Title: DEVELOPING CONCEPTUAL FRAMEWORK FOR ECOSYSTEM MAPPING

Subtitle: Task 222_5_1 ecosystem mapping

Type of Document:

"Draft internal Report"

Prepared by:

UBA: Gebhard Banko, Michael Weiss, Dietmar Moser,

UMA & UAB: Dania Abdul Malak, Raquel Ubach

ETC-BD: Lubos Halada,

ALTERRA: Gerbert Roerink, Gerard Hazeau, Sander Mucher, Stephan Hennekens, Joop Schaminée

GISAT: Lukas Brodsky

GeoVille: Stephan Kleeschulte

Date:

3. December 2013

Project Manager:

Markus Erhard, Branislav Olah

European Environment Agency

Universidad de Malaga

ETCSIA

PTA - Technological Park of Andalusia

c/ Marie Curie, 22 (Edificio Habitec)

Campanillas

29590 - Malaga

Spain

Telephone: +34 952 02 05 48

Fax: +34 952 02 05 59

TABLE OF CONTENTS

1 BACKGROUND

This task shall support EU biodiversity strategy to 2020 Target 2 Action 5 by providing conceptual framework for ecosystem mapping.

Ecosystem mapping shall provide reliable information for identification of Europe's ecosystems to be part of Green Infrastructure or to be restored (15% target).

Ecosystem mapping shall be in direct link to ecosystem services mapping (ESS) and Ecosystem capital accounts (ECA) approaches.

The framework will address:

1. Ecosystem structure (by mapping of their biophysical delineation and health)
2. Ecosystem functions (as predisposition to deliver ecosystem services)

Ecosystem classification will be based on EUNIS and the proposal of ecosystem typology for the MAES working group. It will take into account mapping feasibility at European scale and keep compatibility with national mapping approaches (nested scales).

From operational point of view it shall apply regular mapping (CLC, HRLs) and reporting data flows (N2000, Art. 17, WFD, MSFD) and enable online querying (OLAP cube). Nevertheless, potential of existing or upcoming dynamic datasets will be explored too (e.g. Copernicus high resolution layer).

Ecosystem status indicator builds on ecosystem mapping and it shall provide a structured information on ecosystems health and resilience to inform policy about development of Europe's ecosystems

1.1 EXPECTED RESULTS

Conceptual framework for ecosystem mapping along with a pilot Europe's ecosystems assessment consisting of:

1. Ecosystems classification
2. Ecosystems map + method for ecosystem mapping (input data and their integration)
3. Links to Ecosystems assessment method, ESS and ECA (task 222_5_2 ecosystem assessment)

Ecosystems status indicator – explanatory description of ecosystem quality parameters

2 LINKS TO OTHER TASKS

This task is carried out in close cooperation with the **ETC-BD** and the following task:

- 1.2.2.B.1 "Biodiversity and Ecosystem assessments related to the EU Biodiversity strategy"

Within the **ETC-SIA** close cooperation will be maintained with the following tasks:

- 222_5_2 ecosystem assessment
- 261_3_3 Seasonal Dynamics (HANTS)
- 262_4_11 Spatial analysis on green infrastructure

3 APPROACH

The mapping of ecosystems is here considered at the scale of habitat/biotopes and partly on landscape level. Ecosystem mapping is the spatial delineation of ecosystems following an agreed ecosystem typology (ecosystem types).

3.1 ECOSYSTEM TYPOLOGY

The typology that will be used for mapping ecosystems was developed within the MAES working group (MAES Working paper v 9.7.5). This typology groups the main EUNIS-classes into three distinct groups (terrestrial, freshwater and marine ecosystems

The MAES ecosystem typology differentiates three levels, whereas the Level 2 of the MAES proposal follows closely the EUNIS Level 1. The third level of the MAES typology corresponds therefore to the EUNIS level 2. This level will be the base for the mapping approach. Where necessary and helpful special mapping procedures may be defined as well on EUNIS level 3 (in case this allows a better regional differentiation of habitats).

