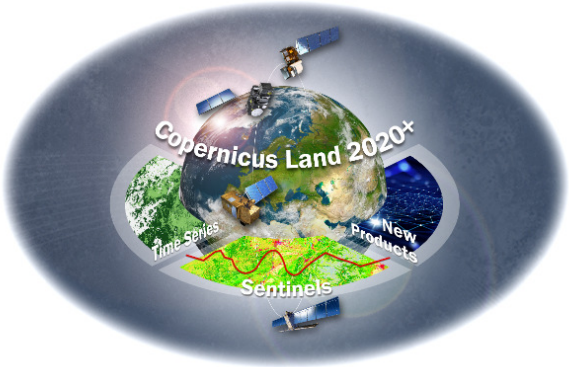
Horizon 2020

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

Grant Agreement No. 730008

ECoLaSS

Evolution of Copernicus Land Services based on Sentinel data



D3.1

"D21.1a – Service Evolution Requirements Report"

Issue/Rev.: 1.0

Date Issued: 09.08.2017

submitted by:

GAFAG

in collaboration with the consortium partners:

SIRS JOANNEUM RESEARCH DIGITAL UCL Université catholique de Louvain DLR

submitted to:

European Commission – Research Executive Agency

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 730008.

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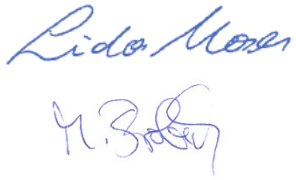
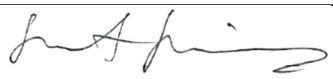
	NAME, FUNCTION	DATE	SIGNATURE
Author(s):	Linda Moser (GAF), Markus Probeck (GAF), Inés Ruiz Gomez (GAF), Christophe Sannier (SIRS), Heinz Gallaun (JR)	28.06.2017	
Review:	Gernot Ramminger (GAF), Christophe Sannier (SIRS)	11.07.2017	
Approval:	Markus Probeck (GAF)	09.08.2017	
Acceptance:	Massimo Ciscato (EC-REA)		
Distribution:			

DISSEMINATION LEVEL

DISSEMINATION LEVEL		
PU	Public	**X**
CO	Confidential: only for members of the consortium (including the Commission Services)	Annex 1

DOCUMENT STATUS SHEET

ISSUE/REV	DATE	PAGE(S)	DESCRIPTION / CHANGES
1.0	09.08.2017	47 + 60 (Annex 1)	First issue of Service Evolution Requirements Report

APPLICABLE DOCUMENTS

ID	DOCUMENT NAME / ISSUE DATE
AD01	Horizon 2020 Work Programme 2016 – 2017, 5 iii. Leadership in Enabling and Industrial Technologies – Space. Call: EO-3-2016: Evolution of Copernicus services. Issued: 13.10.2015
AD02	Guidance Document: Research Needs Of Copernicus Operational Services. Final Version issued: 30.10.2015
AD03	Proposal: Evolution of Copernicus Land Services based on Sentinel data. Proposal acronym: ECoLaSS, Proposal number: 730008. Submitted: 03.03.2016
AD04	Grant Agreement – ECoLaSS. Grant Agreement number: 730008 – ECoLaSS – H2020-EO-2016/H2020-EO-2016, Issued: 18.10.2016
AD05	D1.1 "D11.1a - Agendas and Minutes of Meetings", Issue/Rev.: 1.0, Date Issued: 17.02.2017 (ECoLaSS Kick-Off meeting minutes)

EXECUTIVE SUMMARY

The Horizon 2020 (H2020) project, "Evolution of Copernicus Land Services based on Sentinel data" (ECoLaSS) addresses the H2020 Work Programme 5 iii. Leadership in Enabling and Industrial technologies - Space, specifically the Topic EO-3-2016: Evolution of Copernicus services. ECoLaSS will be conducted from 2017–2019 and aims at developing and prototypically demonstrating selected innovative products and methods for future next-generation operational Copernicus Land Monitoring Service (CLMS) products of the pan-European and Global Components. This will contribute to demonstrating operational readiness of the finally selected products, and shall allow the key CLMS stakeholders (i.e. mainly the Entrusted European Entities (EEE) EEA and JRC) to take informed decisions on potential procurement of the next generation of Copernicus Land services from 2020 onwards.

To achieve this goal, ECoLaSS will make full use of dense time series of Sentinel-2 and Sentinel-3 optical data as well as Sentinel-1 Synthetic Aperture Radar (SAR) data. Rapidly evolving scientific as well as user requirements will be analysed in support of a future pan-European roll-out of new/improved CLMS products, and the transfer to global applications.

This Deliverable "**D21.1a – Service Evolution Requirements Report**" analyses the service evolution requirements of Copernicus Land services, for mid-term (2018) and long-term (2020+) evolution. These requirements were collected by conducting a number of phone and face-to-face interviews with key representatives of European institutions as well as key national users and stakeholders that are in charge of implementing or coordinating CLMS activities. This report considers recent developments regarding Copernicus Land services as well as future plans, and extends the information gathered in the interviews with additional sources such as relevant reports and presentations from recent workshops on the topic.

Summarising, the results of this user requirements analysis show that the methodological and prototypical developments planned for ECoLaSS – which are drafted in the Grant Agreement No. 730008 – largely concur with the perception and future plans of the key users and stakeholders in terms of Copernicus Land Service Evolution.

The ECoLaSS project will focus on the pan-European and Global Component aspects, as these are partially closely related, and take into account the respective needs of the key user and stakeholder community. Most of the requirements for evolution of existing services and for next-generation new services could be initially collected for the pan-European CLMS products, i.e., the High Resolution Layers (HRLs) in terms of improvements in information content and timeliness, and CORINE Land Cover (CLC) in terms of development towards CLC+. Requirements for the Global Component were collected from key representatives of the EC's Joint Research Centre (JRC). There is generally substantial interest about the use of the High Resolution Layers, particularly when equivalent information is not available at national level, but it should be stressed that some users indicated that there is still a lack of awareness about the HRLs, which is hampering their take-up and use.

Furthermore, national users showed particularly high interest in products of the Local Copernicus Component, which is clearly related to the higher spatial resolution of the products, better fulfilling the information needs on a regional level and also perhaps because these products are thematically closer to those already available locally. There is a general trend towards increasing interest in Copernicus (Sentinel) satellite data, which was repeatedly mentioned by several users.

In terms of specifications, the requirement for shorter update frequencies and change products (incremental updates) was mentioned several times. Concerning new services, a pan-European Agricultural Service as well as a Phenology Layer were the most frequently recorded responses. A further outcome is a trend towards the desire for more generic or cross-cutting services and products.

While it was observed that technical issues and limitations of the CLMS products' (satellite and other) input data, as well as the actual methods for generation of the products are not of major concern to the users, it was also found that (depending on the individual user) the knowledge of specifications of the existing

products and metadata is in general rather limited. Requests for obtaining more information on the products and metadata was voiced several times. Additionally, a general requirement for an easier and standardized access to data, products and documentation, on a unified access portal, was repeatedly stated, including the desire for a multi-layer online visualization and/or evaluation tool for the products.

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Abbreviations

AdV	Arbeitsgemeinschaft der Vermessungsverwaltungen (German Association of Land Surveying Authorities
AFIGEO	Association Française pour l'Information Géographique) French Association for Geographical Information)
AG	Aktiengesellschaft (stock company)
BfN	Bundesamt für Naturschutz (German Federal Agency for Nature Conservation)
BKG	Bundesamt für Kartographie und Geodäsie (German Federal Agency for Cartography and Geodesy)
BMUB	Bundesministeriums für Umwelt, Naturschutz, Bau und Reaktorsicherheit (German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety)
BMVI	Bundesministerium für Verkehr und digitale Infrastruktur (German Federal Ministry of Transport and Digital Infrastructure)
BMVIT	Bundesministerium für Verkehr, Innovation und Technologie (Austrian Ministry for Transport, Innovation and Technology)
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Develoipment)
CAP	Common Agricultural Policy
CCM	Copernicus Contributing Mission
CDDA/s	Common Database on Designated Area/s
CGDD	Ministère de l'Environnement, de l'Énergie et de la Mer (French Environment, Energy and Sea Ministry)
CGS	Collaborative Ground Segment
CLC	CORINE Land Cover
CLC+	CORINE Land Cover plus (with improved specifications)
CGDD	Comissariat Général au Développement Durable (French General Office for Sustainable Development)
CLMS	Copernicus Land Monitoring Service
CNES	Centre National d'Études Spatiales (French Space Agency)
CNIG	Conseil National de l'Information Géographique (French National Council for Geographic Information)
CO	Confidential
CODE-DE	Copernicus Data and Exploitation Platform – Deutschland
CSV	Comma-separated values
DEM	Digital Elevation Model
DESTATIS	Deutsches Statistisches Bundesamt (German Federal Statistical Office)
DG/s	Directorate-General/s
DG AGRI	Directorate-General for Agriculture and Rural Development
DG DEVCO	Directorate-General for International Cooperation and Development
DG GROW	Directorate General for Internal Market, Industry, Entrepreneurship and SMEs
DG ENV	Directorate-General for Environment
DIAS (CDIAS)	(Copernicus) Data and Information Access Service
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center)
DRI	Direction de la Recherche et de l 'Innovation (French Innovation and Research Directorate)
DWD	Deutscher Wetterdienst (German Weather Service)

DWH	Data Warehouse
EAA	Environmental Agency Austria (Umweltbundesamt Österreich)
EAGLE	EIONET Action Group on Land Monitoring in Europe
EC	European Commission
ECoLaSS	Evolution of Copernicus Land Services based on Sentinel data (H2020 project)
ECV	Essential Climate Variable
EEA	European Environment Agency
EEA-39	The 33 member countries of the EEA (i.e., the EU-28 member states together with Iceland, Liechtenstein, Norway, Switzerland and Turkey), plus 6 cooperating West Balkan countries (i.e., Albania, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Montenegro, Serbia as well as Kosovo)
EEEs	European Entrusted Entities
EFDAC	European Forest Data Centre
EFFIS	European Forest Fire Information System
EIONET	European Environment Information and Observation Network
ELF	European Location Framework
ELI	Earth and Life Institute
EMS	Emergency Management Service
ENFIN	European Network of Forest Inventories
EO	Earth Observation
EOC	Earth Observation Centre
EPA/s	Environmental Protection Agency/s
ESA	European Space Agency
ETC	European Topic Centre
ETC/ULS	European Topic Centre on Urban, Land and Soil Systems
EU	European Union
EU-28	the 28 member states of the European Union
EUROGI	European Umbrella Organisation for Geographic Information
EVI	Enhanced Vegetation Index
FAO	Food and Agriculture Organization (of the UN)
FISE	Forest Information System for Europe
FOR	Forest (HRL)
FP6	7th EC Framework Programme for Research and Technological Development
FP7	6th EC Framework Programme for Research and Technological Development
FS Unit	Food Security Unit, JRC
GAF	GAF AG (a service provider)
GAFA	Google, Apple, Facebook and Amazon
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GFZ	Deutsches GeoForschungsZentrum (German Research Centre for Geosciences)
GHSL	Global Human Settlement Layer
GIO	GMES Initial Operations
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation)
GmbH	Gesellschaft mit beschränkter Haftung (limited liability company)

GMES	Global Monitoring for Environment and Security (former name of Copernicus)
GHG	Greenhouse Gas
GRA	Grassland
GSAA	Geospatial Aid Application
GUF	Global Urban Footprint
GUI	Graphical User Interface
H2020	Horizon 2020 (the 8th Framework Programme for Research and Technological Development of the EC)
HR	High Resolution
HRL/s	High Resolution Layer/s
IACS	Integrated Agricultural Control System
IGN	Institut National de l'Information Géographique et Forestière (National Institute of Geographic and Forest Information)
IMD	Degree of Imperviousness
IMP	Imperviousness (HRL)
InVeKoS	Integriertes Verwaltungs- und Kontrollsystem (English: Integrated Administration and Control System – IACS)
ISRSE	International Symposium on Remote Sensing of Environment
INSPIRE	INfrastructure for SPatial InfoRmation in Europe
JKI	Julius Kühn-Institut
JR	Joanneum Research GmbH (a service provider)
JRC	Joint Research Centre of the EC
KO	Kick-Off
LABO	Bund-Länder Arbeitsgemeinschaft Bodenschutz (German Federal Working Group on Soil Protection)
LBM-DE	Landbedeckungsmodell Deutschland
LISA	Land Information System Austria
LC	Land Cover
LCC	Land Cover Change
LC/LU	Land Cover/Land Use
LPIS	Land Parcel Identification System
LU	Land Use
LUCAS	Land Use/Cover Area frame Survey
LULUCF	Land Use, Land Use Change and Forestry
MAES	Mapping and Assessment of Ecosystems and their Services
MMU	Minimum Mapping Unit
MR	Medium Resolution
MS/s	Member State/s
N2000	Natura 2000
NA	Not Applicable / No Answer
NFI/s	National Forest Inventory/-ies
NFP	National Focal Point
NGOs	Non-Governmental Organisation/s
NGR	Natural and Semi-natural Grassland (HRL 2012)
NRC	National Reference Centre
NRC-EIS	EIONET National Reference Centres (NRCs) on Environmental Information Systems

