BIO_SOS

Project Title:	**BIO_SOS Biodiversity Multisource Monitoring System: from Space TO Species**
Contract No:	FP7-SPA-2010-1-263435
Instrument:	
Thematic Priority:	
Start of project:	1 December 2010
Duration:	36 months

Deliverable No: D8.9

Recommendations on how Copernicus (GMES) can contribute to Biodiversity (BD) policies

Due date of deliverable:	Month 16
Actual submission date:	October 2013
Version:	1st version of D8.9
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Project ref. number	**263435**
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Deliverable title	Recommendations on how Copernicus (GMES) can contribute to Biodiversity (BD) policies
Deliverable number	D8.9
Deliverable version	Version 1
Previous version(s)	<List of previous versions, if any>
Contractual date of delivery	Month 16th
Actual date of delivery	31 October 2013
Deliverable filename	BIO_SOS_D8.9.doc
Nature of deliverable	R = Report
Dissemination level	PU = Public
Number of pages	
Workpackage	WP 8
Partner responsible	P1
Author(s)	P. Blonda, C. Marangi (P1, CNR), J. Inglada (P16, UPS), I. Manakos (P3, CERTH), C.A. Mücher (P4, Alterra), R. Lucas (Abery)
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COOPERATION

Abstract	This Deliverable deals with recommendations on how Copernicus (GMES) can contribute to Biodiversity Policy related topics. Such recommendations are based on the discussion on biodiversity policies that BIO_SOS partners had with partners of different projects within some recent conferences and experience gained within BIO_SOS
Keywords	European Directive (92/43 EEC), Copernicus, Earth Observation, Biodiversity policies

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1. Executive summary

This Deliverable deals with recommendations on how Copernicus (GMES) can contribute to Biodiversity Policy related topics. Such recommendations are based on:

- The discussion on biodiversity policies that BIO_SOS partners had with partners of different projects within some recent conferences, such as:
  - *the 2nd Biodiversity Knowledge conference: Towards a future Network of Knowledge on biodiversity and ecosystem services in Europe* held in Berlin, Sept. 24th- 26th, 2013;
  - the *IALE conference on Landscape Ecology local-to global*, joint (with Ms.Monina) special session on *Earth Observation for biodiversity surveillance: technology for policy implementation*, held in Manchester, Sept. 9th-12th, 2013;
  - the *Biodiversity Informatics Horizons 2013 conference,* held in Rome, Sept. 3th-7th, 2013;
  - Ecosystem and Biodiversity Monitoring – Best practice in Europe and Globally. GI Forum 2013 'Creating the GISociety', 2-5 July 2013, Salzburg.
  - Earth Observation System for Economic Development. Geospatial World Forum, 13-16 May 2013, Beurs-Worldtrade Center, Rotterdam, the Netherlands.
  - the *Network of Biodiversity Knowledge* (www.biodiversityknowledge.eu) conference;
  - the GEO workshop (GEPW7), held in Barcelona, April 15th-16th, 2013.

  Partners from previous EBONE project and on-going Ms.Monina, Lifewatch, BioVEL, DIVERSITAS, EU_BON projects joined such conferences and this was a good opportunity to discuss about Biodiversity related policies with many of them. Presentations were also very useful for better understanding of the user's need of scientific evidence for decision making.
- The experience gained within BIO_SOS and previous discussions allowed us to provide some insights on the contribution that Copernicus can provide in support to Biodiversity monitoring in Natura 2000 and their surrounding areas and to the evaluation of existing policies and design of new policies.
- Previous deliverable D4.4 (report on criteria for selection of suitable EO datasets) was the basis of the experience done during the last two years in the analysis of different Natura 2000 sites.
- The list of BIO_SOS products as output of the EODHaM system described in Deliverables D8.3, D7.1 to D7.4.

We are not supposed to propose policies, but we can provide tools in support to Biodiversity policy makers.

2. Introduction

The Convention on Biological Diversity (CBD) is an international legally-binding treaty, which pursues three main goals: the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from genetic resources. The Convention was presented in 1992 at the United Nations Conference on Environment and Development in Rio de Janeiro, and entered into force in 1993, after being ratified by 30 parties, including the European Union. The two most important legal instruments of the European Union (EU) for the implementation of biodiversity conservation are the 1979 Birds Directive (79/409/EEC), as changed in 2009 (2009/147/EC) and the 1992 Directive on the conservation of natural habitats and of wild fauna and flora, usually known as the Habitats Directive (92/43/EEC). As also evidenced in Deliverable D8.9, even though the explicitly stated aim of the Habitats Directive is to maintain “Favourable Conservation Status” there is a lack of an explicit methodology as to how to estimate it. At EU level there are certain guidelines but the methodology on how to quantify and measure conservation status is still a matter of scientific debate. So far four criteria are used for the estimation of conservation status: (i) Specific structure and functions of the habitat type, (ii) Future prospects of the habitat type (an estimation based on the pressures and threats of the habitat type), (iii) Area of the habitat type, and (iv) Range of the habitat type. In order to estimate the status and trends of these habitats it is important that they are consistently recognised within the European Union in space and time.

User requirements in support to policy making include:

- Work at spatial scales 1:5,000 or finer, where habitats ought to be represented.
- Increase the system degree of automation (ease of use).
- Increase the system computational efficiency.
- Increase the system accuracy.
- Increase the system robustness to changes in the input data set.
- Increase the system robustness to changes in user-defined parameters, if any.
- Reduce the system timeliness (which is the time span between data acquisition and product delivery to the end user; it increases monotonically with manpower).
- Reduce the system costs (e.g., by reducing manpower, exploiting open source software solutions).

All of these challenges need an easy-to-use and low-cost working system for monitoring and assessment of Natura 2000 sites with special emphasis on their boundaries, as all issues listed above are strongly connected with space and time information and rely on them. Important tools for building up such kinds of monitoring systems are provided by remote sensing data and GIS methodologies.

Since the 1st of January 2013, the Copernicus Global Land Service is operational, providing continuously to European, African and International users a set of biophysical variables describing the vegetation conditions, the energy budget at the continental surface and the water cycle over the whole globe at one kilometer resolution (Lacaze et. al 2013a, 2013b). These generic products can serve numerous applications, such as agriculture and food security monitoring, weather forecast, climate change impact studies, water, forest and natural resources management, biodiversity and ecosystems. Earth Observation (EO) imagery can provide a continuous synoptic view of land cover/use (LCLU) patterns and LCLU changes, which have an impact on biodiversity loss (Turner, 2003; Townsend et al., 2009). However, LCLU classes are not a suitable tool in assessing biodiversity in comparison to habitat classes, which are linked to species, communities and biotopes (Bunce et al., 2012a). While a conversion from LCLU to habitat classes can be of great help, if the spatial resolution is sufficient, differences in taxonomies and definitions have so far limited the establishment of a unified approach for such translation. Expert knowledge can be used for this conversion and for integrating Earth Observation derived products with in-situ data. As a result, updated LCLU/habitat maps guarantee that habitat monitoring can be regularly carried out.