Some classes can not be mapped out of the following constraints:

- Size constraints
    - As CORINE Land cover defines 25 hectares as minimum mapping unit, all features below this MMU can not be mapped with the standard CORINE Land cover data
- Data constraints
    - As the access to other geo-data is not always straight forward, some classes coul not be mapped, although data exist to differentiate these classes (e.g. data from the FWD for differentiation of J5)
- Applicability
    - Some classes are not representing land cover in the narrow sense (e.g. caves) or are out of scope of normal land monitoring data (e.g. volcanic activities)

The following table lists the classes that could not be mapped due to one of the three constraints:

EUNIS_L2_ID	ID_Grid_L2	EUNIS_name	constraint
E5	27	Woodland fringes and clearings and tall forb stands	too small
FA	39	Hedgerows	too small
G5	45	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	too small
H1	46	Terrestrial underground caves, cave systems, passages and waterbodies	not applicable

H6	51	Recent volcanic features	not applicable
J5	58	Highly artificial man-made waters and associated structures	no WFD data

3.2 ECOSYSTEM MAPPING

The basic geometric reference for the mapping exercise is CORINE Land Cover transformed into the 100*100 m grid (using the CORINE land cover value of the pixel centroid as pixel class label). CORINE Land Cover classes are aggregated into EUNIS classes based on detailed expert analysis, additional georeferenced data and relation between land cover classes and the EUNIS classification system. A crosswalk between EUNIS classes and CORINE land cover classes was already developed from the ETC-BD and will be used.

The mapping will be conducted in three separate steps (see figure 1):

1. Land Cover refinement (integrated land cover database)
2. EUNIS-CLC cross walk
3. Thematic refinement
4. Quality assessment (experimental)

Ad 1. Land Cover refinement (building a integrated land cover database):

As the origin of CORINE Land Cover is based on a visual interpretation of satellite images in scale 1:100.000 with a minimum mapping unit of 25 ha, the methodology limits the spatial scale and the spatial detail that can be reached. However due to GIO-Land more detailed land cover information is available.

Although not yet the full program of the high resolution layers (HR-layers) are already available, precursors like the soil sealing degree or the JRC-forest layer (2006) provide enhancements of the current CLC geometric resolution. Beside the HR-layers also other sectorial databases provide useful estimators for an enriched and integrated land cover map with a resolution of 100*100m (e.g. ECRINS water bodies, small linear features). Those data that do not provide explicit spatial delineations (e.g. linear vectors of water courses) will not be taken into consideration for the refined land cover maps. What is needed to be integrated is a spatial explicit value for a specific land cover type that covers at least 50% of a 100*100m grid cell. This approach is currently being discussed within the HELM project (harmonized European land monitoring) as the “grid approach”.

Table: Overview of datasets to build an integrated land cover database

Theme	Dataset	Resolution/scale	coverage	comment
HR-Layer	Soil sealing 2006+2009	20*20m	EEA 39	Original data in 20*20m upscaled to 100*100m, degree of soil

				sealing
	JRC forest type map 2006	25*25 m	EEA 39 (excl. Iceland)	Classes: broadleaved, coniferous and water
WFD	Lakes	> 50 ha	EU 27	
ECRINS	Water bodies		EU 27	
Riparian areas	JRC riparian areas	1*1 km	EU 27	Original dataset 100*100m currently not available
Small linear features	SLF	20*20 m	Pilot areas	Experimental dataset
HR-Layer (experimental)	Grassland	100*100m	Pilot areas	Geoland II transect Munich-Verona
	wetlands	100*100m	tbd.	not yet available
	water	100*100m	tbd.	not yet available
EEZ (marine)	Exclusive economic zones	Vector, European scale	Europe	EEZ-world v.7 will be used, as access to ETC-ICM data can currently not be provided

Ad 2. EUNIS-CLC cross walk

The ETC-BD has developed a MS Access database for the crosswalk between EUNIS and CORINE Land cover. As these two nomenclatures are not mutually exclusive the relation between them is modelled as a m:n relation. This means that one CLC-class can be contain multiple EUNIS classes and vice versa. To resolve this m:n relationship additional data have to be integrated. This step is carried out under step 3 – thematic refinement.

Ad 3 – thematic refinement:

The m:n relation expressed in the crosswalk between the EUNIS classes and CORINE Land Cover will be further refined and resolved using ancillary spatially explicit data. This approach has been chosen as well by Sander Mücher (Mücher et al. 2004) in his work on the spatial distribution modelling of selected Annex I habitats. He identified important and available environmental datasets with the highest possible accuracy for Europe and established a knowledge rule set for each habitat. The knowledge rule set was implemented as graphic decision-tree model within a GIS for each specific habitat type and lead to the assignment of three likelihood classes concerning the occurrence of each habitat type per reference grid cell (in his case 1*1 km2).

Using the ancillary datasets listed below an expert rule system will be developed to define differentiations within the m:n relations between CLC-classes and EUNIS classes. The overlaps can be resolved either using geographic delineations (occurrence of special EUNIS classes in special geographic areas) or using attributive environmental specifications (occurrence of special EUNIS classes only under special environmental conditions).