NSS	Natural systems and sustainability programme, EEA
NSS3	Land systems group, EEA
PEPS	Plateforme d'Exploitation des Produits Sentinel (Sentinel Products Exploitation Platform)
PPI	Plant Phenology Index
PU	Public (Dissemination Level)
PWB	Permanent Water Bodies (HRL 2012)
R&D	Research & Development
REA	Research Executive Agency (of the EC)
RZ	Riparian Zones
S-1 / S1	Sentinel-1
S-2 / S2	Sentinel-2
S-3 / S3	Sentinel-3
SAR	Synthetic Aperture Radar
SAS	Société par actions simplifiée
SDG/s	Sustainable Development Goal/s
SEIS	European Shared Environmental Information System
SIRS	Systèmes d'Information à Référence Spatiale SAS (a service provider)
SOER	State of Environment Report
SOeS	Service de l'Observation et des Statistiques (French Observation and Statistical Service)
SP(s)	Service Provider(s)
SWF	Small Woody Features (HRL 2015)
TCD	Tree Cover Density
TI	Thünen-Institut
UA	Urban Atlas
UBA	Umweltbundesamt Deutschland (German Environment Agency)
UCL	Université Catholique de Louvain (Catholic university of Leuven), Belgium
UFZ	Helmholtz-Zentrum für Umweltforschung (Helmholtz Centre for Environmental Research)
UN	United Nations
UNECE	United Nations Economic Commission for Europe
VHR	Very High Resolution
WaW	Water/Wetness (HRL 2015)
WET	Wetlands (HRL 2012)
WFS	Web Feature Service
WMS	Web Map Service
WP	Work Package

1 Introduction

The Horizon 2020 (H2020) project, "Evolution of Copernicus Land Services based on Sentinel data" (ECoLaSS) addresses the H2020 Work Programme 5 iii. Leadership in Enabling and Industrial technologies - Space, specifically the Topic EO-3-2016: Evolution of Copernicus services. ECoLaSS will be conducted from 2017–2019 and aims at developing and prototypically demonstrating selected innovative products and methods for future next-generation operational Copernicus Land Monitoring Service (CLMS) products of the pan-European and Global Land Components. This will contribute to demonstrating operational readiness of the finally selected products, and shall allow the key CLMS stakeholders (i.e. mainly the Entrusted European Entities (EEE) EEA and JRC) to take informed decisions on potential procurement of the next generation of Copernicus Land services from 2020 onwards.

ECoLaSS will make full use of dense time series of Sentinel-2 and Sentinel-3 optical data as well as Sentinel-1 Synthetic Aperture Radar (SAR) data. Rapidly evolving scientific as well as user requirements will be analysed in support of a future pan-European roll-out of new/improved Copernicus Land Monitoring Service products, and the transfer to global applications.

The Deliverable D3.1: "D21.1a – Service Evolution Requirements Report" is the first Deliverable of Work Package (WP) 3: "WP 21 – Assessment of Service Evolution Requirements", as part of the Horizon 2020 (H2020) project "Evolution of Copernicus Land Services based on Sentinel data" (ECoLaSS), Task 2: "Consolidation of Copernicus Land Evolution Requirement". The main objective of this Task is to collect, update and consolidate the functional and technical evolution requirements of existing and upcoming services for the Copernicus Land Monitoring Service (CLMS) beyond 2020, both of the Continental and Global LMCS Component.

The assessment of service evolution requirements as outcome of WP 21 forms the basis for the developments to be implemented within the ECoLaSS project, e.g. the planned methodological developments (Task 3), prototype demonstrations (Task 4), user consultation/validation, as well as the identification of candidates for future operational roll-out and their integration potential in future (2020+) Copernicus Land services (Task 5). Additionally, the results of WP 21 constitute an important input to the assessment of evolution requirements of future/improved Copernicus Land services in terms of EO and other data needs (WP 22) as well as infrastructure needs (WP 23). The dependencies of WP 21 with the relevant other WPs/Tasks of the ECoLaSS project are visualised in Figure 1:

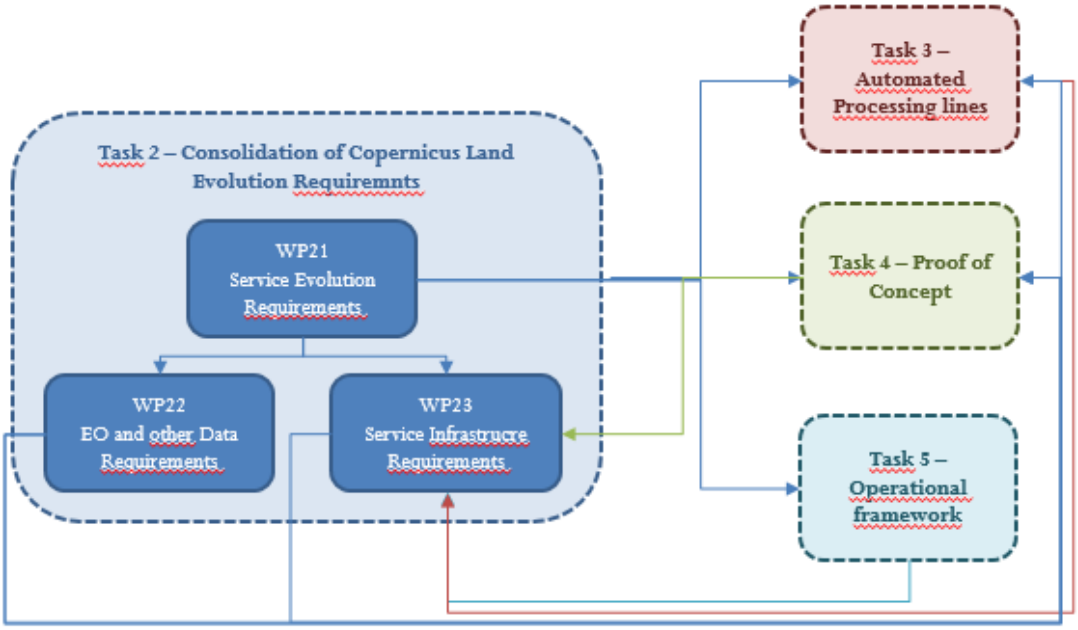

Figure 1: Schematic dependencies and information flows between the main ECoLaSS implementation Tasks

This deliverable "**D21.1a – Service Evolution Requirements Report (Issue 1)**" comprises a collection of the overarching requirements for the evolution of Copernicus Land services. These requirements were collected by conducting a number of phone and face-to-face interviews with key representatives of the main European stakeholders as well as representatives of national users and stakeholders that implement or coordinate Copernicus activities, and by systematically reviewing additional sources such as recent reports and presentations on the topic. Identified evolution requirements are considered taking into account the current (2012), upcoming (2015), future mid-term (2018) and future long-term (2020+) Copernicus Land Monitoring Service.

The ECoLaSS project follows a two-phased approach of two times 18 months duration. This deliverable comprises the first Issue compiled at an early stage of the first 18-month project cycle. As a synthesis report, it contains a compilation of all responses from user and stakeholder interviews, extended by information from additional sources such as reports or presentations on the topic. Despite the Local Component not being part of the developments envisaged in ECoLaSS, requirements for the Local Component were documented in addition to the pan-European and Global component as they were received. While this Deliverable is public in general, the complete interview protocols as documented in Annex 1 thereto, are provided as confidential deliverable (Please refer to document with Registration number: *Ares (2017)4020375*). In the second 18-month project cycle, a second issue of this deliverable will be published, containing all relevant updates of user requirements as known by then.

Chapter 1 of this document outlines the status and state of the art of current products and layers of the Copernicus pan-European and Global Component Land services (section 1.1), the approach for the user requirements analysis (section 1.2), and relevant additional information derived from reports and presentations (section 1.3).

Chapter 2 provides a synthesis of the collected service evolution requirements along policy framework and drivers (section 2.1), current and future use of Copernicus products and their strengths and limitations (section 2.2), as well as technical specifications for next-generation improved and novel CLMS products (section 2.3).

Chapter 3 contains a summary of the findings and conclusions as derived by "WP 21 – Assessment of Service Evolution Requirements", followed by an outlook on the next steps for the second ECoLaSS project phase.

The detailed questionnaires of the user requirements analysis are attached in Annex 1 (Please refer to document with Registration number: *Ares (2017)4020375*), and are referred to in the document as Annex 1-a – Annex 1.k, respectively.

Please note: *This Deliverable is not to be understood as an official reference whatsoever describing the future development of Copernicus Land Monitoring Service components and products. It merely constitutes a H2020 research project output, being based mainly on a non-exhaustive selection of interviews with key representatives of EEEs and the most relevant user communities, collecting their requirements, and aiming to confirm or adjust some of the products and services that are envisaged for development and demonstration as part of ECoLaSS. It does neither represent an official position of the European Commission nor of the EEEs.*

1.1 Status of existing Copernicus Land Services

With its initial operations started in the frame of the GMES/Copernicus Initial Operations (GIO) phase in in 2011, the Copernicus Land Monitoring Service (CLMS) is today providing information on global, pan-European (continental) and local scale, supported by reference data and an additional in-situ data component. All produced and validated Copernicus Land products are available as online viewing, WMS and download services on the Copernicus Land portal at: http://land.copernicus.eu/. In the following, the status of the pan-European and the global CLMS components are briefly explained in more detail, since both are the thematic focus of ECoLaSS:

PAN-EUROPEAN LAND COMPONENT

The pan-European as well as the Local CLMS components are coordinated by the European Environment Agency (EEA). During the GMES/Copernicus Initial Operations (GIO) phase**,** the pan-European Land component addressed mainly a set of five thematic so-called High-Resolution Layers (HRLs): Imperviousness, Forests, Natural Grassland, Wetland and Water Bodies, for the reference year 2012, as well as an update of the CORINE Land Cover (CLC) product for the year 2012. In parallel to the HRL production, European-wide NDVI datasets were calculated, and HR and VHR Image Mosaics created.

From September 2016 onwards, the production of the HRLs for the 2015 reference year had started, with the ECoLaSS consortium partners GAF and SIRS being involved in all five layers, among them GAF as Lead for the HRL Forest and HRL Grassland, and SIRS as Lead for the HRL Small Woody Features, and both being involved in minor roles also in all other Layers. All HRLs 2015 already make partially use of time series analysis of Sentinel and other CCM satellite data.

The Guidance Document (sections 5.2.2. to 5.2.4 and 5.2.6) related to the H2020 Call of the present project had already foreseen a range of evolution topics for the pan-European component. The ECoLaSS team has selected some of them to be addressed within ECoLaSS, pre-dominantly focussing on the evolution potential for the existing and potential future HRLs. The HRLs are currently produced as status and change layers every three years until 2018 (see Dufourmont, 2015[1]).

Based on the experiences from the GMES Initial Operations (GIO) stage between 2011 and 2014, **major bottlenecks** have been identified by EEA relevant for future evolution of the Copernicus Land Monitoring services on pan-European level (see also Dufourmont, 2015[1] and Dufourmont and Langanke, 2015[1]), which are being addressed in ECoLaSS:

- Acquisition of EO data for HR Layer production disconnected from service provision with: **a)** no continuous satellite image acquisition system (only two HR coverages), **b)** lack of timely availability of initial contiguous image coverages, **c)** very long range of image acquisition (4 years, from 2011 to 2014) for complete coverage (EEA-39)
- Complex workflow involving several (regionally split up) service providers and iteration with member states with a negative impact on:
    - timeliness (extended duration of GIO, 2011 to 2015), maturity level of HR Layers (e.g. two grassland iterations, no final product), lack of detailed product specifications
    - Geographic discrepancies and time series inconsistencies with different methods applied requiring better harmonisation of HRLs both from a spatial and temporal perspective.

GLOBAL LAND COMPONENT

The Global Land component, coordinated by the EC's Joint Research Centre (JRC), is providing a series of bio-geophysical products on status and evolution of the land surface, to monitor **vegetation state**, **water cycle** and **energy budget** using mid to low spatial resolution satellite sensors. During the 1st operational phase (2013 to 2015), the portfolio comprised products with a temporal coverage starting from 1998 to present, a temporal resolution between 1 hour to 10 days, a spatial resolution of 1 km to 0.1° and a

timeliness of 1 to 3 days (Cherlet, 2015[1]). For the next phase from 2016 onwards it is planned to add further products (e.g. moderate resolution land cover, Greenness evolution, etc.) to the list of the Global Land service and to increase the spatial resolution of some of the products from 1 km to 333 m / 100 m (Proba-V) and 300 m (S-3). The implementation of a Hot Spot monitoring component (i.e. Land cover and land use mapping) based on HR/VHR data has been initiated. New products (Cryosphere and water products) will also expand the user community. The Cryosphere and Water products are currently being developed and further information is provided on the http://land.copernicus.eu/global/products/ website. At the moment, little information is available for Cryosphere, but there are seemingly some potential overlaps with what is intended at pan-European level even though these products are meant to be produced based on S3 data, hence at 300m resolution (Annex 1.b).

1.2 Approach for User Requirements Analysis

This section outlines the approach for the user requirements analysis taken in this report (section 1.2.1), including the questionnaire that was developed to perform the interviews (section 1.2.2). Additionally, it provides an overview of sources such as reports and presentations of relevance (section 1.2.3).

1.2.1 User/Stakeholder Interviews

The user/stakeholder analysis was applied by performing phone or face-to-face interviews with key representatives of the most relevant European institutions as well as with a selection of key national users/stakeholders which have a mandate for national CLMS implementation or coordination.