In this framework, the BIO_SOS Consortium has developed (see the project Factsheets in Appendix I):

- High Resolution and mainly Very High resolution EO data processing techniques for LCLU mapping for biodiversity monitoring
- A framework based on ecological modelling at habitat level to translate LCLU maps into habitat maps, with these expressed according to Annex I to the Habitats Directive (92/43 EEC) (D6.10; Tomaselli et. al., 2013, Adamo et al., 2013, Kosmidou et al., 2014). LCLU maps are expressed according to the Food and Agricultural Organisation (FAO) Land Cover Classification System (LCCS) (Di Gregorio and Jansen, 2005) taxonomy, which was found to be the most useful for translating EO-derived LCLU classes to habitat categories (Tomaselli et al., 2013).
- A modelling framework based on ecological modelling at landscape level for extracting biodiversity Indicators and for scenario analysis
- A common language between remote sensing experts, botanists, ecologists, and also the Management Authorities of the study sites.

In addition, the consortium has gained experience on the needs and difficulties of the sites' management authorities in regular habitat mapping according to the European Habitats Directive. As a result, the Consortium has identified some main recommendations on how Copernicus programme can contribute to Biodiversity policy related topics, with these mainly based on the possibility to quantify anthropic induced changes that may influence the conservation status of habitats (e.g., extension, fragmentation)

The recommendations are listed hereafter and justified in the following sections:

1. To regularly acquire HR and mainly VHR EO data on the Natura 2000 sites. This will guarantee change detection and the quantification of trends in habitat extension and status. Also the direct surroundings of the Natura 2000 sites need to be monitored since changes here can also have a direct influence on the quality of the habitats present in the Natura 2000 sites.

   In addition to optical data, SAR data (e.g. from Sentinel 1, Cosmo-SkyMed) are suggested for integrating information from both types of sensors mainly in Northern Europe area as well as tropical areas. SAR data can also help to provide information on the abiotic conditions, such as soil moisture.

   The acquisition of LIDAR data is strongly recommended to support the measurement of vegetation structure, such as plant height measurements, which cannot be derived directly from optical data. The spatial distribution of flora and fauna species is often highly determined by vegetation structure, next to types of plant species, and abiotic conditions.
2. To link the Copernicus spatial and in-situ components based on modelling expertise for conversion of LCLU maps into habitat maps.
3. To produce global validated LCLU maps in FAO-LCCS taxonomy. As well known, a new global CORINE Map is planned in the near future, but the FAO-LCCS maps are more suitable for habitat mapping. Consequently the acquisition of global FAO-LCCS maps is **solicited** in this deliverable.
4. To train terrain managers more in the use and interpretation of EO derived products.

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3. Policy framework: Habitats Directive (92/43) and Natura 2000 sites

3.1 Habitats Directive

Article 17 section 1 of the Habitats Directive (92/43/CEE) states:

> *"Every six years from the date of expiry of the period laid down in Article 23, Member States shall draw up a report on the implementation of the measures taken under this Directive. This report shall include in particular information concerning the **conservation measures** referred to in Article 6 (1) as well as evaluation of **the impact of those measures** on the conservation status of the natural habitat types of Annex I and the species in Annex II and **the main results of the surveillance referred to in Article 11.** The report, in accordance with the format established by the committee, shall be forwarded to the Commission and made accessible to the public."*

Under Article 17 of the Habitats Directive (92/43/CEE), Member States must submit information on how the Directive is being implemented every six years. The first reports were for the period 1994-2000 and primarily addressed the transposition of the Directive into national laws and the progress towards identifying and designating Special Areas of Conservation. For the reporting period 2001 to 2006, Member States, for the first time, provided detailed assessments on the conservation status of each of the habitat types (233) and species listed in the Directive and found within their territory. A second report has been provided for the period 2007-2012 (with submission deadline on June 2013) (Spikova et al., 2009). On the basis of the reports submitted by the Member States, the Commission is required to produce a composite report including an evaluation of the progress made and the contribution that the Natura 2000 network has made towards achieving the objectives set out in Article 3 of the Directive. Consequently, it is supposed that policy makers should consider such a composite report for their decisions.

So far, only the first Composite Report from the Commission to the Council and the European Parliament (2001-2009) has been published, as the National 2007-2012 renewed reports should have been submitted by June 2013 (Introductory Note, 2011). The previous Composite Report is available at http://ec.europa.eu/environment/nature/knowledge/rep_habitats/docs/com_2009_358_de.pdf
As evidenced in the Composite Report (2001-2009), Article 2 of the Habitats Directive states that '*measures taken pursuant to this Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest*' (the habitat types listed in Annex I and species listed in Annexes II, IV or V to the Directive). Article 1(e) and 1(i) of the Directive defines the term *conservation status* as applied to habitats and to species in a biogeographical region and is the main concern of ART17 of the Habitats Directive within a Member State. These definitions take into account parameters related to:

- the extent of the area (range) in which the habitat/species is found;
- the surface area of the habitat area;
- the structure and functions (read habitat quality), the size of the population, its age structure, mortality and reproduction (of species);
- future prospects and trends.

The information listed above, is the basis for developing a common assessment method and reporting format, which was agreed by the Habitats Committee in March 2005. The Commission provided explanatory notes on the assessment process in 2006 and 2012. In 2011, an update to the notes was provided and the new Standard Data Form (SDF) for assessment of the conservation of a habitat type or species can be downloaded from:

(https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp). The SDF is for the assessment of the conservation of a habitat type or species on a particular Natura 2000 site. In its revised version (dated 2011), the name *conservation status* is replaced by *degree of conservation* in order to reduce confusion of the term used also for the assessment for a whole biogeographical or marine region, which is the main concern of Article 17. Some tables of the SDF have been included in Appendix 2 of this Deliverable. Orange and green colours are used in Appendix 2 to evidence the measurements/information (e.g. area covered by habitat; pressures and threats) that could be extracted from space through the EODHaM system developed within the BIO_SOS project. It is possible to conclude that EO data can contribute so much to Natura 2000 surveillance and monitoring, if regularly collected on NATURA 2000 sites, along with in-situ data useful for products validation and also for LCLU to Habitats translation. The suggestion is to consider Natura 200O sites as hotspots for biodiversity.