Theme	Dataset	Resolution/scale	Coverage	comment
DEM	Altitude	100*100 m	EEA 39	
	Slope	100*100 m		
	Aspect	100*100 m		
	Landform	100*100 m		
DEM derivates	upper tree line	100*100 m		Modelling of altitude zone montane vs. subalpine
Environmental regions	Metzger et al.	Appr. 1:1 Mio	EEA 39 (excl. Turkey, Iceland)	Environmental stratification including main climatic variables
Potential natural vegetation	Bohn & Neuhäusl	1:2,5 Mio	Europe (excl. Turkey)	
HANTS	Harmonized time series of adjusted MODIS	250*250 m	EEA 39	Differentiation arable & grassland

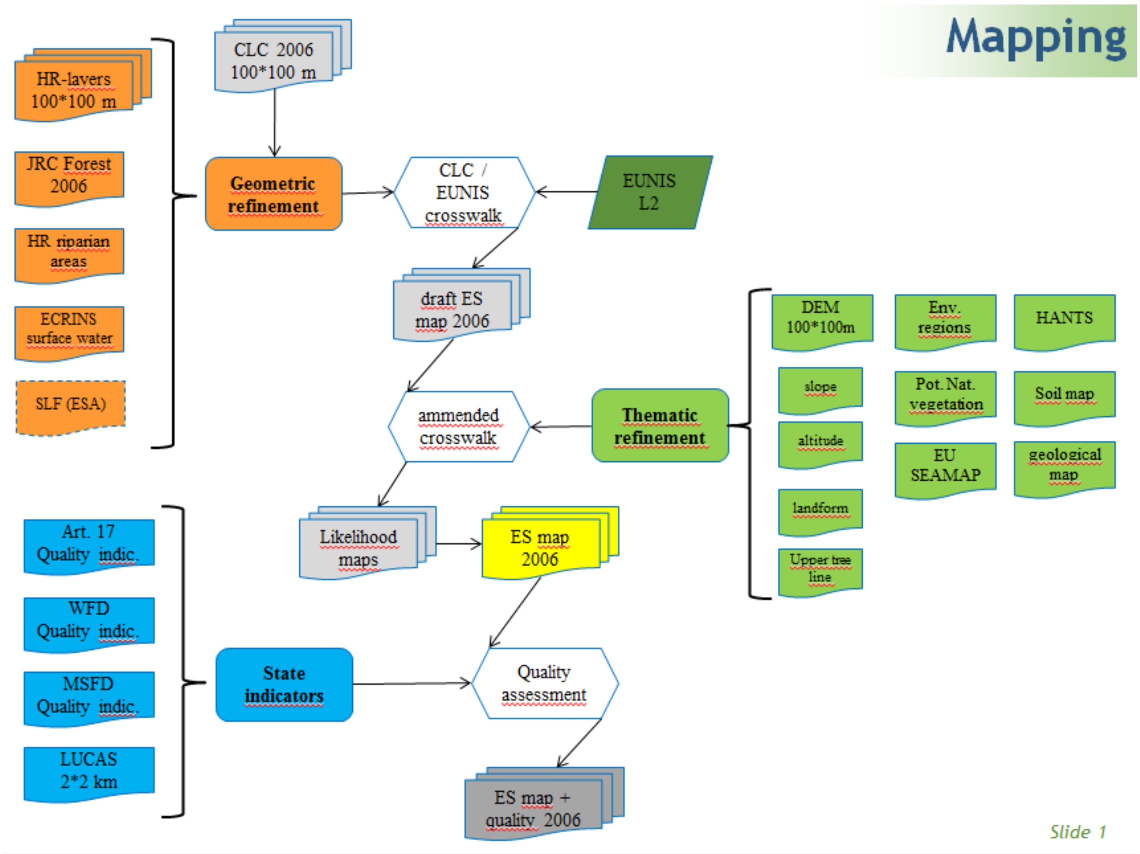
	NDVI data			
EUSEAMAP	Marine habitat maps	Vector, European scale	Celtic, North and Baltic Seal; West Mediterranean Sea	
soil	European soil type map	1:1 Mio	EEA 39 (excl. Turkey, Iceland)	
geology	EuroGeoSurveys	1:5 Mio (geological map) 1:1,5 Mio hydrogeological map)		Mainly modelled within soil types, geological maps not available due to copyright restrictions

Ad 4. Quality assessment:

The quality assessment of the ecosystem map will be of experimental character. In close cooperation with the ETC-BD work package on ecosystem state assessment experimental demonstrations of using reporting obligations data (Art. 17. WFD, MSFD) will be carried out and illustrated.