Since the users and stakeholders all have different roles and mandates, different types and levels of involvement in Copernicus Land, and also different levels of knowledge and expertise about the existing and currently produced products, it was decided to perform guided oral interviews (rather than, e.g., an online questionnaire). Guided interviews allow for some flexibility in the interview process, in that they are more open than fully structured interviews, which tend to focus on closed questions. It was found that guided interviews better allow the interviewee to make suggestions and the interviewer to adapt the questions to the context. Thus, this allows the interviewer to provide explanations and guidance during the interviews, as well as for intermediate questions and for flexibility.

The interviews were carried out by the consortium partners GAF, SIRS, UCL and Joanneum Research. Despite the form of guided interviews, standard (empty) interview questionnaires were sent to all participants in advance to familiarise themselves with the matters, and the interviews were performed +/- along the structure of the questionnaire, with as much flexibility as deemed appropriate in the course of the interviews. From notes taken simultaneously by at least one additional person, interview protocols were compiled (see Annexe 1) and sent to the interviewees afterwards for updates, amendments or approval.

The first round of user requirements analysis is one of the first activities at the beginning of the project. It is primarily a qualitative analysis featuring questions with possibilities for open responses. The second round of analysis (planned in the second project phase between M19 and M22) will provide an update to this version of the Deliverable, and will focus on specific topics of interest.

Table 1 and Table 2 provide an overview of key representatives of relevant European institutions as well as key national stakeholders and users with a relevant Copernicus mandate, which were interviewed in the first round of assessment of the CLMS service evolution requirements. It should be stressed that the selection of interviewees was not meant to be exhaustive, but to select key representatives of EEEs and the most relevant user communities to confirm or adjust some of the products and services that are

[1] See http://land.copernicus.eu/event

envisaged for development and demonstration as part of ECoLaSS. As indicated, this is meant to be a proxy of the extensive user consultation process taking place as part of the Copernicus programme. In addition, it is an iterative process with further consultations planned during the course of the project. The filled interview protocols are given in Annexes 1.a – 1.k. Due to the sensitivity of part of the contained information, the Annex 1 is provided as a separate, restricted document (Please refer to document with Registration number: *Ares (2017)4020375*):

Table 1: Addressed European stakeholders and key national users

ANNEX	ORGANISATION	CONTACT POINT	ROLE OF ORGANISATION IN COPERNICUS
1.a	European Environment Agency (EEA)	Tobias Langanke	European Entrusted Entity (EEE) for Copernicus implementation
1.b	Joint Research Centre (JRC)	Michael Cherlet	European Entrusted Entity (EEE) for Copernicus implementation
1.c	Joint Research Centre (JRC)	Guido Lemoine, Olivier Léo	European Entrusted Entity (EEE) for Copernicus implementation
1.d	DG Environment (DG ENV)	Frank Vassen	Key European stakeholder and user
1.e	DG Environment (DG ENV)	Peter Löffler	Key European stakeholder and user

Table 2: Selected key national stakeholders/users:

ANNEX	ORGANISATION	CONTACT POINT	ROLE OF ORGANISATION IN COPERNICUS	COUNTRY
1.f	UBA Germany	Christian Schweitzer	key national coordinating Copernicus entity and user	Germany
1.g	BKG Germany	Ralf Gehrke	key national coordinating Copernicus entity and user	Germany
1.h	DLR Raumfahrtmanagement	Michael Bock	key national coordinating Copernicus entity and user	Germany
1.i	EEA Austria	Andreas Littkopf	key national coordinating Copernicus entity and user	Austria
1.j	CGDD (DRI+SOES)	Vincent Pircher, Benoit David, Frédérique Janvier	representatives of national user	France
1.k	CNIG, AFIGEO (workshop)	Pascal Lory	Group of national users	France

1.2.2 Questionnaire Template

The template for the stakeholder interview questionnaire that was used for all user and stakeholder interviews is the following:

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1. Description of your Organisation

Organisation:

Department/Unit:

Contact person:

Please describe the overall mission/mandate and policy objectives of your organisation and state which department/unit is responsible for following up on Copernicus Land Services.

2. Policy Framework

2.1 Role in Copernicus Land

Please describe the role of your organisation in relation to the CURRENT implementation/use of Copernicus Land Monitoring Services. [2]

Please describe the involvement of your organization for FUTURE (2020+) Copernicus Land Service implementation/use.

2.2 Policy-related Events/Milestones

What are the policy related events/milestones/reports for the work of your organisation within the next 5 years, with relevance to Copernicus Land Services?

2.3 Policy Drivers

(a) Highlight the main environmental regional/national and international environmental policies that your organisation implements or provides implementation support for (either directly or indirectly); (b) Explain how these policies drive your geographical information needs in relation to Copernicus Land Monitoring Services.

[2] http:\\land.copernicus.eu

2.4 Use of Copernicus Land Products

(a) Which Copernicus Land Service products are used in your organisation, and in which context?

(b) Where do you see the strengths and most valuable information in these products, and why?

(c) Which current shortcomings do you experience? (e.g., frequency, quality, thematic content…)

2.5 End Users & Applications:

2.5.1 Product Users

(a) Which kind of users are the users of the CURRENT Copernicus Land products (as far as you are aware of)? (include also national stakeholders, the private sector as well as research organizations…)

(b) Can you predict possible new kinds of users in 2020+?

2.5.2 End-use Applications

(a) What are the main end-use APPLICATIONS of the CURRENT Copernicus Land products (as far as you are aware of)?

(b) What are your thoughts on the situation in 2020+? (e.g., derived statistics for xyz report)

3. Technical Specifications for Copernicus Land Service Evolution:

3.1 Evolution of Existing Products

3.1.1 Products for Service Evolution

(a) Based on the current Copernicus Land product specifications, for which existing products do you consider an improvement/evolution as necessary? (you may address more than one product)

(b) Please state the reasons why?

3.1.2 Evolution of Key Specifications

Please provide desired specifications for the products under evolution (question 3.1.1): (e.g., MMU, spatial resolution, change monitoring, update frequency, nomenclature, thematic accuracy, data format, projection, attributes, quality information, INSPIRE metadata, access mechanism)

3.2 New Services/Products

3.2.1 Definition of New Services

Which new Copernicus Land products do you envisage?

(a) Mid-term (until ~2018 Update)

(b) Long-term (2020+)

3.2.2 Key Specifications for New Services

Please provide your idea of specifications for these new products (question 3.2.1): (e.g., nomenclature, spatial and temporal resolution, etc.)

3.2.3 Cross-cutting Services

(a) Do you see the need for new cross-cutting Copernicus Services? (b) If yes, which?

3.3 Implementation of Improved (see 3.1) and New Services & Products (see 3.2)

3.3.1 Implementation Schedule

What is your required schedule and plan for implementation of improved or new services/products into the operational Copernicus Land Monitoring Service portfolio?

3.3.2 Infrastructure

Do you have any specific requirements in terms of service provision via online platforms, data and information access services?

1.2.3 Relevant Reports and Presentations

Additional relevant material supporting the collection of service evolution requirements was compiled from different sources, such as (i) reports originating from previous studies and contracts related to the evolution of Copernicus Land services; and (ii) presentations at relevant meetings and workshops on the topic of the CLMS. Both were either provided by the interview partners or are available online or through the respective workshops.

The information gathered in the interviews is complemented in this report by additional information from reports of relevance in the following fields:

- Future potential Agricultural Service: The Joint Research Centre (JRC) emphasised the concept note entitled “Towards Future Copernicus Service Components in support to Agriculture” which has been drafted by JRC in April 2016 (JRC, 2016).
- Climate change indicators: The German Environment Agency – Umweltbundesamt (UBA) emphasized a report on the contribution of remote sensing – in particular Copernicus data and services – to the development and assessment of selected indicators as part of the indicator set of the German national adaption strategy to climate change (Schönthaler et al., 2017). UBA is involved in the indicator development and assessment and supports the above-mentioned study.
- Copernicus Strategy in Germany: DLR emphasised the „Nationales GMES Maßnahmenprogramm“ which is relevant to the Copernicus strategy in Germany (BMVBS, 2011).

Further important information on the CLMS evolution requirements are provided by several studies on various topics which were undertaken by the European Topic Centre on Urban, Land and Soil Systems (ETC-ULS) under a contract by the EEA:

- HRL partial incremental updates: The report "Task 17 – Analyse the possibilities for moving from 3 or 6 yearly snapshots into yearly partial incremental updates of land monitoring products, including the assessment of changes required in workflows" from 31.03.2016 (Hazeu et al., 2016) contains HRL product update considerations that had seemingly been already partially adopted for the HRL 2015 tender specifications.
- Inclusion of SAR data: The studies on "D1 - Fine tuning of technical specifications – Task II.6.2 – Define a methodology to ingest SAR based information in the HRLs on land cover characteristics over areas prone to cloud cover" from 30.11.2015 (Surek et al., 2015a), as well as "D2 - Summary report by case studies about potential use of SAR data – Task II.6.2 – Define a methodology to ingest SAR based information in the HRLs on land cover characteristics over areas prone to cloud cover" from 30.11.2015 (Surek et al., 2015b), summarize methodologies and tools for the processing of SAR data and provide case studies. These methods were not adopted into the HRL 2015 tender specifications to a large extent, however, dense SAR time series are operationally applied for the HRL 2015 production of Lot 3 - Grassland, and Lot 4 - Water/Wetness.
- Phenology: A scoping paper on "Remote Sensing Phenology for Ecosystem Assessment" from 15.11.2016 (Roering et al., 2016) had been drafted by the University of Wageningen in cooperation with EEA. It summarizes state-of-the-art methodologies for phenology parameter derivation and assessment, using existing tools such as Timesat, HANTS etc. amongst other methodologies.
- Land Degradation: The report entitled "Task 182_9 Scoping Study on Land Degradation" from 29.09.2015 (Aksoy and Prokop, 2015) provides an overview about land degradation assessment, including the use of remote sensing indicators and a respective case study. Copernicus services or products are not specifically addressed in the report, but there could be a potentially interesting connection to future Copernicus Land services.

Requirements from the following most relevant presentations from recent Copernicus workshops and scientific conferences were collected and considered for compiling this deliverable (more recent ones are named first):

- "Copernicus Programme": M. Massart, WorldCover 2017 Conference, Frascati, ESA/ESRIN, 14-16 March 2017 (Massart, 2017).
- "Sentinel-based Evolution of Copernicus Land Services on Continental and Global Scale": L. Moser, WorldCover 2017 Conference, Frascati, ESA/ESRIN, 14-16 March 2017 (Moser et al., 2017).
- "Advances in Copernicus High-Resolution Land Monitoring": L. Moser, WorldCover 2017 Conference, Frascati, ESA/ESRIN, 14-16 March 2017 (Ramminger et al., 2017).
- "Update and feedback from pan-European Copernicus land monitoring service": T. Langanke, ECoLaSS Kick-Off Meeting, 20 January 2017 (Langanke, 2017).
- "Copernicus Programme Status & Product Intentions for 2018": Copernicus User Forum 13, 11 January 2017, Brussels, Belgium (Copernicus User Forum, 2017).
- "Copernicus Data and Information Access Service (DIAS)": ESA, Industry Information Day, ESA/ESRIN, Frascati, 20 December 2016 (ESA, 2016).
- "Copernicus Agriculture and Forestry Applications User Requirements Workshop": P. Löffler, Brussels, 30 June 2016 (Löffler, 2016).
- "Copernicus Land Monitoring Service": T. Langanke, Fachworkshop: Die Herausforderung: Deutschland Monitoring. Nationales Forum für Fernerkundung und Copernicus 2015, Berlin, 3-5 November 2015 (Langanke, 2015).
- "Land monitoring service evolution: short term evolution": T. Langanke and H. Dufourmont, New Horizons for European and global land monitoring, 20 October 2015 (Langanke and Dufourmont, 2015).

- "EC policy perspective on the role of land in the Copernicus programme": P. Breger and C. Bamps, New Horizons for European and global land monitoring, Copenhagen, 19 October 2015 (Breger and Bamps, 2015).
- "Copernicus Land Monitoring – Global Land": M. Cherlet, New Horizons for European and global land monitoring, Copenhagen, 19 October 2015 (Cherlet, 2015).
- "Pan-European land monitoring: results and challenges": H. Dufourmont, New Horizons for European and global land monitoring, Copenhagen, 19 October 2015 (Dufourmont, 2015).
- "Copernicus in our operations": C. Steenmans, 36th International Symposium on Remote Sensing of Environment (ISRSE), Berlin, 11-15 May 2015 (Steenmans, 2015).

