted? | Both for forestry (including worldwide) and for LULUCF it is important to map changes, i.e. what the land was/is used for. In all cases it is important to provide uncertainty estimates for the products as well as validation. |
| Any other comments? | No |

# EvoLand Consortium