An overall flow chart for the main steps of the GIS approach is given in the figure below.

Figure 1: graphical flow chart of the main steps for ecosystem mapping



3.3 OUTLOOK FOR ECOSYSTEM MAPPING/MODELLING

3.3.1 Bottom-up approaches using vegetation relevés

Vegetation relevés are increasingly becoming available across Europe, in a standardized way, and in large numbers (Schaminée et al., 2007). Schaminée et al. (2009) revealed already that more than 1.8 million vegetation relevés had been computerised in Europe. European vegetation data are not only a source to determine the floristic composition of habitat types, but can also be an excellent repository for species and habitat distribution modelling (Mücher et al. , 2009; Mücher, 2009). In Figure 1a the distribution of Beech (*Fagus sylvatica*) is shown, which is based on approximately 20.000 phytosociological relevés. Although the distribution seems to cover a large part of Europe some areas are clearly unrepresented on not represented at all, like Scandinavia and Spain. However, when applying a species distribution model (in this case Maximum Entropy; Berger et al. 1996) beech is likely to be present in some parts of Scandinavia and Spain (see Figure 1b); colours varying from grey, over green to red, indicating an increasing probability). To model the distribution of the Beech the MaxEnt software (Philips et al. 2004) is used applying many environmental spatial layers (e.g. climate, topography and soil) .

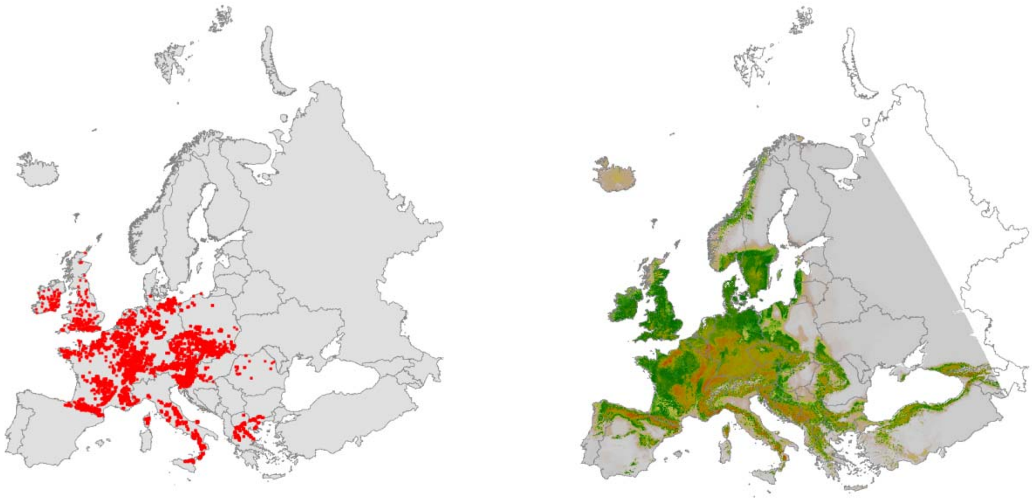


Figure 1a (Left): Distribution of phytosociological relevés with Fagus sylvatica. Figure 1b (Right): Probability map of Fagus sylvatica based on a distribution model.

Although this kind of modelling on a European scale can be carried out already for many species there is a need for more geo-referenced vegetation-plot data, especially for under-represented areas. And further a fully harmonised taxonomic reference list is needed, because the data comes from many different (national) sources using different taxonomic concepts.

3.3.1.1 Linking the EUNIS habitat classification to vegetation-plot data

On the basis of the spatial distribution of individual species, the different ecosystems can be identified. But to do so, one must determine the floristic composition of the habitat types or ecosystems. On the basis of European vegetation data one can determine the floristic composition of habitat types. For this reason, an information system is being to set-up at this moment for the EEA to identify all species related to each EUNIS habitat class. This makes it in principle possible to identify each EUNIS habitat class. In an attempt to achieve this some time ago, the European Vegetation Survey (EVS) developed the first overview of European vegetation units at the levels of alliances, orders and classes, published in The Diversity of European Vegetation, funded by the Dutch National Reference Centre for Agriculture, Nature and Fisheries (Rodwell et al. 2002). The development of the EUNIS Habitat Classification (Davies & Moss 1999) created an opportunity to provide a sound scientific cross-reference between widely accepted European habitats and phytosociological definitions of vegetation types. Future crosswalks between EUNIS and syntaxa will be implemented in the information system SynBioSys Europe (Schaminée et al. 2007), as was done for the 1998 and 2002 versions and has been indicated in the 2012 report on the development of vegetation syntaxa crosswalks to the EUNIS habitat classification (Schaminée et al. 2011). SynBioSys Europe incorporates a GIS platform for the visualisation of layers of information on plant species, vegetation and landscape (Schaminée et al. 2007).