RECENT AND UPCOMING EVENTS

Additional, broader stakeholder consultation is carried out through participating in open conferences and workshops with strong focus on ECoLaSS key topics, such as LC/LU, time series applications, and continental to global scale Land applications and products. More targeted and stakeholder and user focused consultation is performed in the course of national and international Copernicus events. Recent and upcoming important events for user/stakeholder interaction where ECoLaSS consortium members participate(d) are stated in Table 3:

Table 3: Recent and upcoming events of relevance for user/stakeholder interaction

CONFERENCE	DATE	LOCATION	RELEVANT TOPICS
WorldCover 2017 Conference	14-16 March 2017	ESA, Frascati, Italy	LC/LU, Global CLMS Products
German National Copernicus User Forum	14-16 March 2017	Berlin, Germany	Copernicus (national)
CNES COSPACE Workshop on Vegetation	28 March 2017	Paris, France	Copernicus (national)
French national event with different stakeholders , such as National Council for Geographic Information (CNIG), French Mapping Agency (IGN) and French Association for Geographical Information (AFIGEO)	30 March 2017	Marne la Vallée France	Copernicus (national)
37th International Symposium on Remote Sensing of Environment	8-12 May 2017	Tshwane, South Africa	LC/LU, including Global Land Service special session
French Ministry of Solidary Ecological Transition	13 April 2017	France	Copernicus (national)
French National Copernicus User Forum: workshop on the evolution of Copernicus Services	14 June 2017	Paris, France	Copernicus (national)
MultiTemp 2017	27-29 June 2017	Bruges, Belgium	LC/LU, time series methods and monitoring applications
Coastal Monitoring Workshop	29 June 2017	Brussels, Belgium	Copernicus (international), coastal applications

CONFERENCE	DATE	LOCATION	RELEVANT TOPICS
Annual General Meeting of the European Association of Remote Sensing Companies (EARSC)	04-05 July 2017	Brussels	GEO and global Land products and evolution potential, ESA plans for Land services evolution
CCI+ Information Day	06 July 2017	Frascati	R&D plans for further evolution of land services, amongst others on bridging the gap between global and continental CLMS component
Copernicus Global Land workshop	27 September 2017	Brussels	Status and evolution of the CLMS Global component
EIONET NRC Land Cover Annual Meting	09-10 October 2017	Copenhagen	Upcoming CLC 2018 and CLC+, Member State involvement in future Copernicus services

2 Service Evolution Requirements

Chapter 2 provides a synthesis of the outcome of the user and stakeholder interviews. The collected requirements are structured along the questions in the interview questionnaires. The filled questionnaires are provided in Annex 1, and are referred to as Annex 1.a – Annex 1.k throughout this document. The requirements are grouped into three different sections: policy framework, drivers and milestones (section 2.1), products and technical specifications for existing services/products (section 2.2), and products and technical specifications for novel services/products (section 2.3).

2.1 Policy Framework, Drivers and Milestones

The following sections summarise the user's and stakeholder's responses related to their current and future role in the CLMS (section 2.1.1), and policy related events/milestones as well as policy drivers related to the CLMS (section 2.1.2). This is collectively considered the prerequisite to understand the related requirements for further evolution of the CLMS services and products.

2.1.1 User/Stakeholder Role in Copernicus Land (Current and Future)

When assessing the CLMS evolution requirements, it is first important to understand which role(s) the interviewed stakeholders have in the context of Copernicus. The aim was to assemble as broad a coverage of different CLMS mandates as possible in the frame of the ECoLaSS project. The current and future roles in the CLMS of the following organizations were recorded in the phone or face-to-face interviews:

European key stakeholders which are entrusted with the implementation of the CLMS:

- The European Environment Agency (EEA), interview partner: Tobias Langanke, of the Natural systems and sustainability programme (NSS), Land systems group (NSS3) / Coordinator of the High Resolution Layer (HRL) Implementation as part of the pan-European CLMS (see Annex 1.a).

  The EEA acts as the European Commission's (EC) European Entrusted Entity (EEE) to implement the pan-European and Local Copernicus Land Service Component, as well as to coordinate the cross-cutting In-situ activities. An important role of EEA in shaping the future CLMS implementation and use results from its own intense engagement and experience collected as user of the CLMS data. Experience from the current use is captured, and requirements and ideas for future service evolution and new products are systematically collected from the thematic user groups within EEA. This close integration is also structurally implemented by the close integration of Copernicus project managers in the NSS programme at EEA.

- The Joint Research Centre (JRC), interview partners: Michael Cherlet - Coordinator of the Copernicus Global Component, from the Knowledge Management for Sustainable Development & Food Security Unit - (see Annex 1.b) and Olivier Léo and Guido Lemoine from the Food Security Unit (see Annex 1.c).

  The JRC acts as the EC's EEE to implement the Global Copernicus Land Service Component until 2020. The JRC Food Security (FS) Unit acts as user of some of the Copernicus Land products, and has strong interest in the development of a future pan-European Agricultural Service. In April 2016, the JRC FS unit drafted a Concept Note: "Towards future Copernicus Service Components in support to agriculture?" (JRC, 2016), which is currently being updated following a series of consultations with Member States and the development of pilot studies initiated by Member States (CZ, DK, ES and EE) and some of which were recently launched through ESA.

- The DG Environment (DG ENV), interview partners: Frank Vassen, from Unit D3 – Nature conservation; Directorate „Natural Capital" (see Annex 1.d), who was, amongst other things, involved in the CLMS local component's Natura2000 product definition. And Peter Löffler from Unit D1 – Land Use & Management, Directorate D „Natural Capital" (see Annex 1.e), responsible for all Forest topics in Unit D1 and for the Forest Information System for Europe (FISE).

DG ENV acts as European key stakeholder and user of Copernicus Land Products and is interested in future developments of the pan-European CLMS, with specific focus on the HRL GRA (Unit D3) and HRL FOR (Unit D1).

National key users and stakeholders responsible for national Copernicus implementation/coordination:

- The German Environment Agency, Umweltbundesamt (UBA), interview partner: Christian Schweitzer, from the Environmental Information Systems and Services; "Sachgebiet I 1.5 - Umweltinformationssysteme und Dienste" Department (see Annex 1.f).

  UBA provides the deputy thematic coordinator for the Copernicus Land service in Germany through Dr. Thomas Schultz-Krutisch. The Agency was recently nominated as member of the Copernicus Relay network. It has further roles in Copernicus Land, such as being the EEA-EIONET national focal points (NFP) and National Reference Centre (NRC) for air quality as well as for Environmental Information Systems (EIS) which is responsible for CORINE Land Cover (CLC) updates. It is the general EIONET contact point for EEA for the CLMS pan-European and local components. Projects and feasibility studies will be conducted, focussing on Copernicus data application (e.g. for several thematic fields such as land sealing (imperviousness) or land cover and land use mapping, air quality). The role of UBA is expected to remain as it is, but the user behaviour could potentially change to a different need and possible use demand. There is an increasing recognition that financing further Copernicus related projects and feasibility studies through the „Ressortforschungsplan" of the German Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety (BMUB) is necessary to foster further national Copernicus uptake. Additionally, UBA is foreseen to be involved in the initial assessment of a future CLC+.

- The German Federal Agency for Cartography and Geodesy (Bundesamt für Kartographie und Geodäsie – BKG), interview partner: Ralf Gehrke, from the Development and Remote Sensing (Referat GI 7 Entwicklung und Fernerkundung) Department (see Annex 1.g).

  BKG is involved in Copernicus Land services through one of the "Fachkoordinatoren" (thematic coordinators) (Mr. Hovenbitzer), and is as member of the Copernicus Relay network since February 2017. BKG participates as well in the national CLC activities as subcontractor to the UBA. Currently, the Agency is running or starting several projects which are using Copernicus satellite, aiming to support the sustainable uptake of CLMS products. Among these are: *LBM-DE:* Landbedeckungsmodell Deutschland (BKG product); *CopKoordLand:* Support for the technical coordinator for Copernicus Land service and quality assessment of HRL and UA; *Cop4Stat*: Areal statistics in cooperation with the German Federal Statistical Agency (Statistisches Bundesamt) on national and European Level, as well as some research projects (*Landbedeckung mit Radardaten*: Sentinel-1 SAR data for land cover classification; *LaVerDi*: Sentinel-2 time series for change detection and SDG indicators; *Funkie*: testing datasets for natural hazard monitoring; *Open GeoEdu:* Remote sensing e-learning with Copernicus data). BKG is further foreseen to be involved in the initial assessment of a future CLC+. BKG is also taking part in the Copernicus User Forum.

- The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt (DLR) Raumfahrtmanagement), interview partner: Michael Bock, from the Earth Observation Department (see Annex 1.h).

  The DLR is the executive arm for the implementation of Copernicus in Germany, which had been entrusted by the German Federal Ministry of Transport and Digital Infrastructure (BMVI), to document the national Copernicus Strategy in the "Maßnahmenplan 2011". The DLR Space administration provides interfaces for Copernicus Land to users via national thematic Copernicus service coordinators and contact points ("Fachkoordinatoren"), which are UBA and the BKG in case of Land. DLR represents Germany in the Copernicus User Forum und the Copernicus Program Committee together with the thematic Copernicus coordinators. DLR is also co-organisor of the

National Copernicus Forums and info days. DLR's activities regarding Copernicus data cover informing, coordinating and integrating, qualifying and providing support and making data available. It is in charge of the national Copernicus website „Copernicus in Deutschland" (Copernicus in Germany). The DLR is also responsible for implementation of the German national Collaborative Ground Segment (CGS), called CODE-DE. One other DLR main activity is funding programs for German institutes. Currently, discussions with the BMVI are ongoing related to the continuation of the Copernicus Strategy from 2017 – 2022, as well as the national "Maßnahmenprogramm".

- The Environment Agency Austria (EAA), interview partner: Andreas Littkopf, from the Soil and Land Management Department. EAA is the Austrian EIONET National Reference Centre (NRC) for Land Cover (see Annex 1.i).

  The Agency leads the European Topic Centre on Urban Land and forest Systems and is directly supporting the Copernicus team at the European Environment Agency (EEA). Long-term cooperation with EEA is expected also to continue beyond 2020 e.g. in the frame of (future) European Topic Centres. The EAA advocates Copernicus services being used for national applications and further developments related to land and biodiversity monitoring.

- The General Office for Sustainable Development (CGDD) of the French Environment, Energy and Sea Ministry - Commissariat Général du Développement Durable du Ministère de l'Environnement, de l'Énergie et de la Mer - , interview partners: Mr Vincent Pircher from CGDD/ Direction de la Recherche et de l 'Innovation (DRI), French representative at Copernicus User Forum); Mr Benoit David from CGDD/DRI, Satellite National Plan and Mrs Frédérique Janvier which is the French EIONET NRC representative on Land Cover (see Annex 1.j).

  CGDD/DRI represents the French position to the Copernicus User Forum and steering group and is in charge of liaising with French stakeholders. Its main role is to provide feedback from French institutional needs. CGDD/SOeS is the French EIONET NRC and oversees the implementation of CLC for France as well as other Copernicus land products. It also develops statistical indicators based on Copernicus and other geospatial products for the French government. Regarding future activities, CGDD/DRI will provide input to future requirements from French institutions as part of the Copernicus steering group and user forum whilst SOeS will provide more technical input/feedback as part of the EIONET NRC meetings/activities and will address the national expression of need for environmental statistics, and the needs of other end users.

- The National Council for Geographic Information (CNIG)/ French Mapping Agency (IGN) and French Association for Geographical Information (AFIGEO). Interview partner: Pascal Lory, user interface for Copernicus Land services (see Annex 1.k).

  CNIG and AFIGEO are two organisations focusing on the development of Geographical Information in France. A workshop was recently organised involving French institutions and service providers, making use of Copernicus data, to present their solutions. This information was gathered at an information day organised by the French CNIG/IGN and AFIGEO on 30 March 2017 to foster exchanges between the Copernicus programme and the needs of end-users. Producers of in situ data (i.e. mainly IGN) also presented their vision regarding the complementarity between Copernicus and national infrastructure. The main activities towards these users are: Awareness of the Copernicus services offer, improve the relationship between these services and users' expectations, identification of service opportunities for private sector, support the users to position themselves in the added value chain, coordination of geographic information actors in France, recommendations to the Copernicus point of contact for France, recommendations at European level (European Commission, ESA, EEA, etc.), notably concerning favourable development conditions for service companies.

2.1.2 Policy Drivers and Milestones

For understanding the requirements of the stakeholders and users, it is of high importance to understand which obligations these do have in terms of reporting to international, European and/or national policies. Typically, these policies drive the needs for data and products. The most important policies related to Copernicus Land services are listed here below together with the main drivers and events related to them. European organisations as EEA, JRC or the various EC DGs, have a strong interaction, supporting several European international (environmental) policies.

State of Environment Report (SOER) (Annex 1.a, Annex 1.i):

The EEA is in charge of producing the State of Environment Report (SOER), which is the most important EEA internal use of CLMS data and addresses both the Common Agricultural Policy (CAP) and other environmental related policies as the Fishery and Cohesion ones. It is the only relevant report that is repeated regularly. It is issued in a 5-year cycle. Next SOER is upcoming in 2020, however, a major part will already be published in mid-2019 to feed into the ongoing policy making cycles of the Common Agricultural Policy, the Common Fisheries Policy and the Cohesion Policy.

EU Common Agricultural Policy (CAP) (Annex 1.a, Annex 1.c, Annex 1.i):

The European Union's Common Agricultural Policy (CAP) is one of the main leading policies of the Copernicus Land services. At international level, the "greening" legislation of the CAP is particularly relevant. There is also a scope on simplifying CAP management and controls considering the wide area and frequent monitoring capacities of the Sentinel sensors. EU actors such as JRC and EEA follow actively this policy.

European Forest Policies (Annex 1.a, Annex 1.c, Annex 1.e, Annex 1.i)

This **European Forest Strategy**, adopted in 2013, has a strong influence on the Copernicus Land services, both at international and national levels. Its monitoring and situation is also reflected in EEA's SOER publication. The EU agencies are also collecting the requirements from the Land Use, Land Use Change and Forestry (**LULUCF**) reporting (2021+) for more frequent monitoring of forest areas. DG ENV considers forested land as carbon sink; therefore, carbon stocks and flows shall be represented for forest in this reporting, suggesting the possibility of using Sentinel satellite data for this topic.

The **Forest Information System for Europe (FISE)** is the focal point for data and information on forests and forestry in Europe. Its development follows the EU Forest Strategy. The DG ENV considers that the envisaged focus of FISE shall be on: forest base data (extent, distribution, forest types etc.); forest biomass indicators; forest biodiversity and forest carbon. FISE is expected to become a cross-cutting public service. Unit D1 of this DG is also in charge of producing the **State of Europe's Forests Report**.