When a report from a Member State was received, it was screened by the European Topic Centre for Biological Diversity (ETC-BD) of the EEA to assess the quality and completeness of the information. Requests for clarifications, additions and amendments were sent to the Member State with a short deadline for submitting any missing/updated data. It is worth noting that in the previous Composite report (2006), some 13 % of regional habitat assessments and 27 % of regional species assessments were reported by Member States as ‘unknown’. The number of ‘unknown’ classifications was particularly high for species found in the countries of southern Europe, with Cyprus, Greece, Spain and Portugal, all indicating ‘unknown’ for more than 50 % of the species reported in their territories. Many Member States lacked comprehensive and reliable information (Composite report from the Commission to the Council and the European Parliament, 2009). As the composite report (2001-2009) also states, even when information is available, problems often arise due to the different ways in which data is collected and presented.

BIO_SOS project is offering a methodology to support Member States in their obligations. However, regular collection of mainly VHR EO data is mandatory to detect changes and trends over time. As well-known, HR data (e.g. new LANDSAT 8, future Sentinel 2 data) cover all the globe, but ecological processes need to be monitored at a different spatial resolution (grain), including VHR (<4m.). At the same time it must be mentioned that VHR EO data cannot always help in mapping and monitoring of specific habitats, since some of them can only be detected in the field (including their quality). Nevertheless terrain managers and surveyors are very happy with support on the monitoring of larger habitats and species that are very dominant, so that field work can be more targeted on specific phenomena. This will lead to efficiency in resources in the end.

3.2 Natura 2000 sites

The Habitats Directive requires that the Commission’s composite report shall address the contribution of Natura 2000 to achieving the objectives set out in Article 3. Under Article 3 of the Habitats Directive, Member States are required to establish a series of protected sites. These sites are part of the Natura 2000 network (comprising sites designated under the Habitats and the Birds Directives), which is the biggest ecological network in the world, including areas located on a diverse range of land use types – agriculture, forests, wilderness areas in 11 Bio-geographic Regions (7 land an four marine). In particular, Natura 2000 aimed to enable the habitat types listed in Annex I to the Directive and the species listed in Annex II ‘to be maintained, or where appropriate, restored at a favourable conservation status in their natural range’.

Under the Directive, once a site is formally added to the EU list of Sites of Community Interest, a Member State has six years to develop the conservation measures needed to protect the ecological value of the area. However, due to the lack of standards in site monitoring, conservation measures are still being developed. The Composite report (2009) concludes that:

> *Protecting biodiversity is a priority for the European Union and for our policies to be successful we must have a comprehensive and reliable measure of the status of our biodiversity. Therefore, it is vital that sufficient resources are invested in monitoring and reporting under both the Habitats and the Birds Directives. This report demonstrates that many Member States need to invest considerably more in this work and that information is weak or lacking for marine habitats and species….The results of the 2001-2006 reports show that for many of the habitats and species listed under the Habitats Directive, favourable conservation status has not been achieved either at national or bio-geographic regional level".*

In this framework, it is urgent for Copernicus initiative to consider Natura 2000 sites, including their surroundings, as areas to be regularly monitored at multi-temporal (based on phenology information) and multi-spatial resolution (grain) .

4. How Copernicus can contribute to Biodiversity (BD) policy

All the biodiversity existing policies show that the provision of quantitative figures on fragmentation and extent of habitats and their trends is fundamental for general policy formulation in relation to the maintenance and enhancement of biodiversity across Europe (Bunce et al., 2008). The development of the series of Natura 2000 sites based on the above mentioned Directives is the major EU initiative for the protection of primary nature conservation areas (EU Council Directive, 1992; Ostermann, 1998). However, at the same time, these sites do not guarantee the maintenance of biodiversity in the wider countryside, because inevitably many habitats and species are outside protected areas (Bunce et al., 2008). Therefore, there is a need to develop additional policy instruments for nature conservation outside protected areas that are equally appropriate to those applied within.

4.1 BIO_SOS service description

In support to policy makers, the expert knowledge based EODHaM system, proposed in BIO_SOS, can provide HR and mainly VHR LCLU maps in FAO-LCCS taxonomy, and their translation into habitats maps (both Annex I and GHCs maps) through both the integration of LCLU maps and in-situ data or the exploitation of spatial relations between classes in the landscape (D 5.1).

The list of *VHR products* includes:

- LCLU map, as *core service*
- LCLU change map
- GHC map, as *biodiversity downstream service*
- Annex I map, as *biodiversity downstream service*
- *Annex I and GHC change maps*
- Binary map for specific thematic layers from LCLU maps, such as:
  - Permanent natural grasslands
  - Broadleaved evergreen forests
  - Broadleaved deciduous forest
  - Needleleaved evergreen forest
- Spectral features to be used for landscape modeling, such as: *NDVI; WBI; PSRI; texture features (e.g,. entropy)*
- Binary maps of target habitats, such as:
  - priority habitats from Annex I map (e.g., 2250; 7210; 1150; 62A0)
  - GHC category related to areal elements (e.g. CUL(WOC); CUL (CRO))

- Biodiversity indicators from habitat maps (e.g., habitat extension, number of priority habitats)
- Biodiversity indicator trends
- Landscape Indicators useful for habitat status assessment e.g., *PLAND, MESH, PD, SHAPE*)
- A dedicated geoportal for metadata

4.2 Recommendation_1: Regular tasking of EO data on Natura 2000 sites

To obtain LCLU and Habitat maps products, as well evidenced in Deliverables D5.1, D5.2 and D5.5, the knowledge base approach, adopted in EODHaM, focuses mainly on three components: a) spectral knowledge; b) temporal (phenological) relations and c) spatial relations. In –situ data are also used for LCCS or GHC to Annex I map translation (D6.1; D6.10; Tomaselli et al., 2013). Plant phenology is the fundamental element in the determination of the LC classes for the frequently encountered cases, for which 2 different classes have the same spectral behavior at some given times. In order to access phenology information, regular and frequent remote sensing data acquisitions have to be tasked over the areas of interest, as described in the following sub-ctions.

4.2.1 Service requirements

The BIO_SOS project has shown the usefulness of the availability of several VHR images per year in order to discriminate many LC classes of interest. In this context, the concepts of “pre”, “peak” and “post” observation have been introduced. These correspond to 3 dates relative to the peak of the vegetation flush for a given site.

However, this approach is only a trade-off between mapping quality and data availability (VHR images are expensive and the acquisition capacity of the existing satellites is limited). Furthermore, if the dates of these acquisitions change too much in consecutive years, the detection of changes for evolution monitoring may decrease in accuracy.