The most recent study designed to collect estimates of the total number of vegetation plots Europe (Schaminée et al. 2009), revealed that more than 1.8 million relevés had been already computerised, 75% of which are found in centralised databases of countries or regions. Of all captured relevés 59% are available in TURBOVEG format. Already 83 European databases covering more than 1.6 million relevés have currently been registered. The GIVD platform also assisted in revealing gaps in the coverage and/or availability of the vegetation plot data. The other young initiative – the European Vegetation Archive (EVA; http://euroveg.org/eva-database) – will yield a centralised database of phytosociological relevés to which data from the Czech Republic, The Netherlands, Slovakia, Austria, Germany, Italy, Poland, United Kingdom, and some Nordic and Baltic regions have already been pledged. Each relevé in this Archive will have a unique Global Unified identifier (GUID) and version control will be used to date uploads.

The floristic composition is now being determined for the EUNIS forest habitats, using all available vegetation relevés (report is in preparation for the EEA). With regard to the definition of forests, the following EUNIS types have been taken into account: GI (deciduous), G2 (broadleaved evergreen) and G3 (coniferous) and one type from the dunes (B1.7). The procedure consisted of two steps. In a first step, the relevés of these – regional and national – datasets have been classified at the level of alliances of the 2013 EuroVegChecklist. This was done by matching the regional and national classification systems, to which the relevés in the datasets of the data providers were assigned, with the European overview. At present, about 40% of the 670,000 relevés could be assigned to one of the alliances accepted in the 2013 EuroVegChecklist (236,000), 26 % of which belong to forest habitats (62,000 relevés). In a second step, the assignment to the EUNIS forest habitat types was performed by merging the datasets of the alliances to the corresponding EUNIS type (according to the EUNIS-syntaxa crosswalk), by averaging based on national constancy columns (not by simply adding up). This results also in a frequency table of the individual plant species within a EUNIS habitat type. The syntaxa of the EuroVegChecklist that have been considered were selected on the basis of the crosswalks. Work on all other habitats still has to be done in the coming years.