Mid- to long-term climate change & forest health could also be improved by using Sentinel data to monitor leaf discoloration, defoliation, phenology changes and impacts of increasing extreme-weather events such as droughts, storms and heavy rainfall.

EU Biodiversity Strategy to 2020 (Annex 1.d, Annex 1.e, Annex 1.i)

This policy is based on 6 main targets focused on the Birds and Habitats Directives. Its aim is to maintain and restore ecosystems and their services; increase the contribution of agriculture and forestry to biodiversity; ensure the sustainable use of fisheries resources; combat invasive alien species and help avert global biodiversity loss. The DG ENV indicates that the 'Fitness check' of the Habitats and Birds Directives concluded that the directives are fit for purpose, but are insufficiently implemented. Conservation status of the forest habitats and species is unsatisfactory. 80% of assessments of protected forest habitats gave

an unsatisfactory result. Sentinel satellite data could be of use in improving the conservation status Copernicus data could provide substantial input to reduce the effort of biodiversity monitoring using in-situ observations.

State of Nature Report (Annex 1.d):

The DG ENV produces the **"State of Nature" report**. It is published every 6-years (next one will be in 2019), primarily based on information reported by the Member States according to Article 12 Birds Directive and Article 17 Habitats Directive. In addition to the Member States' contributions, the utilisation of the (spatially extended) Copernicus Land Local Component "Natura 2000" product is planned by DG ENV, doing an own evaluation of the European N2000 site land use changes/trends.

EU Food Security and EU Development Policy, both under the DG DEVCO (European Commission Directorate-General for International Cooperation and Development) – (Annex 1.b, Annex 1.c):

There is a collaboration between JRC and DG DEVCO for the hot spot monitoring service on protected areas, supporting as well the food security policy at international level. Recently, the JRC has begun supporting to monitoring of land grabbing.

Sustainable Development Goals (SDGs) (Annex 1.a, Annex 1.b, Annex 1.k)

In addition to the above described, specifically European policies, the European stakeholders also participate to and support the Sustainable Development Goals (SDGs) of the United Nations (UN), contributing with indicators reporting and the **Atlas of Desertification,** amongst other elements.

Some national/local stakeholders also contribute to these goals as main policy drivers, which are currently (i) the provision of Sustainable Development Goals (SDGs) indicators, and (ii) for accompanying the "ecological transition" in some countries.

Other European policies that are linked to Copernicus Land activities, and could be linked to the Sentinel data use, are:

Bioenergy policy/Renewable Energy Directive: dealing with forest growth and use intensification. The potential intensification of biomass and exploitation versus biodiversity conservation is an area of conflict and a concern to DG ENV. Potential reduction of the forest carbon sink is also a concern.

Bioeconomy policy/"green growth": The amount of biomass in the forest (data on short-, medium- and long-term changes) are unreliable and partly missing. Additional quantitative information on forest carbon content is required.

In addition to all these global and European policies, by the year 2020 the conclusions of several EU flagship policies will be drawn, for which substantial inputs from the CLMS are expected to be used in advance (**7th Environment Action Programme, Europe 2020/Horizon 2020, EU Biodiversity Strategy to 2020**). The SOER is a good example of the potential role of Copernicus Products being used for the formulation and impact assessment of policies within the EEA. It is expected that for the 2020 SOER, CLMS data will be used to a much larger extent as compared to the 2015 SOER, with an anticipated availability of Local Component, HRL and CLC data with recent update dates.

The interviewed EU stakeholders are supporting such policy making and impact assessment. They are going, as well, through consultations and collection of results of the member states' own initiatives. Further reports are being produced. A number of other **EEA reports and publications** use CLMS data. These thematic reports are however only planned and known around 2 to 3 years in advance, so it is difficult to

predict exact policy drivers (and therefore CLMS data use). Past EEA reports that have used CLMS data were e.g. EEA report 31/2016 **Land Recycling** or report 11/2016 on "**Urban sprawl in Europe**". Reports planned in the near future comprise a report on "**Land resource efficiency**", and upcoming reports on "**Past land cover trends**" and on "**Environmental performance of cities**".

All the European directives are relevant not only at international/EU level but also at national and local level. Therefore, national and regional level policies related to Copernicus Land services are also provided in some cases and taken into account.

Most of the countries have their own specific policies, more specific than the European ones for their particular situation.

National Strategies for Biodiversity Conservation (Annex 1.f, Annex 1.j):

In particular the following two national strategies were pointed out from national users:

UBA reported that Germany has its own National Sustainability Strategy that helps Germany to report to the United Nations (UN). UBA is involved in consultations and discussions on this strategy (Annex 1.f).

CGDD reported the French National Strategy for Biodiversity. It has a "national state of the environment report" which is due in 2018 and is currently planned every four years (Annex 1.j).

Climate Change (Annex 1.f): Some countries have their own national adaption strategies to climate change, such as Germany. UBA is involved in the indicator development and assessment, and supports a study assessing the potential of remote sensing data for further indicator development and monitoring.

2.2 Use of Copernicus Land Monitoring Products, End-users and Applications

The following sections present the users' and stakeholders' responses related to their current use of CLMS products (section 2.2.1), including the strengths and shortcomings of these products (section 2.2.2). This builds the basis to identify targeted needs for product improvements or new developments (as further described in chapter 3. Additionally, section 2.2.3 summarizes product end-users and end-use applications that are currently known to the stakeholders and higher-level users.

2.2.1 Current Use of Copernicus Land Products

This section summarizes the Copernicus Land Monitoring Service products that are currently used in the interviewed stakeholders' organisations.

COPERNICUS LAND SERVICE PRODUCTS CURRENTLY USED IN STAKEHOLDER ORGANIZATIONS

EEA– Pan-European Component (Annex 1.a):

- Current use mainly of CLC and derived land take indicator for a number of reports and tasks where changes and trends in land use and cover are relevant.
- Use of imperviousness data both as a published EEA indicator, and in work and reports on urban issues and on biodiversity issues.
- Explorative use of HRL forest data and local component data, in particular Urban Atlas (UA) and Riparian Zones (RZ).

JRC – Global Component (Annex 1.b):

- Global Atlas of Desertification is derived from some Copernicus Land products

- Diverse products use in the Food Security Unit and Forestry Unit.

JRC – Food Security Unit (Annex 1.c):

- Current use of Copernicus Land products is very limited. HRL Grassland was considered potentially of great interest, but thematic content and quality issues in the HRL Grassland 2012 product prevented using it to its potential.

DG ENV – D3 Unit (Annex 1.d):

- The local component Natura 2000 product is planned to be used. So far, only 750 "pilot" N2000 sites are covered via the GIO-phase Natura 2000 project. The scope of the Natura 2000 product is currently being extended in close collaboration between EEA and DG ENV to cover all Natura 2000 sites with significant occurrences of grassland habitats in the current operational phase of Copernicus, by 2018/ early 2019. This will significantly increase the product's use potential.
- There are currently limited own capacities in DG ENV to analyse remote sensing/Copernicus data or products, however it is made use of external contracts.

DG ENV – D1 Unit (Annex 1.e):

- The evaluation and use of Copernicus products are still in an initial stadium.

UBA (Annex 1.f):

- Use and testing of CLC (used for several applications); HRL Imperviousness (IMP) (for calculation of imperviousness); Local Component Products: Urban Atlas (UA); and other Copernicus biodiversity topics like forest HRL products, Riparian Zones (RZ) and Natura2000 and others.
- Regarding HRL Forest (FOR): Feasibility study to detect tree species using Sentinel-2. In the future, tenders may be issued for the implementation of a tree species mapping. There is a further demand for a tree species map in Germany at Bundesamt für Naturschutz (BfN) and Thünen-Institut (TI) for the German State-of-Forest report ("Wald-Zustandsbericht").

BKG (Annex 1.g):

- Data of Copernicus Land services may be used in addition for various projects: HRL and UA in the project CopKoordLand, HRL/CLC in Cop4Stat

DLR Raumfahrtmanagement (Annex 1.h):

- DLR Raumfahrtmanagement does not use Copernicus products themselves, since in their coordinative function they rather provide funding for the development, implementation and use of Copernicus services to German public institutions and value adding industry.
- At the Earth Observation Center (EOC) of DLR Oberpfaffenhofen, Copernicus products may be used as well.

EAA (Annex 1.i):

- Land monitoring products are only used in a limited manner currently for European reporting. On basis of S2 products it is expected that also usage of the national level will be possible.

CGDD (Annex 1.j):

- CLC is the main source of data to provide various land cover indicators as part of the national strategy for biodiversity. Other sources are national or based on TERUTI-LUCAS (indicators for UN SDGs or the national ecological transition policy). However, the use of HRL IMD appears promising.

In summary, it seems that the current use and uptake of Copernicus products is quite different from entity to entity, both at European and national level. This appears to be more correlated to the different policies' information needs than to European or national level. One further component may be also the entities' heritage and record of Copernicus "exposure".

2.2.2 Strengths and Shortcomings of Current Copernicus Land Products

This section summarizes the strengths and shortcoming of the CLMS products, as collected from the stakeholders and other information sources. This collection builds the basis for voiced service update / evolution needs (as documented in section 2.3), and for the further development work to be undertaken in the ECoLaSS Tasks 3, 4 and 5 (cf. Figure 1).

STRENGTHS AND MOST VALUABLE INFORMATION OF THE PRODUCTS:

The following key strengths of the products were voiced (Annex 1.a, Annex 1.f, Annex 1.g, Annex 1.h, Annex 1.i, Annex 1.j). Some of these remarks have been mentioned by several stakeholders:

- Full spatial EEA-39 coverage
- Consistent reference time step
- Regular update cycle
- Consistent pan-European information
- Information layers partially not available in Member States
- Free and open availability
- Proven and documented quality
- HRLs are receiving very good feedbacks. HRL IMD appears particularly interesting in terms of quality, precision and complementarity with existing datasets
- Urban Atlas and Riparian Zones products are also receiving good feedback regarding MMU
- Sometimes, at national scale, only intermediate products are used, because of scale or thematic resolution. This is however considered still beneficial as to allow retrieving a spatially explicit probability of change occurrence, e.g. for stratification and reducing monitoring efforts.

SHORTCOMINGS THAT ARE EXPERIENCED:

The following shortcomings were recorded (Annex 1.a, Annex 1.d, Annex 1.f, Annex 1.g, Annex 1.h, Annex 1.i, Annex 1.j). Some of these remarks have been mentioned by several stakeholders:

- Thematic gap: i.e. primarily an agricultural service, or e.g. phenology
- Quality gap: HRLs 2012 Grassland and Wetland are potentially of great interest, but thematic content-related quality issues prevent using it to its potential
- Temporal gap: frequency of product updates of the pan-European Component (e.g. HRLs)
- Duration until product provision is too long (data processing, product generation)
- Communication gap: Need for more transparency/communication: website, description of products, metadata, and production process behind the data (as it was also discussed at the WorldCover conference in ESRIN/Frascati, March 2017).
- Spatial resolution (20m) is not sufficient for some users. 10m HR Layers would be appreciated.
- Imperviousness (IMP): insufficient quality of first product releases and re-calibration of previous IMP products as part of the 2015 update might be perceived as confusing.
- There is a perception among some users that scientific testing and selection processes were not applied consistently for all past HRL products, and some unconsolidated products were released. Therefore, the ECoLaSS project with its approach on testing and benchmarking, involving different service providers and institutes, is appreciated.
- Quality control, validation and consolidation of products: Some of the products did not totally fulfil quality requirements, but these requirements were somewhat set arbitrarily. There is a lack of detailed product specifications for some HRLs. A good quality control and validation before the release of products, is considered mandatory. In general, for future HRL, validated data at 0.5 ha MMU should be provided
- Awareness and knowledge about Copernicus products need to be improved.

Though not being focus of ECoLaSS, Local Component requirements were recorded as well:

- Temporal gap of Local Component products: More timely information of Natura2000 (local component) - e.g. from the past year – would be desirable. The limitations caused by the data situation of current Europe-wide VHR image coverages, as well as quality constraints of the 2012 VHR image coverage using Spot-5 resolution-merged data and data outside the vegetation period, are recognised.
- Parcel-based information would be required for some applications. Copernicus Land local component products might not completely fulfil the need, but their added value was not yet analyzed and the products not yet applied.

2.2.3 Further Use Potential of Copernicus Land Monitoring Products and Applications:

After an analysis of the current users and uses of the Copernicus Land products, a view into their potential future is reflected in this section, as collected from several of the interviewed stakeholders.

Current users are mainly European Institutions (such as EEA, JRC or DG ENV…); service industry (mainly for downstream services); research and academia; countries' national and regional administrations and NGOs. On the level of Member States, current use is more common at national than at regional or local level, as current specifications are not always in line with needs at this level.

In some regional environmental agencies, Copernicus data are nevertheless reviewed and thought about, but have not yet been used, as there is a lack of capacities and personnel. Workshops take place on national and regional level to overcome obstacles on the user side, such as awareness, data access and documentation of the products. These regional users are expected to increase their interest in Copernicus Land products.

Possible future additional users could be environmental industries, NGO's or national agencies working with geodata. Moreover, interest within the R&D/academia community should be further raised, particularly for applications on continental scale. One example of a recent scientific paper using Copernicus High Resolution Layer Imperviousness Degree data is presented by Lefebvre et al. (2016).