Therefore, added to the regular tasking of HR satellites through COPERNICUS (i.e. Pléiades HR) and mainly VHR data (e.g., WorldView2 recommended, QuickBird, IKONOS) in order to provide the aforementioned 3 (or more) acquisitions per year on Natura 2000 sites for downstream services, like EODHaM, other contributions from COPERNICUS will be very helpful as explained hereafter.

One of such contributions will be the availability of Sentinel-2 imagery, which during the operational phase with 2 satellites will provide a global coverage of continental surfaces every 5 days. These data may be usefully completed with Landsat-8 data during the phase, when only Sentinel-2 A will be in orbit.

Added to the precise description of the phenology, Sentinel-2 data will be crucial for early warning of changes and in order to ensure the availability of observations, which is comparable across different years. A shorter revisit cycle also increases the probability of cloud-free acquisitions.

Finally, image processing techniques will allow the combination (fusion) of VHR and Sentinel-2 images in order to provide improved LCLU maps useful for bio-diversity monitoring.

The most detailed discriminations of vegetation will be produced when SWIR bands are recorded and multiple dates within the same growing season are available at very high resolution (better than 10*10 m. as for future Sentinel 2 data). In these cases it may be possible to get down to species level for some of the vegetation types.

In the BIO_SOS project, the usefulness of hyperspectral data has been analysed and was found to be less useful than the adopted solution using multi-temporal VHR images (3 or 4) per year.

For sites where cloud cover is very frequent or even nearly permanent, radar imagery will have to be exploited. A similar schema as the one described above for optical data can be devised by using Sentinel-1 and Cosmo-Skymed or TerraSAR-X imagery.

4.2.1.1 Satellite Data requirements

For the majority of sites, a pre and peak flush image is required with these representing relatively stable periods. These typically represent the winter and summer periods in northern Europe but also the dry and wet season periods in India. A post flush image can also be used as a substitute for a pre-flush image if conditions are similar. For example, in northern Europe, the reflectance of surfaces observed in late November may be most similar to those acquired in February or early March and so the latter can be substituted. More detailed information on the habitats can also be obtained by obtaining images during transition periods between the pre- and peak-flush and peak-flush and post-flush. In some sites, the complexity in the reflectance characteristics of the land surfaces necessitates the use of multiple acquisitions. This was the case, for example, in Murgia Alta site (690 Km^2), where four EO images (Table 4) per year were needed to produce a LCLU map (see Deliverable D7.4).

Table 1. List of Worldview-2 data required for characterisation of the Murgia Alta site, Italy.

Sensor	Date of acquisition
WorldView2, Bundle	April/May 2011
	October 2011
	January 2012
	July 2012

In this case, the approximate costs associated to new image acquisitions covering the whole area (about 690 km^2 are reported hereafter:

- 14.200,00€ for one single image;
- 26.980,00€ for two dates (5% cost reduction);
- 51.120,00€ for four dates (10% cost reduction);

Such costs should be reduced in some way based on specific conventions with National or Regional management authorities

The specific requirements for all the BIO_SOS sites are reported in the Deliverables D7.1 to D7.4 of WP7

4.2.1.2 Aerial campaigns for vegetation height and DEM measurements

The use of LiDAR data for characterisation of vegetated and also non-vegetated environments is considered to be of major benefit for habitat mapping and monitoring within the EODHAM system, particularly as these relate directly to the categories of woody vegetation classes both in the LCCS and GHC schemes. The derivation of the digital elevation surface is also useful for characterisation of, for example, aquatic systems (levees, peat cuttings etc.). However, LIDAR data are not readily available in many Mediterranean Countries and are certainly not regularly updated as is the case in northern European countries.

Stereo optical acquisition could be provided as complementary measures when LIDAR data cannot be collected, because of their cost or resource availability. For instance, the Pléiades HR system is able to produce synchronous tri-stereo acquisitions allowing the production of DEMs, which are much more accurate than those generated with multi-pass stereo imagery. Moreover, VHR SAR data interferometry have been recently used for DEM extraction from very high resolution SAR data.

4.3 Recommendation_2. Linking the Copernicus space and in-situ components based on modelling expertise for conversion of LCLU maps into habitat maps

There is a need to link the two COPERNICUS space and in-situ components as ground truth data are required for:

- Conversion of LCLU maps into habitat map using ancillary data, LCCS environmental attributes and GHC environmental qualifiers collection, as discussed in Deliverable D6.12.
- Ground truth data for validating LCLU and habitat maps as well as their changes:

  For Natura 2000 sites, there is a lack of long term in-situ data collection and, when collected, data accessibility is not guaranteed by the link to a centralized unit. As an example, in Mediterranean areas, different Units collect data, such as the Regional Agencies for Environmental Prevention and Protection (ARPA), research institutions and local Natura 2000

site management Authorities. In addition, if available, such data are not always adequate, in terms of both spatial and temporal frequency, to be used as input to ecological models (e.g. Niche Models). A different situation characterizes the sites belonging to the Long Term Ecological Network (LTER) network, where data are regularly collected according to specific protocols. However, only a low percentage of overlap can be found between LTER sites and NATURA 2000 sites.

- Accurate atmospheric corrections are needed for EO data calibration.

  Routine and open source procedures for atmospheric correction of satellite sensor data are needed to allow accurate retrieval of surface reflectance data and calculation of derived indices. Aerosol loadings (soot, dust etc) are particularly important to correct for and reference can be made to the AErosol RObotic NETwork (AERONET) station data (http://www.nasa.gov/topics/earth/features/aeronet.html). Alternatively, reference can be made to estimates generated from coarser spatial resolution sensors (e.g., MODIS) operating a higher temporal spatial resolution..

4.3.1 LCLU map to Annex I map translation

BIO_SOS has developed a semantic framework for LCLU to habitat map translation (Deliverables D6.1, D6.10). FAO-LCCS can be used as a brokering tool to combine LCLU and habitat domains (see D6.10 and D5.2), as recently demonstrated in BIO_SOS papers (Tomaselli et al., 2013, Adamo et al., 2013, Kosmidou et al., 2014). In (Tomaselli at al.,2013), a validated LCLU map was firstly converted from the original CLC taxonomy to LCCS taxonomy based on the report on (GOFC-GOLD report n.20, 2004). Then, the output FAO-LCCS map was translated into an Annex I map by integrating in-situ data according to expert rules from botanists and ecologist. The translation is not based on a look-up table, but as already mentioned, it is based on specific habitat and site knowledge rules. For the translation, key elements are:

- an appropriate selection of EO data, which should also be optimized for costs, with this mainly based on phenological constraints and class set characteristics;
- the frequency of in-situ data measurements updating, with this depending on specific LCCS environmental qualifiers (e.g. lithology, soil surface aspect, water salinity) and on site (e.g. water salinity) characteristics. Some of these qualifiers do not vary over time, other can vary very rapidly (seasonally, monthly, daily). Consequently the collection of in-situ data useful for habitat mapping should be agreed between scientific users, who know the rules and ecological models, and site management authorities or regional authorities, who should collect those data. As an example, it is important to evaluate the frequency of water salinity data collection based on modelling studies of the impact that water salinity changes may have over time on biodiversity loss in wetland habitats.