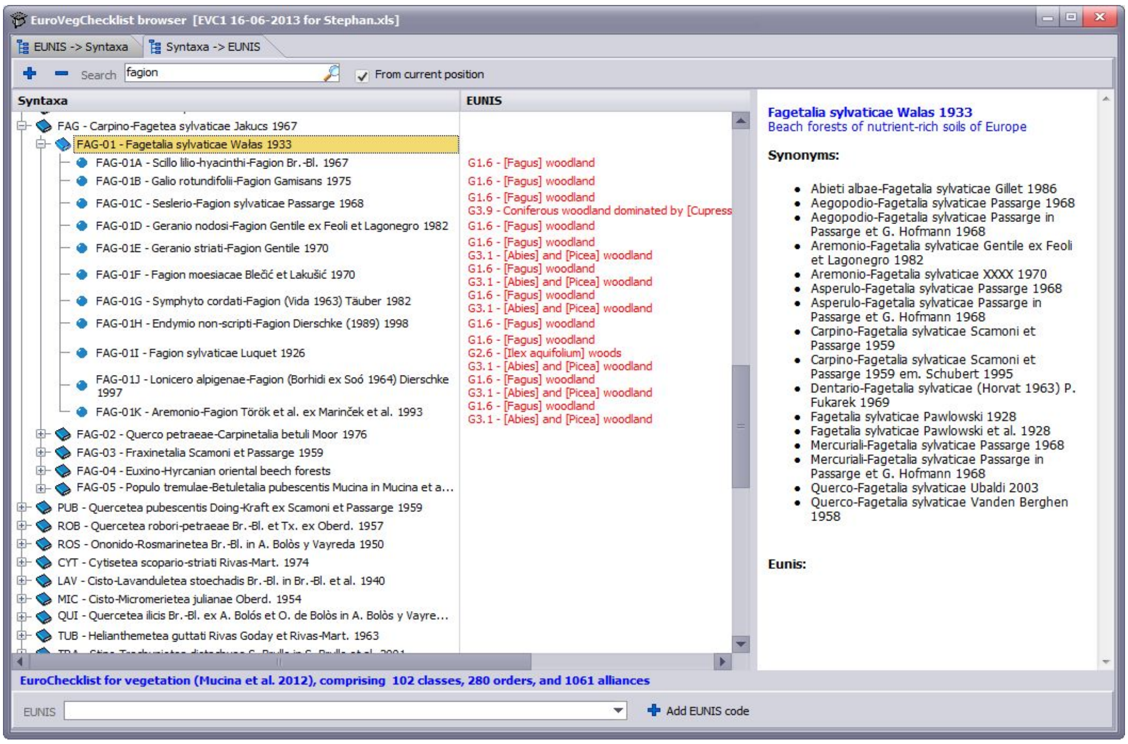


Figure 2.2. EuroVegChecklist (Mucina et al. 2013) browser with tab "Syntaxa -> EUNIS" open, based on the 2013 EuroVegChecklist.

3.3.2 Top-down approaches: refinement of land cover information

The major objective here was to develop a refinement of land cover information into relevant ecological classes (read ecosystem or habitat classes). This ecological refinement concerned the land cover information as for example produced within EU FP6 project ECOCHANGE, the pan-European Land Cover Mosaics (PLCM's) with a 100 meter spatial resolution, see also deliverable report D01.02.01 and http://www.synbiosys.alterra.nl/ecochange/plcm.aspx . The methodology used is based on the experience from the PEENHAB project (Mücher et al., 2004, 2005, Mücher, 2009). Land cover information next to environmental data sets plays a crucial role in this methodology. Since it became clear that in-situ information is often crucial next to information derived from remotely sensed information (Mucher 2009, Clerici et al. 2012) much effort was put in the collection of vegetation relevés across Europe. The land cover refinements focused in ECOCHANGE especially on the forest and grassland ecosystems, since they are the major focus of the ECOCHANGE project. Since no list of key species was yet available when we started with this activity we made a proposal of interesting vegetation types and related Annex I habitat types (European Commission, 2007) to be modeled in terms of their probability in actual distribution across Europe. Much effort was made on the establishment of the knowledge rules for the relationship between CORINE land cover classes (CEC, 1994; Bossard et al, 2000; Büttner et al, 2004) and the Annex 1 Habitats (European Commission, 2007), see also the website http://www.synbiosys.alterra.nl/ecochange/singleclasses.aspx . The knowledge rules were largely based on the ecological knowledge of Dr R.G.H. Bunce who was responsible for this specific part. The following sections will discuss the selected Annex I habitat types and related vegetation types, the established knowledge rules, and their implementation as spatial distribution models and the final map results for the selected habitat types. EUNIS habitat types could be used also Instead of Annex I also, but as mentioned before they still need a better definition of their classes. Finally, it lead to the selection of 14 Annex I habitat types), for which European distribution maps were produced.