New potential users are as well very interested in the Copernicus Sentinel satellite data. Depending on the degree of their own capacities, some users prefer Copernicus Sentinel data over the actual Copernicus products, for performing their own analyses.

Regarding the **use/application of Copernicus Land data**, the biggest potential is seen in the synergistic use of products and the combination of Copernicus products with other data, e.g. a combination of status layers, change layers and additional data (e.g. Imperviousness combined with population data to get per-capita figures). This would enable a wider spectrum of product uses and applications.

Some future applications of Copernicus Land Products are seen in the fields of:

- Statistics
- Agriculture
- Biodiversity, environment and ecosystem services
- Marine
- Forest
- Grassland
- Freshwater

Statistics from different Copernicus Land products would be very interesting for the biodiversity related users. For example, for the Sustainable Development Goals (SDG), the use of LUCAS data, CORINE-related indicators or Imperviousness-based indicators are explored, amongst others.

For agricultural activities, the current number of users for existing Copernicus Land products is limited, but could potentially be extended to Member States' institutions in charge of the CAP implementation and controls as well as farmers themselves, especially for CAP impact monitoring. The main current use could be in the identification of pastures, but the current HRL Grassland 2012 is not of a sufficient level of quality. In addition, HRL Grassland and Riparian Zones & Natura 2000 LC/LU products are used for cross-checking of LUCAS data. Further added-value potential is in the area of agricultural statistics (e.g. there are no agricultural data covering all areas). Potential use post-2020 could be much wider. CAP-related use of Copernicus satellite data (Sentinels) would in general be welcome, although in terms of spatial resolution the presently available Sentinels can only to a limited extent contribute to CAP Monitoring. The Small Woody Features (SWF) product could be potentially of use.

A stronger promotion of the Natura2000 product towards the general public and academia has been requested. Policy relevant questions might be of relevance for academic users as well. An ability to go further back into the past with time series is seen as an asset and could possibly attract further users, such as national N2000 site managers. Also monitoring of biodiversity could be improved through longer time series: historically, forest cover has been going up in Europe during the last decades, but all major European reports on conservation status and biodiversity suggest that there are problems.

Forest monitoring products are highly demanded. Currently, main activities in this area are oriented to forest damage assessment, mapping of tree species composition, monitoring of forest area changes, and regional forest administration purposes. Potential future forest related tasks could be on-demand monitoring of potentially illegal forest logging; spatially explicit monitoring of forest cover and forest type changes; distinguishing between intensive/extensive forest uses; monitoring of tree cover density development; forest cover and timber stock monitoring. It should be noted that most European member states have well developed NFIs, and even though the value of HRL FOR is recognised at that level, there is significant room for improved use of these data at national level.

Imperviousness: there are few other equivalent data for monitoring urban sprawl, even though the temporal consistency appears problematic. The quality of the HRL Imperviousness should get substantially improved with the 2015 update.

Grassland and Wetland products are currently being improved with the 2015 HRL production. Various users are expected from European to regional level as products become available. Additional HRL Grassland users could be attracted as well through an open/public online viewer, providing new ways of data representation for investigation of LU/LC changes and continuous representation of grassland variations.

2.3 Technical specifications for Copernicus Land Service Evolution

The requirements for improved/new technical specifications of Copernicus Land services & products are mainly based on recognised existing gaps or shortcomings (cf. section 2.2.2) in the current CLMS portfolio, and on the stakeholders' respective needs. The analysis is split into (i) products and specifications for improving existing services (section 2.3.1), in contrast to (ii) products and specifications for new services (section 2.3.2), and (iii) infrastructure for implementation of improved and new services & products (section 2.3.3).

2.3.1 Evolution of Existing Services/Products

The following sections provide an overview of the collected general requirements for evolution of existing services (section 2.3.1.1), and, separately, respective technical specifications (section 2.3.1.2).

2.3.1.1 Products for Service Evolution

This section provides an overview of voiced requirements for evolution of already existing Copernicus Land services and products. ECoLaSS targets the Copernicus Land pan-European and Global Land Components. Despite the Local Component is not part of the developments envisaged in ECoLaSS, requirements for the Local Component which the stakeholders brought forward were documented in addition.

The current status is that the pan-European Copernicus Land products are in an operational state and target diverse user groups and applications, whereas the Global Land products are used more by the scientific user community.

PAN-EUROPEAN COMPONENT

The Pan-European **HRL 2018 / HRL 2020+** evolution was mentioned by almost all key representatives that were interviewed. As described in Annex 1.a and Langanke (2017), an update is planned for the 2018 reference year with specifications presumably similar to the ones of the HRLs 2015 (AD02: Guidance Document to the call EO-3-2016; Ramminger et al., 2017), but potentially more frequent update options will be included further in the future. Among the five currently produced HRLs 2015: Imperviousness, Forest, Grassland, Water/Wetness, and Small Woody Features, four layers were pointed out specifically:

- HRL Grassland (GRA) was multiply voiced, from users with particular interest in natural habitat types relevant for biodiversity, or agricultural focus (Annex 1.a; Annex 1.c; Annex 1.d; Annex 1.e; Annex 1.i).
- HRL Forest (FOR) was specifically pointed out as promising layer for various applications, considering also future higher resolution products from Sentinel data (Annex 1.a; Annex 1.d; Annex 1.e).
- HRL Imperviousness (IMP) was pointed out repeatedly (Annex 1.a; Annex 1.f; Annex 1.g)
- HRL Water/Wetness (WaW) was mentioned regarding the importance of mapping wetlands for biodiversity or soil protection (Annex 1.a; Annex 1.f)

A concern was raised about the partial co-existence of the HRLs with other, global products of more scientific origin, e.g., HRL FOR or Global Forest Initiative; HRL IMP or Global Urban Footprint (DLR) or Global Settlement Map (JRC) (Annex1.h). Quality advantages of the HRLs which have been stated e.g. in the frame of the Copernicus Validation project, should be highlighted and promoted.

The pan-European **CORINE Land Cover CLC 2018 / CLC+ in 2020+** was repeatedly stated, particularly national users showed strong interest (Annex 1.a; Annex 1.f; Annex 1.g; Annex 1.h; Copernicus User Forum, 2017). The current CLC 2012 as part of the pan-European component and with an MMU of 25 ha, shall be improved towards 0.5 ha in CLC+, which – in terms of spatial resolution – is tending towards the Local Component. The CLC production in 2018 is foreseen to be carried out in a standard way, and in parallel, testing of CLC+ for some countries as part of a CLC 2018 exercise will be performed. The full implementation of CLC+ is envisaged for a next implementation stage (Annex 1.a). Testing by Member States is carried out on a voluntary basis as part of the production cycle 2018 within framework service contracts until 2021, working towards an improved CLC+ for the period after the 2018 reference year. No specifications and details are yet defined (call for tender to draft specifications is in planning).

GLOBAL COMPONENT

Currently, the **Global Component Biophysical Variables** are based on Proba-V (Cherlet, 2015; CLMS, 2017c). There is a need to adapt the processing chains to Sentinel-3 and take the opportunity to revisit workflows, resolve interdependencies and adopt a more modular approach. Currently, there are several new Cryosphere and Water products under development (Annex 1.b; CLMS, 2017c). Calibration between sensors and the development of a long time series is also a priority (Annex 1.b; Copernicus User Forum, 2017).

The implementation of the **Hot Spot Monitoring of the Global Component** has been initiated in 2016 and is currently ongoing. At the moment, the programme focuses primarily on African protected areas and was initiated by DG DEVCO. It is planned until at least 2020 (Annex 1.b).

LOCAL COMPONENT

The Local Component is not the main focus of ECoLaSS, however the (non-exhaustive) information received from stakeholders during the interviews is given here. Specifically, a need for further evolution of the **Natura 2000** product as part of the Local Component was mentioned by DG ENV (Annex 1.d). Further mainly national users and stakeholders that are currently using the Natura 2000 product or see use potential thereof (Annex 1.c; Annex 1.f; Annex 1.i) could become interested in the future, which will likely be connected to geoinformation needs on higher spatial resolution / scale for national and regional-level applications.

2.3.1.2 Evolution of Key Specifications

This section provides suggested specifications for evolution of the existing Copernicus Land services, as stated in section 2.3.1.1.

PAN-EUROPEAN COMPONENT

In terms of evolution of key specifications, a general comment was on the trade-off that will have to be made between targeting very specific thematic issues, and more generic, multi-purpose products such as tree cover density (TCD) or biophysical products (Annex 1.a). Common specification for all pan-European products are:

- the coverage of the EEA39 area,
- the use of HR data, as well as
- the expected increasing use of VHR data.

Most of the requirements for future specification evolution target the **HRLs in general**, as follows:

- Update frequency and temporal interval: Higher temporal resolution/more frequent updates, depending on dynamics of individual HRL product-related land cover changes (Langanke, 2017; Annex 1.a). In some cases 3-yearly status layers were considered sufficient (Annex 1.i) but in other cases yearly status layer updates would be desired (Annex 1.d; Annex 1.h). Regular updates solely regarding changes (rather than updating the full European surface) were mentioned (Annex 1.h), or were recommended as yearly incremental updates (Annex 1.h; Langanke, 2017; Dufourmont and Langanke, 2015) – e.g. in terms of changes between the 3-yearly status layers, or as developments towards dynamic HRL products (Annex 1.h), or a yearly alert by change detection only (Annex 1.i); The GRA and WET/WaW services were specifically mentioned related to more frequent update frequencies or dynamic products (Annex 1.g; Annex 1.j).
- Shortened production time: Increased timeliness of availability of the products (Annex 1.g; Annex 1.j). It is recognised however that there are still open issues and that these are connected to incremental updates, e.g. the production of partial coverages (in terms of area, temporal interval or interpretation) (Langanke, 2017).
- Time series (multi-sensor) input data: The change from largely mono-temporal classification to time series analysis and multi-sensor analysis has been already implemented with the HRL 2015 production and shall be further fostered, including SAR data where possible (Langanke, 2017); Increased product quality is expected through the use of time series data as input (Annex 1.g).
- Higher spatial resolution: The current spatial resolution of 20m is described as appropriate for European applications (Annex 1.h); however development towards higher spatial resolution – taking into account technical/sensor constraints – was mentioned (Annex 1.d) in case quality can be maintained (Annex 1.h). National users would desire a spatial resolution that regularly allows retrieving objects with a 0.25 ha or 0.5 ha Minimum Mapping Unit (Annex 1.h; Annex 1.i).

- Continuously scaled products: Towards more continuously scaled products in the future, such as the current Imperviousness Density (IMD) or Tree Cover Density (TCD) (Annex 1.a), in order to further supplement categorical HRL products with additional, continuous information.
- Generic products: Towards more generic products – such as biophysical parameters – also on pan-European scale (Annex 1.a).
- Legend information: Should be consistent and be provided in several formats (ArcGIS, QGIS, CSV) (Annex 1.f).
- Quality & Consolidation: All existing products should be consolidated, quality controlled and consistently provided in the next releases. A thorough (external) validation should be performed before product release (Annex 1.h). Provision of a "Flag-Layer" would be of help, in order to provide pixel-based geolocated quality information to the users (Annex 1.h).
- Accuracy requirements: Current requirements of ~85/90% accuracy should be maintained (Annex 1.h; Annex 1.i), as well when applying automated updates based on time series (Annex 1.h), which is acknowledged to be a challenge.
- Historical time series: Going back to the past with longer time series of HR optical satellite data (e.g., SPOT/IRS/Landsat etc.) to derive long-term trends of changes. Relevance for Grassland was specifically mentioned (Annex 1.d); Operationalization of full time series analysis (calibration between different historical image sources) would be desired (Langanke (KO), 2017). It is understood that archive image data are only available with reduced temporal frequency (as compared to Sentinel-2), and that the spatial resolution is in some cases lower (e.g., 30m in the case of Landsat).
- Ensuring backward compatibility of HRL time series: compatibility could be established by transformation possibilities, especially in view of time series for change monitoring (Langanke, 2017).
- Harmonisation & product information: Better harmonisation and streamlining between global and pan-European components. This should lead to a situation where users are fully clear about the differences and commonalities of the respective products (Annex 1.a).
- New data model: from mapping & classification to components and attribution: e.g. along the EAGLE model, or the national example of the Land Information System Austria (LISA) approach – which is based on public domain software such as QGIS plugins (Annex 1.i).
- Well documented methods and workflows: Provision of detailed product specifications (Annex 1.j); where possible with freely available open source scripts/tools (Langanke, 2017).
- Cartographic visualisation: a more sophisticated product presentation and visualisation in an online viewer would be of high value for users (Annex 1.a; Annex 1.d; Annex 1.f; Annex 1.g; Annex 1.h), see also section 2.3.2.3 on "Cross-cutting Services" and on 2.3.3 "Infrastructure".