4.4 Recommendation _3. Provision of global LCLU maps in FAO_LCCS taxonomy

As well known, a new global CORINE Map is planned in the near future, but the FAO-LCCS maps are more suitable for habitat mapping. Among the LCLU taxonomies, the FAO land cover classification system (LCCS) (Di Gregorio and Jansen 1998, 2005) taxonomy was identified (Herold et al. 2008) as the most appropriate for providing a common language for translating and harmonizing different LCLU legends, as recognized by the panel of the Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) (GOFC-GOLD report n.20 2004). In addition, within BIO_SOS, FAO-LCCS was also recognized in (Tomaselli at al.,2013) as the most suitable LCLC taxonomy for LCLU to habitat classes translation as it can describe natural and semi-natural classes better than CLC. However, even though there is the possibility to easily translate CORINE LAND COVER (CLC) maps into FAO_LCCS maps (GOFC-GOLD report n.20 2004), the criteria of labelling ground data is completely different in the two taxonomies and this might induce errors in translations, as discussed in the literature related to map validation (Congalton R. & Green K (2009)).

More recently (2009), the Environmental Information and Observation Network (EIONET) initiative has set up the voluntary Group on Land Monitoring in Europe (EAGLE) to find bottom-up solutions to better integrate and harmonise national mapping activities with European land monitoring initiatives. The main aim of the EAGLE group is not to develop yet another classification system. It is, rather, a semantic transformation tool that is applicable at EU, national and sub-national level, can translate between different land cover/land user classification systems as a thematic meta-language, and is open to be implemented in future land monitoring initiative. As an outcome of intense discussions, starting in 2009, the EAGLE group has evidenced some gaps in CLC taxonomy based on the technical and semantic limitations resulted in more and more European countries trying to meet European community data requirements by developing and enhancing their own methods of mapping and data collection. As written in Arnold et. al (2013), a proposal for an enhancement of CLC nomenclature guidelines is foreseen to be given to EEA by EAGLE. According to EAGLE, enhanced class definitions should provide a more consistent harmonized CLC map production (both with traditional photo-interpretation and bottom-up/semi-automated methods). Coherently, the group proposes to decompose class description to land cover, land use and characteristic landscape components through an appropriate EAGLE matrix, which include three blocks, as reported in Arnold et. al (2013) and in Appendix 3 to this Deliverable.

In this framework, BIO_SOS offers a different perspective. Based on the experience gained by analyzing data of Natura 2000 sites from different climatic areas, it appears worth noting that the attention should directly focus on the potentialities offered by the FAO-LCCS taxonomy and its associated classification framework for LCLU mapping and subsequent translation to habitats through more extensive experimentation of such framework. As discussed in most recent BIO_SOS papers (Tomaselli at. al., 2013; Kosmidou et. al, 2014; Adamo at al., 2013) the FAO-LCCS is based on the concept of Life Forms (Di Gregorio et. al, 2005; Bunce at al. 2008) that can better harmonize different national and international taxonomies used for LCLU mapping. Based on expert rules, through both the FAO-LCCS environmental attributes and additional LCCS class specific attributes (e.g. cycle) the integration of in-situ data needed for LCCS to Annex I habitats translation is feasible and habitats can be mapped and monitored over time (Tomaselli et. al, 2013).

Concerning the EAGLE framework, it appears that, better than CLC, the FAO-LCCS taxonomy could also directly match the Land Cover component (see Appendix 3) of the EAGLE matrix, proposed by the authors for semantic class description standardization purposes.

Should it not be possible in the short term to agree on the implementation of a pan-European FAO-LCCS map, as a minimal recommendation, BIO_SOS project would strongly encourage:

- the collection of ground truth data to be explicitly labelled according to both CLC and FAO-LCCS taxonomies during the already planned future pan-European campaigns for CLC map updating and validation. Such data will be very useful for CLC to FAO-LCCS translation and validation phases.
- The training of expert photo (image)-interpreters to FAO-LCCS taxonomy, as objects on the earth surface might also be labelled according to both CLC and FAO-LCCS taxonomies.
- The potential use of crowd-sourcing as a means for gathering ground truth data to support the validation of the LCCS maps, as proposed by the FP7 COBWEB (http://cobwebproject.eu/project), being at the same time also considered by the FAO.

4.5 Recommendation_4. Train terrain managers more in the use and interpretation of EO derived products

The last recommendation concerns the possibility to train terrain managers more in the use and interpretation of EO derived products. Linking EO data providers with experts in habitat mapping, with these including botanists, ecologists, Natura 2000 site managers, and other relevant actors is critical. The examples for such cooperation and specialties' integration may be found within FP7 projects, where from the suggested tools and combined approaches evolved by EO experts, who gained experience in habitat mapping.

Also visual interpretation of very high resolution satellite data could support their work in deriving specific information. This is not only valid for terrain managers, but all kind of experts that are making using of field surveys. In BIO_SOS project, the use of co-registered multi-temporal EO data was appreciated by expert photo interpreters for the selection of areas to be used for output products validation, as well as to reduce the costs of in-field campaigns.

5. Appendix 1. BIO_SOS Project Factsheet

Project: BIO_SOS	**BIOdiversity multi-SOurce monitoring System: from Space TO Species** **FP7-SPACE-2010-1** **Ga. 263435**
Description	**The main objective** of BIO-SOS has developed a **knowledge-based** pre-operational ecological modelling system suitable for effective and timely multi-annual monitoring **of NATURA 2000 sites and their surrounding areas** particularly exposed to different and combined type of pressures. Its input data sources are satellite-based measurements and on-site data. Main achievements: • The development of pre-operational automatic high spatial resolution (HR), and mainly very high spatial resolution (VHR) EO data understanding techniques for land cover/use (LC/LU) map and LC/LU change map generation • The development of an ***ecological modelling framework*** at *both habitat and landscape level* to combine EO and *in-situ* data for habitat mapping, biodiversity indicators extraction, for assessing relationships between both spectral feature/landscape structure indices and biodiversity surrogates, and community structure indicators relevant to the *Biodiversity Process.*
Status	Pre-operational ready for application Project Closing (30/11/2013)
Spatial Coverage	The products will be provided on a regional/local scale by producing results for Natura 2000 sites (pilot areas) in Wales, Portugal, Italy, Greece, The Netherlands, India, Brazil. Potential applicability: European and global.
Temporal Coverage	2009-2013
Products (mainly VHR)	• LCLU maps; LCLU change maps; • Habitat maps as both Annex I and General Habitat Category (GHC); • Spectral Indices (e.g. NDVI, WBI) to be used as input to modelling • Binary mask images of specific LCLU thematic layers (target classes) from previous maps (e.g. permanent natural grasslands, broadleaved deciduous and evergreen forest as well as endangered habitats); • Binary mask images of specific priority habitats (e.g., 2250; 7210; 1150) • Biodiversity indicators (e.g., habitat area extension, number of priority habitats) and indicator change; • Landscape indicators as basis for habitat status assessment
Producers	BIO_SOS Consortium
Data Source (s)	EO data (WorldView2, QuikBird, SPOT, Landsat)
Data policy	Open source software. Concerning products: TBD
Source	www.biosos.eu