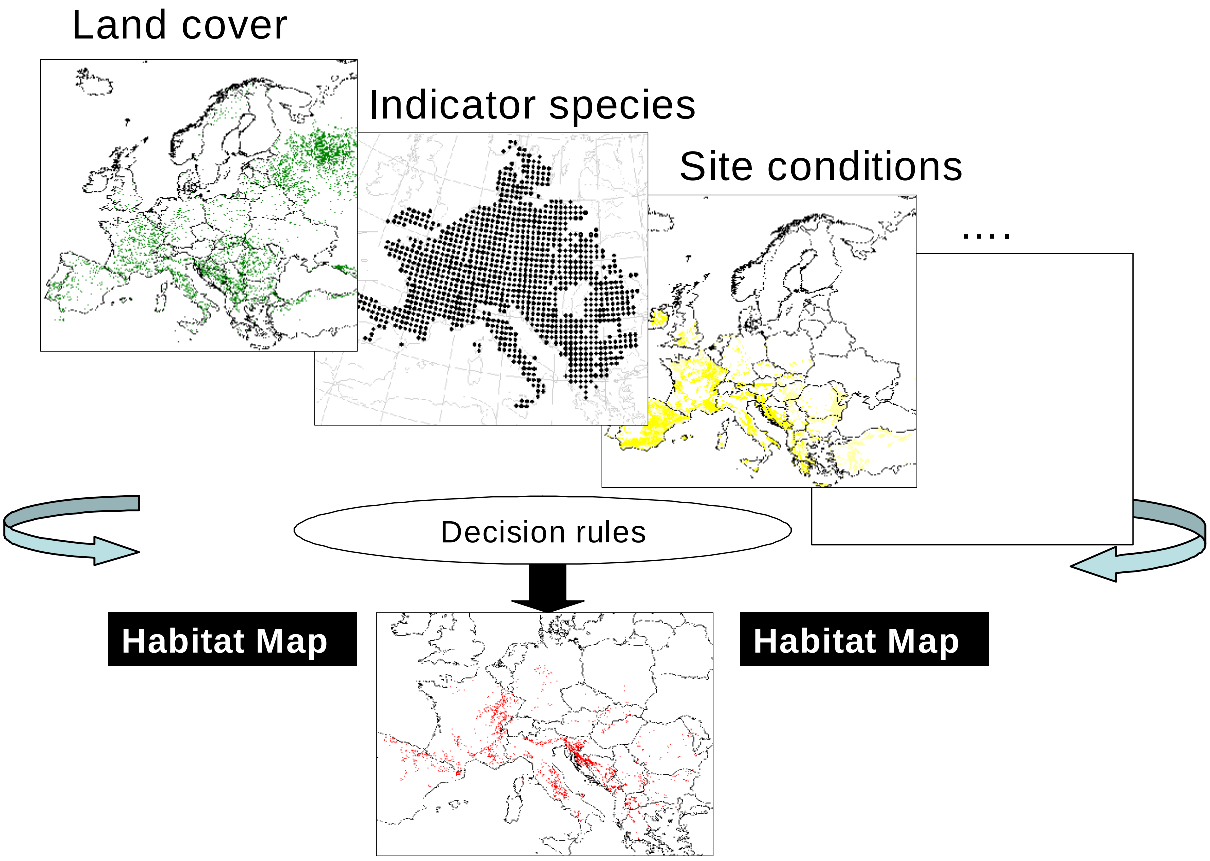


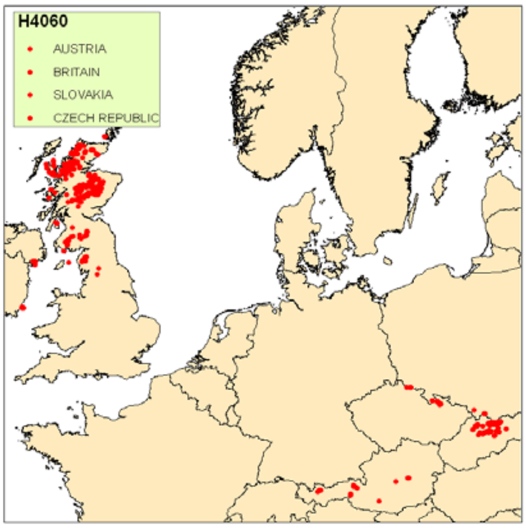
Figure 1 Flowchart of the methodological approach (Mücher et al 2009) to identify the spatial distribution of European Habitats.

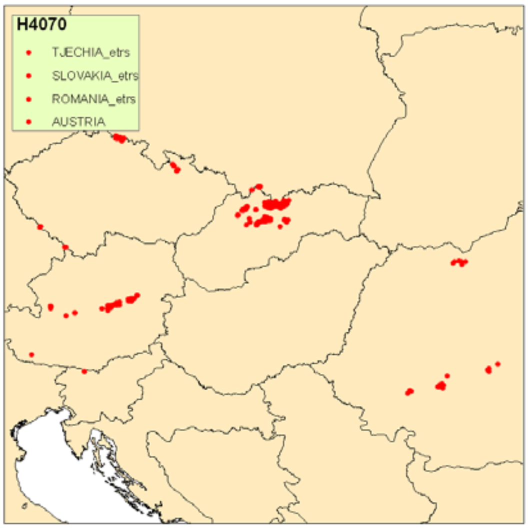
3.3.2.1 In-situ data

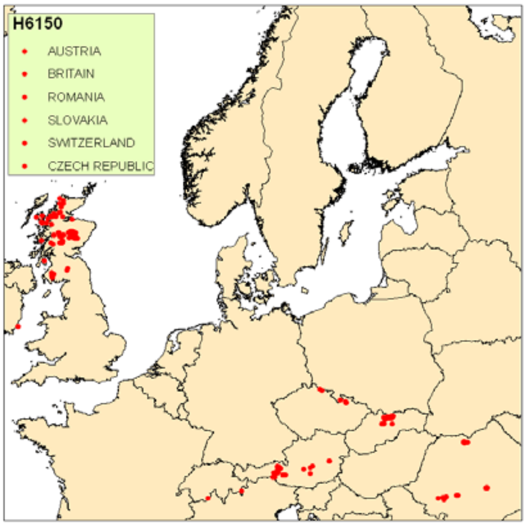
To perform validation and improvement of the knowledge rules the availability of in situ vegetation data (plot observations or relevés) is highly required. The estimation is that throughout Europe there are more than one million computerized plot observations stored in numerous local databases. Most of these observations are available in so-called Turboveg databases. Turboveg (Hennekens and Schaminée, J.H.J 2001) is a software package (for Microsoft Windows®) that was developed in the Netherlands for the processing of plot observations. It's an easy-to-use data base management system and provides methods for input, import, selection, and export of plot dat. In 1994, Turboveg was accepted as the standard computer package for the European Vegetation Survey. Currently it has been installed in most European countries with more than thousand users. For the EcoChange project in-situ (stored in Turboveg databases) has been obtained through the network of EcoChange partners and the network of SynBioSys Europa (Schaminée et al., 2007). In Table 1 an overview is given of all the collected vegetation relevés. Unfortunately, there are still a lot of EU countries for which we did not succeed yet to obtain vegetation plot data, although we know that they exist. The vegetation relevés were classified into the relevant vegetation classes, which are related to the specific Annex I habitat types of interest, using the TurboVeg software and additional specific criteria are mentioned in Annex I.