Specific evolution requirements the **HRL Grassland** specifications have been additionally raised (Annex 1.d; Annex 1.c; and Annex 1.i):

- Phenology/Seasonal Information: Seasonal instead of static information. Phenology parameters, e.g. the timing and frequency of (i) changes or (ii) cutting/grazing would be of relevance (Annex 1.d). Grassland information should include the management practice (Annex 1.c).
- Update frequency and temporal interval: In terms of temporal changes/losses, a yearly update that would allow to quantify areas and changes, including a cartographic visualization would be desired (Annex 1.d).
- Longer time series: not only reaching into the future (starting with the Sentinels ~2015) – but going back to the past. A yearly change would not necessarily be required, but a trend/tendency towards regional changes/losses would be of value (Annex 1.d).
- Nomenclature (Annex 1.d):
    - Separation between grassland and cropland (+ change/conversion);
    - Separation between (i) species-rich (extensively used) and therefore relevant for biodiversity and (ii) species-poor (intensively used) and managed grassland (+change/conversion);

  - A differentiation amongst different types of species-rich grassland habitats, based on land use type, altitude and latitude, hydrology, geology and soil quality (although it is recognised that this probably is an unreachable objective unless in a dedicated downstream service);
- Identification of pressures on grassland areas in terms of:
  - intensification (i.e. increased fertilisation and earlier/more frequent mowing or grazing);
  - extensification (i.e. the opposite trend);
  - abandonment (e.g. shrub encroachment due to lack of grazing or mowing management);
  - transformation (i.e. into cropland or other non-grassland land uses, e.g. infrastructure).
- In-situ data: There would be an identified improvement potential through the use of LPIS data which are currently mostly not openly available (Annex 1.i)
- Combinations: Use of different parameter combinations to derive intensive/extensive management of grassland/forest, for large-area trends in the EU (Annex 1.e).

Desired specific evolution requests for the **HRL Forest** specifications comprise: Tree species (shifts between extensive and intensive management, loss of habitats); Texture (tree rows, shapes) (Annex 1.e; Löffler, 2016), or discrimination of plantation forests vs. other types (Annex 1.d). As an accompanying measure under the forest theme, a general (improvement of) cooperation with *National Forest Inventories (NFIs)* and/or the European Network of Forest Inventories (ENFIN) for product validation purposes was recommended (Annex 1.e), which is already piloted or carried out in some European regions (e.g. Sweden, Baden Württemberg in Germany). Satellite-based spatially explicit monitoring products (from Copernicus) could (at least in parts) be validated by the NFIs through their ground data, even if the respective data sources as such are not made available publically or for the service (Annex 1.e).

Regarding the **HRL IMP**, it was stated that in view of the European Settlement Map (ESM) produced by JRC and available for the year 2012; a comparable HRL product with 10m spatial resolution and 3-year update frequency would be interesting in case it becomes operational/will be regularly updated (Annex 1.g). Purely as per its definition, the ESM actually could become a subset (building identification) of the HRL IMD (all sealed surfaces). One further observation was that the improvement of the HRL IMP product to better match with statistical data in industrial and traffic areas would be appreciated (Annex 1.f), and that the legend information should be consistent/transferable to CLC and MAES (Annex 1.f).

The **HRLs Water/Wetness 2015** and **Wetlands 2012** are of interest in terms of service evolution as well (Annex 1.d; Annex 1.f). Potential enlargement of the product's scope might be towards wetland habitats, biodiversity and soil protection in the future. Further parameters such as water quality (pesticides, hot spot areas) or flood mapping were pointed out (Annex 1.g).

The **CORINE Land Cover** specifications will likely move towards higher spatial resolution with **CLC+**: from 25 to 0.5 ha MMU (Annex 1.a; Copernicus User Forum, 2017). The nomenclature is foreseen to be closely aligned to the EAGLE concept, so that CLC+ would feature the first implementation of the EAGLE matrix model on an operational level (Langanke, 2017; Copernicus User Forum, 2017; Dufourmont and Langanke, 2015), while allowing the continuation of a CORINE legacy product. The challenging aspect was raised that CLC+ shall be harmonized with the Local Component products, and duplication of work with respect to Local Component products shall be avoided (Annex 1.a). The question was raised if the HRLs and the CLC+ product should complement each other, should be produced in parallel, and if the two products contain partially the same information (Annex 1.h). Preferentially, the whole portfolio should be complementary, easy to understand, and usable in combination (Annex 1.a).

GLOBAL COMPONENT

In terms of specifications for the Global Component – **Biophysical variables,** the current portfolio of the Global Component is foreseen to remain stable (Annex 1.b), but be extended to additional data sources. It is planned to be expanded by Sentinel-2 based products for biophysical variables. Processing chains will be adapted from Proba-V to Sentinel-3, and calibration between sensors and the development of a long time series is also a priority.

LOCAL COMPONENT

In **general**, future Local Component products are expected to ensure that no duplications with a future CLC+ will occur (see above), that geometry consistency between products is realised and more detailed classes/different classes will be established (Annex 1.a).

Ideally, more timely information of the **Natura 2000** product (e.g. from the past year) would be desirable (Annex 1.d). The limitations caused by the data situation of current Europe-wide VHR image coverages – as well as quality constraints of VHR image coverages using Spot-5 resampled data and data outside the vegetation period – are recognised.

From the view of a national user, adaption to **national user requirements** would be desired (Annex 1.i).

2.3.2 New Services/Products

The following sections provide an overview of the collected general requirements for desired/envisaged new services and products (section 2.3.2.1), and, separately, their respective technical specifications (section 2.3.2.2). The most frequently voiced new service was a pan-European Agricultural Service, followed by a pan-European Phenology Layer.

2.3.2.1 Definition of New Services

This section provides information on desired or foreseen Copernicus Land services to be newly developed, as far as they are already known or have been communicated:

PAN-EUROPEAN COMPONENT:

There was a consensus on the most needed new service being an **Agricultural Service** (Annex 1.a; Annex 1.c; Annex 1.d; Annex 1.f; Annex 1.g; Annex 1.j; JRC, 2016; Langanke, 2017) which shall include crop status and monitoring within the pan-European Component. There are also requirements requesting estimations of biomass & yield (Annex 1.g). This service will likely be implemented more on the long term (2020+). A user requirements workshop organized by DG GROW was held in 2016 and a concept note drafted by JRC in June 2016 (JRC, 2016). At a recent Copernicus User Forum meeting (11th January 2017) it was announced that a second round of consultation will be done, expected to result in an updated concept paper. An expert group (DG-AGRI, DG-GROW, DG-JRC and member states) is currently discussing. After the summer 2017 experimental phase, requirements and Sentinel potential will be evaluated, testing is ongoing for various countries (Annex 1.c; Langanke, 2017).

In Annex 1.a it is further noted that there are multiple possible policy contexts related to a future Agricultural Service, which will strongly influence the definition of the future service(s): Greening the CAP, LULUCF reporting for the Climate Change and Energy Union (forest/carbon fluxes, biofuel crops, grassland etc…), SDG indicators, or Land accounting - ecosystem services monitoring (more details in section 2.1.2).

A further need has been voiced for a **Phenology product** as a potentially new pan-European layer (Annex 1.a; Annex 1.i; Annex 1.j; Copernicus User Forum, 2017). There are already plans from EEA for an implementation, but seemingly earliest in 2020. Currently, in-house studies are ongoing at EEA and at JRC in order to draft specifications (Annex 1.a), which might contain common phenology derivatives, such as start, duration and end of season. The need for a plant phenology index (PPI) has been raised, using medium to high resolution data (Annex 1.i)

Regarding a potential pan-European **Snow and Ice Service** or "Permanent snow and ice cover monitoring" (Annex 1.a; Dufourmont and Langanke, 2015; Breger and Bamps, 2015), the specifications are yet to be drafted by the ETC (Annex 1.a).

Further potential pan-European products of interest, which to date have not been planned as a Copernicus Land service or Layer, have been mentioned once or twice:

More **generic products** based on largely automated high-spatial resolution ”low-level” products (from generic products to biophysical variables) could be added in the future to the pan-European Component (Annex 1.a; Annex 1.j; Langanke, 2017).

There have been some general requests to provide more support to the monitoring of **natural habitats**, although there is a recognition that satellite imagery may only provide part of the information required (Annex 1.d; Annex 1.i; Annex 1.j). No such service is planned for the moment.

A **Soil Layer** was mentioned once (Annex 1.h), as well as one on **Essential Climate Variables** (Annex 1.j).

GLOBAL COMPONENT:

Focus will be on stabilization of the **current 2016–2017 product portfolio** and implementation to full operations, including transitions to the use of Sentinel instruments (Copernicus User Forum, 2017). Service updates are in preparation for the Copernicus Work Programme 2019.

The emphasis will be on additional Analysis Ready Data Layers, building on initial global mosaics, which will potentially result in new thematic products, e.g. on **Forest, Water**, or **Imperviousness (human settlement mapping (GHSL))** which are potentially foreseen for the Global Component evolution. These thematic products will follow a similar approach as the pan-European HRLs and could be developed by JRC and rolled out to operational service provision once consolidated (Annex 1.b; Copernicus User Forum, 2017).

Another set of products envisaged for the Global Component are **biophysical products** on a Sentinel-2 scale with increased spatial resolution (Copernicus User Forum, 2017)**.**

Moreover, a **Phenology Layer** is potentially foreseen for the Global Component, providing phenological parameters (e.g. start, duration, end of season, etc.) (Annex 1.b). Discussions are held with EEA to harmonise the definition of such a product both at pan-European and global level.

Recently, a Copernicus Emergency Management Service (EMS) **Drought Observatory** was revealed as future 2018 product, which could have potential **synergies with the Copernicus Land service** (e.g.: ECVs, water surface) or the Copernicus Climate Change service. Monitoring and forecasting of droughts shall be performed in terms of **European** and **global** early warning. The service will be based on satellite data, hydro-meteorological modelling and in-situ observations. Satellite data play a key role for monitoring vegetation stress, soil moisture and land surface temperatures. The combination of different indicators is expected to provide decision support to policy makers and different economic sectors (Copernicus User Forum, 2017).

LOCAL COMPONENT

Interest in a potential future **Coastal Zone service** was raised several times (Annex 1.a; Annex 1.d; Annex 1.e; Copernicus User Forum, 2017). This new service is foreseen to provide a link between the Copernicus Land and Marine Services. The Coastal Zone service will likely become part of the Local Component (Annex 1.a; Copernicus User Forum, 2017; Dufourmont and Langanke, 2015; Breger and Bamps, 2015). The implementation will presumably start in 2018. An initial workshop was conducted in December 2016, followed by a second workshop (http://workshop.copernicus.eu/coastal) on 29 June 2017 (Annex 1.a).

2.3.2.2 Key Specifications of New Services

This section provides suggested specifications of potential new Copernicus Land services and products as stated in section 2.3.2.1, as far as they are already known or have been communicated:

PAN-EUROPEAN COMPONENT:

According to Annex 1.a, for the **Agricultural Services / crop status and monitoring** there is a trade-off to be made for operational implementation: cropland mask or detailed crop monitoring. According to Annex 1.f, capturing the phenology as well as the crop type (different classes) would be of importance. Case studies based on Sentinel data exist that monitor a large number of crop types. They are, however, highly dependent on dense field data, and might not work in case of limited in-situ data availability and in countries with small field sizes and diverse agricultural practices, or be not feasible for a continental scale implementation (Annex 1.a).

Regarding spatial and temporal resolution of a future agricultural product, 20m spatial resolution (similar as for the HRLs) would be required (Annex 1.f). Also a dynamic product with updates on a yearly or intra-yearly basis (e.g. more frequent products to capture crop rotations) would be of interest. Especially in case of product availability with a 3-yearly update frequency, agricultural dynamics would otherwise not be captured. LPIS or IACS/InVeKoS data would be very useful, but are currently restricted in their accessibility (Annex 1.f). Specifically a connection with the Integrated Agricultural Control System (IACS) would be of value, i.e. for setting up a digital dossier of a farm, and collect information at farm level through GSAA (Geospatial Aid Application). The IACS is at the core of CAP implementation in Europe, and JRC provides methods and technical guidance in support of this implementation (Annex 1.c).

The issue was raised who the future users of such Agricultural Service would be, since the requirements for specifications will largely depend on the users (e.g. the requirements differ among countries and from European requirements) (Annex 1.h). Moreover, as a foreseen future operational CLMS product, the service has to adhere to the conceptual boundary between Copernicus services and downstream services (Annex 1.a; Annex 1.h).

According to Annex 1.c, detailed specifications for the Agricultural Service are not yet defined and more requirements could be expressed, resulting from the Member State consultations / experiments. However, the following information services have already been identified and are primarily based on the new capabilities of the Sentinel-1 & -2 full (A & B) and Sentinel-3 constellations – further details are given in the April 2016 concept note (JRC, 2016). The currently identified information services are (Annex 1.c):

- International and national crop monitoring:
  - Incremental in-season crop specific masks, crop area estimates and crop status monitoring
  - Food security applications in developing countries
  - More standardized crop area estimates and associated phenology products at national and regional level
  - As Sentinel needs are driven by Member States, it is difficult to catch one general product as there can be different needs from one state to another (dates different as well). It could be useful to look at commonalities (e.g.: change map, edge density in LPIS) and consider the future Data and Information Access Services (DIAS) as a common platform through which common functionality can be offered and tailored to specific needs.
- CAP management
  - Control with remote sensing by providing better and more frequent imagery
  - Identification and mapping of permanent grassland
  - Crop diversification checks at farm level (crop rotation is a current concern)
  - Monitoring of land use management
  - Potential identification of some land elements for Ecological Focus Areas
  - Sentinels to identify areas requiring an LPIS update, and quality control of LPIS
  - Exploring monitoring of agriculture outside the scope of LPIS
  - Assessment of CAP measures performance

    - Support to modelling tools for assessing medium- to long-term impact of policy options
- Farm level and other potential downstream services
    - Precision agriculture, crop status indices, bare soil state, etc.
    - CAP management and control is considering new options. A better target could be the farm (or group of farm) level, i.e. setup of a digital dossier of a farm, and collect info at farm level through GSAA (geospatial Aid application). This would also widen the potential in other farm applications (precision farming, farm advice), e.g. via integration in DIAS services.

Some of the abovementioned service/product specifications may have to be further adjusted to account for the Copernicus – Downstream service boundary.