6. Appendix 2. Tables from Art 17-Reporting-Formats

Here are reported some significant Tables extracted from the Art 17-Reporting-Formats-final. Doc document that can be found at:

https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp

In the Tables, questions on habitat status in terms of extension, trend, and conservation status are evidenced in orange and questions on pressures are evidenced in green colour. EO data can be used to automatically extract information useful to provide answers to such questions according to the EODHaM proposed approach (D5.2, D5.5, D6.9) discussed, but regular (at least every 5 years) acquisition of multi-temporal EO data on Natura 2000 site network is mandatory.

Field definition	***Brief explanations***
0.1 Member State	The MS for which the reported data apply; use 2 digit code according to list to be found in the reference portal
0.2 Habitat code	From checklist for reporting under nature directives, e.g. 1110 (do not use subtypes). Should subtypes be used, e.g. for marine habitat types, please ensure that there is also a format filled in for the habitat type as in the directive – Annex I)
1 National level	
1.1. Maps	Distribution and range within the country concerned
1.1.1. Distribution map	Submit a map as a GIS file – together with relevant metadata. Standard for submission is 10x10km ETRS grid cells, projection ETRS LAEA 5210.
1.1.2. Method used - map	3 = Complete survey 2 = Estimate based on partial data with some extrapolation and/or modelling 1 = Estimate based on expert opinion with no or minimal sampling 0 = Absent data
1.1.3. Year or period	Year or period when distribution data was collected
1.1.4. Additional distribution map Optional	This is for cases if MS wishes to submit an additional map deviating from standard submission map under 1.1.1.
1.1.5. Range map	Submit a map that was used for range evaluation following the same standard as under 1.1.1. or 1.1.4.

Table 1a.

2. Biogeographical level Complete for each biogeographical region or marine region concerned	
2.1. Biogeographical region or marine regions	Choose one of the following: Alpine (ALP), Atlantic (ATL), Black Sea (BLS), Boreal (BOR), Continental (CON), Mediterranean (MED), Macaronesian (MAC), Pannonian (PAN), Steppic (STE)), Marine Atlantic (MATL), Marine Mediterranean (MMED), Marine Black Sea (MBLS), Marine Macaronesian (MMAC) and Marine Baltic Sea (MBAL)

2.2. Published sources	If data given below is from published sources give bibliographical references or link to Internet site(s). Give author, year, title of publication, source, volume, number of pages, web address.	
2.3. Range	Range within the biogeographical region concerned.	
2.3.1. Surface area Range	Total surface area of the range within biogeographical region concerned in km². The method described in the section IV.a.i 'Range' of the guidelines is recommended	
2.3.2 Method used Range	3 = Complete survey 2 = Estimate based on partial data with some extrapolation and/or modelling 1 = Estimate based on expert opinion with no or minimal sampling 0 = Absent data	
2.3.3. Short-term trend Period	2001-2012 (rolling 12-year time window) or period as close as possible to it. Indicate the period used here. The short-term trend is to be used for the assessment.	
2.3.4. Short-term trend Trend direction	0 = stable + = increase - = decrease x = unknown	
2.3.5. Short-term trend Magnitude Optional	**a) Minimum**	Percentage change over the period indicated in the field 2.3.2. - if a precise figure, to give same value under 'minimum' and 'maximum'
	b) Maximum	As for a)
2.3.6. Long-term trend Period Optional	A trend calculated over 24 years. For 2013 reports it is optional (fields 2.3.6 -2.3.8 are optional). Indicate the period used here.	
2.3.7 Long-term trend Trend direction Optional	0 = stable + = increase - = decrease x = unknown	
2.3.8 Long-term trend Magnitude Optional	**a) Minimum**	Percentage change over the period indicated in the field 2.3.6. - if a precise figure, to give same value under 'minimum' and 'maximum'
	b) Maximum	As for b)
2.3.9 Favourable reference range	a) In km². Submit a map as a GIS file if available.	
	b) Indicate if operators were used (using symbols ≈, >, >>)	
	c) If Favourable Reference Range is unknown, indicate with "x"	
	d) Indicate method used to set reference value (if other than operators) (free text)	
2.3.10 Reason for change Is the difference between the reported value in 2.3.1. and the previous reporting round mainly due to:	a) genuine change? *YES/NO*	
	b) improved knowledge/more accurate data? *YES/NO*	
	c) use of different method (e.g. "Range tool") *YES/NO*	
2.4 Area covered by habitat	Area covered by habitat within the range in the biogeographical region concerned (km^2)	

2.4.1 Surface area	In km²	
2.4.2 Year or period	Year or period when data for area surface was recorded.	
2.4.3 Method used Area covered by habitat	3 = Complete survey or a statistically robust estimate 2 = Estimate based on partial data with some extrapolation and/or modelling 1 = Estimate based on expert opinion with no or minimal sampling 0 = Absent data	
2.4.4 Short-term trend Period	2001-2012 (rolling 12-year time window) or period as close as possible to it. Indicate the period used here. The short-term trend is to be used for the assessment	
2.4.5 Short-term trend Trend direction	0 = stable + = increase - = decrease x = unknown	
2.4.6 Short-term trend Magnitude Optional	**a) Minimum**	Percentage change over the period indicated in the field 2.4.4 - if a precise figure, to give same value under 'minimum' and 'maximum'
	b) Maximum	As for a)
	c) Confidence interval	Indicate confidence interval if a statistically reliable method is used
2.4.7 Short-term trend Method used	3 = Complete survey or a statistically robust estimate 2 = Estimate based on partial data with some extrapolation and/or modelling 1 = Estimate based on expert opinion with no or minimal sampling 0 = Absent data	
2.4.8 Long-term trend Period Optional	A trend calculated over 24 years. For 2013 reports it is optional (fields 2.4.8. – 2.4.10 are optional). Indicate the period used here.	
2.4.9. Long-term trend - Trend direction Optional	0 = stable + = increase - = decrease x = unknown	
2.4.10 Long-term trend Magnitude Optional	**a) Minimum**	Percentage change over the period indicated in the field 2.4.8 - if a precise figure, to give same value under 'minimum' and 'maximum'
	b) Maximum	As for a)
	c) Confidence interval	Indicate confidence interval if a statistically reliable method is used
2.4.11 Long-term trend Method used Optional	3 = Complete survey or a statistically robust estimate 2 = Estimate based on partial data with some extrapolation and/or modelling 1 = Estimate based on expert opinion with no or minimal sampling 0 = Absent data	
2.4.12 Favourable reference area	a) In km². Submit a map as a GIS file if available.	
	b) Indicate if operators were used (≈, >, >>[1])	
	c) If Favourable Reference Area is unknown indicate with "x"	