Specifications for a specific pan-European **Phenology product** are currently drafted. There is a thematic overlap with the Global Component, and in terms of specifications it is important to ensure compliance between the related HR and MR products (Annex 1.a). It was mentioned that the Phenology Layer should serve as basis for other products, e.g. yield estimation (Annex 1.h).

Specifications for a future **Snow and Ice Service** will presumably be based on existing, currently non-Copernicus precursor projects (e.g. from FP7), products and methods (rather than new developments) (Annex 1.a; Dufourmont and Langanke, 2015).

Related to more **generic products** and biophysical variables, particular specifications were not voiced.

In the case of **habitat types monitoring** – which is currently not planned within Copernicus – combined time series from S-2 and S-1 were suggested as input data source (Annex 1.i). Specifically grassland habitats were discussed (see section 2.3.1.2) and coastal habitats mentioned (Annex 1.d).

GLOBAL COMPONENT:

In terms of specifications for new **thematic products (Forest, Water, GHSL)** as part of the Global Component, the common denominator is that the products should be based on high spatial resolution data from Sentinel-2, for which there are some thematic precursor projects existing: The current GHSL product (GHSL, 2017) produced by JRC is the most advanced product; the recently produced Water product (Pekel et al., 2016; Global Surface Water Explorer, 2017) is based on the Landsat archive processed with Google Earth Engine; for the Forest product a similar approach as for the Water product is planned. These new global thematic products could be rolled-out to operational service provision once consolidated. Further specifications are not yet defined. These are envisaged to be drafted by user groups that have yet to be organised (Annex 1.b; Copernicus User Forum, 2017).

The situation is similar with regards to specifications of the envisaged **Phenology Layer** of the Global Component. Specifications, which should be based on Sentinel-3 medium resolution data, are foreseen to be drafted by user groups that have yet to be organised (Annex 1.b).

LOCAL COMPONENT:

Regarding specifications for a **Coastal Zone service** (Annex 1.a; Annex 1.e; Copernicus User Forum, 2017) the LC/LU related part of the product is expected to be similar to the Local Component specifications (e.g. MMU 0.5ha) (Annex 1.a). Such 0.5 ha MMU and a 6 year update cycle are considered adequate (Annex 1.e). According to Annex 1.e it is important that a future Coastal Zone service will be able to observe location and dynamics of relevant (i) buildings (e.g. hotels and tourism areas), (ii) streets (linear elements), and (iii) sand dunes (fixed versus dynamic) and other valuable coastal habitats. DG ENV specifically stressed the importance of capturing dunes, dune habitats and loss of respective habitats due to e.g. urbanization or erosion. In view of major severe weather events, a more regularly updated service – perhaps on a yearly basis and possibly focusing on specific events, such as e.g. a local monitoring of the coast-line after a major severe weather event – would be desirable (Annex 1.j). It was argued that the nomenclature should be largely consistent with the other Local Component products (Annex 1.h).

2.3.2.3 Cross-cutting Services

Although not scope of the development work undertaken in ECoLaSS, this section on cross-cutting services summarises the requirements captured from stakeholders in terms of future generic cross-cutting services, which may per definition comprise e.g. to:

- share activities across the Local, pan-European and Global Land Components (such as the ongoing GIO/Copernicus Land Monitoring Service for Validation of products of the Continental and Local Components including in-situ Data), or
- provide a link to the Copernicus In-situ Component (such as the ongoing Services supporting the EEA's implementation of the cross-cutting activities for coordination of the Copernicus in-situ component), or
- strengthen the link to the user community (such as the ongoing EC/DG GROW User Uptake initiative), or
- provide overarching generic technical support / visualisation / data processing services.

Amongst others, **Harmonization of Local, pan-European and Global Component** product boundaries was mentioned as a way forward in terms of cross-cutting activities between the different CLMS Components (Annex 1.a).

A dedicated cross-cutting service addressing a gap in the **visualization, presentation and communication** of Copernicus Land data was proposed by some users (Annex 1.d; Annex 1.a; Annex 1.f; Annex 1.g; Annex 1.h). Particularly DG ENV emphasised that there should be a focus on provision of information in a way which is understandable and immediately usable for multiple users (cf. Annex 1.d):

- A cartographic visualization tool/viewer including zoomable information layers and enabling the overlay of different products on top of each other would enhance and simplify the use of Copernicus products (Annex 1.d; Annex 1.h). Non-intuitive data visualisation/presentation is an obstacle for many uses (not the data formats itself). Additionally, a better GUI, cartographic presentation and visualization would improve the usability (Annex 1.f).
- Presentation and Visualization in terms of statistical analyses, diagrams and dashboards would be of value for users, also without downloading the products. According to DG ENV, online visualization and deduction of statistics is actually seen more important than data download, and might enable the use of Copernicus data also for users that usually do not work with geographic data formats (Annex 1.d). E.g. in current public forest reporting systems, there is a large amount of information displayed as tables, numbers, data, figures etc. Coherent thematic maps would make a big difference for comprehensive visualization of forest information (Annex 1.e).
- In case a large number of thematic CLMS products from time series will be available in the future, a timeline visualization tool/viewer, showing the timing and frequency of existing data would be an asset (as applied for the German Collaborative Ground Segment CODE-DE, see section 2.3.3) (Annex 1.g).
- Visual identity should be coherent, and complexity should be optimized for ease of use by policy makers (e.g., thematic maps, figures and tables) (Annex 1.e).
- A user-targeted thematic support was requested on how to use the CLMS products, explaining targeted, meaningful combinations of different Copernicus Land products, i.e. thematic "utilisation support" to end users through definition and testing of end-use applications (Annex 1.d). This requirement has meanwhile been largely addressed through establishment of the network of Copernicus Relays and Copernicus Academies, as well as through the setup of a central Copernicus Support Office by the EC.

As a summary of the above, product/service conceptualization and description should – from the beginning – also consider applicability/usability of the service/s, as well as cartographic/statistical value-adding options (Annex 1.d).

Another suggestion made by the stakeholders relates to "**human sensors**" (Annex 1.g). This crowd-based concept related to in-situ data could involve smartphones to take pictures to serve e.g. validation

purposes, possibly for a little payment, by sending humans to specific points of interest. Eventually data in movement (streets, traffic...) could be additionally captured. It is acknowledged that crowd-sourcing activities might be more suitable for research projects, and that there are restrictions towards operational products, e.g. related to reliability, product delivery etc.

The **EAGLE data model** as new (object-based) model in connection with public domain software for attribution was generally mentioned multiple times from mainly national stakeholders and users, mostly in connection with CLC+ future developments (Annex 1.a; Annex 1.f; Annex 1.g; Annex 1.h; Annex 1.i). This object oriented data model is considered a potential means for overcoming currently existing inconsistencies between various products' nomenclatures, both on Copernicus, national and international level.

2.3.3 Infrastructure

In terms of implementation requirements for the next-generation CLMS, the infrastructure requirements for product provision are summarised in this section.

The need for a **common access point** to CLMS services and products was repeatedly pointed out during the stakeholder interviews. Currently, Copernicus Land service products are provided through the **Copernicus Land online platform** (CLMS, 2017a). EEA reported that ideally, the look and feel, and the provision of services for all the Copernicus services should be further streamlined and harmonized. It is envisaged to avoid separate and different registration procedures, and to implement consistent naming of products and availability of downloads and Web Map Services (WMS) and viewers, in a consistent way across all services (Annex 1.a). It was reported that the current Copernicus Land portal works fine and data provision should be continued as until now (Annex 1.g). On the other hand, it was mentioned that the usability of the current portal depends on the experience of the user – for some users it is difficult to get CLMS data from the portal (Annex 1.f). The access on the Land Service portal is described as being more intuitive than for e.g. the Atmosphere and Marine Service portals (Annex 1.f). EEA plans to continue to improve documentation and level of professional presentation on the current Copernicus Land platform, but major changes are likely to be implemented as part of the upcoming Data and Information Access Services (DIAS) (Annex 1.a; ESA, 2016).

The upcoming **Copernicus Data and Information Access Service(s) – (C)DIAS** (ESA, 2016) were multiply mentioned by European and national stakeholders (Annex 1.a; Annex 1.b; Annex 1.c; Annex 1.f). For some applications, it was mentioned that the role of DIAS will potentially be essential for both public and private value adding services in the future (e.g. Annex 1.c). Limited prototypes of such unique access points are (currently being) implemented in the frame of several national Copernicus **Collaborative Ground Segments (CGS)**. For example, the Copernicus Data and Exploitation Platform – Deutschland (CODE-DE) (CODE-DE, 2017) was referred to by German national stakeholders (Annex 1.f; Annex 1.g). CODE-DE provides a unified access point/entry point as a start, and a similar implementation on a European level would be desirable (Annex 1.f). Different requirements for a future service infrastructure were discussed, with the common goal to simplify the product access, make it consistent throughout products, and therefore, more user-friendly. Access via Web Map Service/Web Feature Service (WMS/WFS) is recommended (Annex 1.g) (see section 2.3.2). A central and easy access via a portal without searching through menus is recommended (Annex 1.h), preferably provided via online platforms, such as DIAS or the Copernicus Open Access Hub (previously known as Sentinels Scientific Data Hub) in case of Sentinel data (Annex 1.i). It was argued that for all the various products a common, consistent access portal would probably not be feasible, considering all the different product characteristics and user communities, but a common entry point would greatly facilitate data access (Annex 1.f). One idea was to connect the provision of satellite data and Copernicus products, eventually including Copernicus Contributing Missions (CCMs), in the same portal (Annex 1.h).

3 Summary and Outlook

In order to contribute to a comprehensive assessment of the evolution requirements towards future Copernicus Land Services and to identify focus areas for the development of relevant improved/new products and service demonstrations, a user requirements analysis was carried out. This was conducted via phone and face-to-face interviews with relevant users and stakeholders, as well as by collecting requirements from recent workshops, presentations and reports. The interview partners were representatives of key European institutions as well as important national users and stakeholders, which are in charge of implementing or coordinating national Copernicus activities. The time frame of interest ranges from mid-term (2018) to long-term (2020+) evolution of the CLMS service and product portfolio. This report summarises the findings of the analysis.

The ECoLaSS project focuses on the pan-European and Global CLMS Component aspects and therefore has to take the needs from the user and stakeholder community properly into account. The highest need for evolution of existing services and for next-generation new services was recognised for the pan-European Copernicus products, i.e. for the High Resolution Layers (HRLs): towards qualitative and timely improvements, and for CORINE Land Cover (CLC): towards significantly higher information content and spatial detail through CLC+. Requirements for the Global CLMS Component were collected mainly from key representatives of the Joint Research Centre's relevant thematic units, and further available documentation. The highest interest in products of the Local CLMS Component was typically shown by national users, since the higher spatial resolution of the products is generally better fulfilling the needs on a national and regional level. There is a generally high interest in Copernicus (Sentinel) satellite data, which was repeatedly mentioned by several users.

Detailed analyses of respective new/updated product specifications have been provided in section 2.3, and are therefore not repeated in detail here. Nevertheless, there are a few key aspects to be highlighted: In terms of future service specifications, a general requirement for shorter update frequencies and change products (e.g. through incremental updates) were mentioned throughout. Concerning new services, a particular need for a pan-European Agricultural Service as well as for a Phenology Layer were the most frequently recorded responses. A certain trend is further recognised towards more generic products being requested.

While on the one hand it was observed that, technical issues and limitations of the CLMS products' (satellite and other) input data, as well as the actual methods for generation of the products are not of major concern to the users, on the other hand it was also found that (depending on the individual user) the knowledge of specifications of the existing products is in general rather limited. Requests for establishing mechanisms enabling to obtain more information on the products and metadata were brought up several times. Additionally, a general requirement for an easier and standardized access to data, products and documentation, on a unified access portal, was repeatedly stated, including the desire for a multi-layer online visualization and/or evaluation tool for the products.

More frequent and incremental updates are already a key aspect of the developments addressed in ECoLaSS. Time series analyses from Sentinel-1, -2 and -3 data build the backbone of future product developments in the ECoLaSS *Task 3: Automated High Data Volume Processing Lines*. For the development of an Agricultural Service prototype, the specific *WP 44: Crop Area and Crop Status/Parameters Monitoring* is foreseen, and a range of further new products/services is addressed in the frame of *WP 45: New LC/LU products*. Derivation of phenological parameters is among the key methods to be developed e.g. in *WP 41: Time-series derived Indicators & Variables*. Improvement of existing CLMS products such as Grassland is addressed as a core topic in *WP 43: Improved Permanent Grassland Identification*.

The results of the analyses undertaken in the present report show that basically all activities already planned for ECoLaSS – which are drafted in the Grant Agreement No. 730008 – largely concur with the perception and core requirements of the key users and stakeholders in terms of future Copernicus Land service evolution. The rich pool of further recommendations collected from the key stakeholders will be thoroughly analysed, and build the basis for integrating some further aspects into the ECoLaSS

developments in Tasks 3 and 4 as far as feasible. This document is further deemed a valuable source of reference also for other activities and developments beyond the scope and possibilities of the ECoLaSS project. The non-public Annex 1 additionally provides detailed records of all conducted stakeholder/user interviews, allowing to further analyse individual, specific needs.

In Phase two of the ECoLaSS project, this Service Evolution Requirements Assessment, including the User Requirements Analysis, will be updated and refined, considering all relevant ongoing developments and future evolution plans. The second analysis cycle will be targeted to more specific aspects as needed, and will provide an update of this Deliverable.

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