[1] Special case: symbol "<" can be used only in special cases like for the habitat type Degraded raised bog still capable of natural regeneration (7120)

	d) Indicate method used to set reference value (if other than operators) (free text)	
2.4.13 Reason for change Is the difference between the reported value in 2.4.1. and the previous reporting round mainly due to:	a) genuine change? *YES/NO* b) improved knowledge/more accurate data? *YES/NO* c) use of different method (e.g. "Range tool") *YES/NO*	
2.5 Main pressures		
a) Pressure	**b) Ranking**	**c) Pollution qualifier**
List max 20 pressures. Use codes from the list of threats and pressures to at least the 2nd level[2]	• H = high importance (max 5 entries) • M = medium importance • L = low importance	*optional*
2.5.1 Method used – pressures	3 = based exclusively or to a larger extent on real data from sites/occurrences or other data sources 2 = mainly based on expert judgement and other data 1 = based only on expert judgements	
2.6. Main threats		
a) Threats	**b) Ranking**	**c) Pollution qualifier**
Same explanation as for the pressure	Same explanation as for the pressure	*optional*
2.6.1. Method used –threats	2 = modelling 1 = expert opinion	
2.7 Complementary information		
2.7.1 Typical species	List the typical species used	
2.7.2 Typical species – method used	Describe method(s) used to assess the status of typical species as part of the overall assessment of structure and functions.	
2.7.3 Justification of % thresholds for trends	In case a MS is not using the indicative suggested value of 1% per year when assessing trends, this should be duly justified in this free text field	
2.7.4 Structure and functions - Methods used	3 = Complete survey or a statistically robust estimate 2 = Estimate based on partial data with some extrapolation and/or modelling 1 = Estimate based on expert opinion with no or minimal sampling	
2.7.5 Other relevant information	Free text	
2.8. Conclusions *(assessment of conservation status at end of reporting period)*		
2.8.1. Range	a) Favourable (FV) / Inadequate (U1) / Bad (U2) / Unknown (XX)	
	b) If CS is U1 or U2 it is recommended to use qualifiers[3]	
2.8.2. Area	a) Favourable (FV) / Inadequate (U1) / Bad (U2) / Unknown (XX)	
	b) If CS is U1 or U2 it is recommended to use qualifiers[10]	
2.8.3. Specific structures	a) Favourable (FV) / Inadequate (U1) / Bad (U2) / Unknown (XX)	

[2] List of threats and pressures is available on the Art 17 Reference Portal
[3] If conservation status is inadequate or bad, it is recommended to indicate use '+' (improving) or '-' (declining), '=' (stable) or 'x' (unknown).

and functions (incl. typical species)	b) If CS is U1 or U2 it is recommended to use qualifiers[10]
2.8.4. Future prospects	a) Favourable (FV) / Inadequate (U1) / Bad (U2) / Unknown (XX)
	b) If CS is U1 or U2 it is recommended to use qualifiers[10]
2.8.5. Overall assessment of Conservation Status	Favourable (FV) / Inadequate (U1) / Bad (U2) / Unknown (XX)
2.8.6 Overall trend in Conservation Status	If CS is inadequate or bad, use of qualifier '+' (improving) or '-' (declining), '=' (stable) or 'x' (unknown) is obligatory.

Table 1.b. It is the Table on "the main results of surveillance under Article 11" for Annex I extracted from Annex D of the Reporting Formats. In such Table, questions on habitat status in terms of extension, trend, and conservation status are evidenced in orange and questions on pressures are evidenced in green colour. EO data can be used to automatically extract such information according to the EODHaM proposed approach, but regular acquisition of EO data should be activated on Natura 2000 site network.

(https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp) ,

In addition, from Annex D and Annex E of the Reference Format, the tables to be used for: a) reporting on conservation measures and b) for evaluating the conservation status, are reported hereafter in Table 2 and Table 3 , respectively.

3. Natura 2000 coverage & conservation measures - Annex I habitat types ***on biogeographical level***		
3.1 Area covered by habitat		
3.1.1 Surface area Estimation of habitat type surface area included in the network (of the same biogeographical region).	**a) Minimum**	In km^2
	b) Maximum	Same as above
3.1.2 Method used	3 = Complete survey or a statistically robust estimate 2 = Estimate based on partial data with some extrapolation and/or modelling 1 = Estimate based on expert opinion with no or minimal sampling 0 = Absent data	
3.1.3 Trend of surface area within the network Optional	0 = stable + = increase - = decrease x = unknown	

3.2 Conservation measures

List up to 20 conservation measures taken (i.e. already being implemented) within the reporting period and provided information about their importance, location and evaluation. Fields 3.2.2-3.2.5 to be filled in for each reported measure.															
3.2.1 Measure	**3.2.2** **Type** Tick the relevant case(s)					**3.2.3** **Ranking**	**3.2.4** **Location** Tick the relevant case concerning where the measure is PRIMARILY applied			**3.2.5** **Broad evaluation of the measure** Tick the relevant case					
	a) Legal/statutory	**b) Administrative**	**c) Contractual**	**d) Recurrent**	**e) One-off**		**a) Inside**	**b) Outside**	**c) Both inside & outside**	**a) Maintain**	**b) Enhance**	**c) Long term**	**d) No effect**	**e) Unknown**	**f) Not evaluated**
Use codes from the checklist on conservation measures						*Highlight – using a capital 'H' – up to 5 of the most important measures*									

Table 2. Taken from Annex D of the reference report.

Parameter	**Conservation Status**			
	Favourable ('green')	**Unfavourable – Inadequate ('amber')**	**Unfavourable - Bad ('red')**	***Unknown (insufficient information to make an assessment)***
Range[4]	Stable (loss and expansion in balance) or increasing AND not smaller than the 'favourable reference range'	Any other combination	Large decrease: Equivalent to a loss of more than 1% per year within period specified by MS OR More than 10% below 'favourable reference range'	*No or insufficient reliable information available*
Area covered by habitat type within range[5]	Stable (loss and expansion in balance) or increasing AND not smaller than the 'favourable reference area' AND without significant changes in distribution pattern within range (if data available)	Any other combination	Large decrease in surface area: Equivalent to a loss of more than 1% per year (indicative value MS may deviate from if duly justified) within period specified by MS OR With major losses in distribution pattern within range OR More than 10% below 'favourable reference area'	*No or insufficient reliable information available*
Specific structures and functions (including typical species[6]**)**	Structures and functions (including typical species) in good condition and no significant deteriorations / pressures.	Any other combination	More than 25% of the area is unfavourable as regards its specific structures and functions (including typical species)[7]	*No or insufficient reliable information available*
Future prospects (as regards range, area covered and specific structures and	The habitats prospects for its future are excellent / good, no significant	Any other combination	The habitats prospects are bad, severe impact from threats expected;	*No or insufficient reliable information available*

[4] Range within the biogeographical region concerned.
[5] There may be situations where the habitat area has decreased as a result of management measures to restore another Annex I habitat or habitat of an Annex II species. The habitat could still be considered to be at 'Favourable Conservation Status' but in such cases please give details in the Complementary Information section ("Other relevant information") of Annex D.

[6] See definition of typical species in the guidance document
[7] E.g. by discontinuation of former management, or is under pressure from significant adverse influences, e.g. critical loads of pollution exceeded.

Parameter	**Conservation Status**			
	Favourable ('green')	**Unfavourable – Inadequate ('amber')**	**Unfavourable - Bad ('red')**	***Unknown (insufficient information to make an assessment)***
functions)	impact from threats expected; long-term viability assured.		long-term viability not assured.	
Overall assessment of CS [8]	All 'green' OR three 'green' and one 'unknown'	One or more 'amber' but no 'red'	One or more 'red'	Two or more 'unknown' combined with green or all "unknown'

Table 3. From Annex E of the Reference Format, useful for assessing the conservation status of Habitas.

[8] A specific symbol (qualifier +/-/=/x) is to be used in the unfavourable categories to indicate overall trend in conservation status

7. Appendix 3. EAGLE Land Cover matrix component

All Tables reported in this Appendix are taken from Arnold at. al. (2013). They represent the three blocks of the proposed EAGLE matrix, useful for harmonizing different LCLU taxonomies. The description of landscape by a clear separation land cover and land use perspective is proposed.

Table 1: LAND COVER COMPONENTS (LCC) of the EAGLE matrix

ABIOTIC / NON-VEGETATED	Artificial Surfaces and Con-structions	Sealed	Buildings
			Other Constructions
		Non-Sealed	Waste Materials
			Other Artificial Surfaces
	Natural Material Surface	Consolidated Surface	
		Un-Consolidated Surface	Mineral Fragments
			Bare Soils
			Natural Deposits
BIOTIC / VEGETATION	Woody Vegetation	Trees	Broadleaved Trees
			Coniferous Trees
			Palm Trees
	Bushes, Shrubs	Regular Shrubs	
		Dwarf Shrubs	
	Herbaceous Plants (grasses and forbs)	Graminaceous (grass-like)	Regular Graminaceous
			Reeds (high growth)
		Non-Graminaceous (forbs, ferns)	
	Succulents and Others		
	Lichens and Mosses	Lichens	
		Mosses	
WATER	Liquid	Inland Water	Water Courses
			Water Bodies
		Coastal Water	Estuaries
			Lagoons
		Open Sea	
	Solid	Permanent Snow	
		Ice and Glaciers	

Table 2: LAND USE / FUNCTION ATTRIBUTES (LUA) of the EAGLE matrix

PRIMARY Production Sector	Agriculture	Commercial crop production
		Agricultural facilities
		Production for own consumption
	Forestry	Short rotation
		Interim or long rotation
		Continuous cover, selective logging
	Mining and quarrying extraction sites	Surface mining
		Underground mining
		Under water mining
		Salines
	Aquaculture and fishing	
	Other primary production	
SECONDARY Production Sector / Industries	Manufacturing/producing industry	
	Energy production	
TERTIARY Production sector / Services	Commerce, Finances	
	Communication, Information services	
	Accommodation, gastronomy	
	Community services	Public admininstration, defense, military, secu-
		Science, research, education
		Health and social services
		Religious facility
		Other community services
	Culture, entertainment, recreational	
Transport networks, Logistics, Utilities	Transportation	
	Logistics	
	Utilities	
Residential	Permanent residential	
	Residential-commercial mixed	
	Other residential	
Other Non socio-economic Functions	Inland water functions	Drinking water
		Irrigation
		Fire-fighting
		Reservoir for artificial snow
		Nature protection
		No specific function
	Flood protection (water retention area)	
	Nature protected land	
	Renaturation	
	Abandoned	
	No use, not known, not relevant	

Table 3: LANDSCAPE CHARACTERISTICS (CH) of the EAGLE matrix

Land Management	Agricultural cultivation type	Arable crop land
		Permanent crop land
		Permanent grass land
	Cultivation pattern	Crop rotation
		No crop rotation
		Plantation (intensive)
		Orchards (extensive)
		Agroforestry
		Shifting cultivation
	Cultivation measures	Fertilizing
		Irrigation
		Drainage
		Mowing
		Grazing
		Shrub clearance
	Forest management type	Intensive monoculture
		Regular
		Extensive (selective logging)

8. Appendix 4. Acronym list

BIO_SOS	**Biodiversity Multisource Monitoring System: from Space TO Species**
CORINE	**COoRdination of INformation on the Environment**
CLC	**CORINE Land Cover**
DEM	**Digital Elevation Model**
EBONE Project	**European Biodiversity Observation Network Project**
EU_BON Project	**Building the European Biodiversity Observation Network**
EAGLE	**EIONET Action Group on Land monitoring in Europe**
EIONET	**Environmental Information and Observation Network**
EO	**Earth Observation**
EODHaM	**EO Data for Habitat Monitoring**
ESA	**European Space Agency**
FAO	**Food and Agriculture Organization**
FAO-LCCS	**FAO - Land Cover Classification System**
GHC	**General Habitat Category**
LCLU	**Land Cover/Land Use**
LCC	**Land Cover Change**
LCCS	**Land Cover Classification System**
MS	**Multi Spectral**
NRC	**National Reference Centre**
VHR	**Very High Resolution**
HR	**High Resolution**

9. References

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