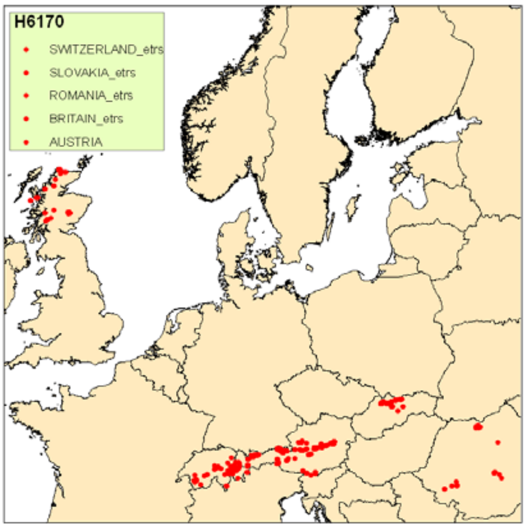
Table 1 Table of selected Natura 2000 habitat types and their relation to vegetation types, according to the European Vegetation Classification.

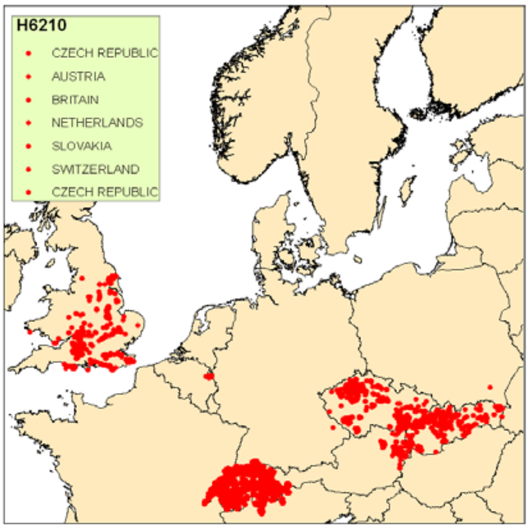
Nr.	Natura 2000 code	Natura 2000 description	Code	Vegetation type
1	4060	Alpine and Boreal heaths	62A02	Loiseleurio-Diapension
			62A05	Rhododendro-Vaccinion
			63A01	Erico-Pinion sylvestris
2	4070	Bushes with Pinus mugo and Rhododendron hirsutum (Mugo-Rhododendretum hirsuti)	66B01	Pinion mugo
			25C02	Ledo-Pinion
3	6150	Siliceous alpine and boreal grasslands	46A04	Caricion curvulae
			46A08	Juncion trifidi
			46B05	Nardion strictae
4	6170	Alpine and subalpine calcareous grasslands	44D08	Seslerion albicantis
5	6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates(Festuco-Brometalia) (* important orchid sites)	28C02	Bromion erecti
6	6230	Species-rich Nardus grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe)	46A04	Caricion curvulae
7	6240	Sub-pannonic steppic grasslands	28F	Festucetalia valesiacae
8	6250	Pannonic loess steppic grasslands	28E	Festucetalia vaginatae
9	7110	Active raised bogs	25A01	Ericion tetralicis
10	7130	Blanket bogs (* if active bog)	25A01	Ericion tetralicis
11	9150	Medio-European limestone beech forests of the Cephalanthero-Fagion	59B05	Cephalanthero-Fagion
12	9410	Acidophilous Picea forests of the montane to alpine levels (Vaccinio-Piceetea)	66C01	Dicrano-Pinion
13	9420	Alpine Larix decidua and/or Pinus cembra forests		
14	9510	Southern Apennine Abies alba	66A01	Abieti-Piceion

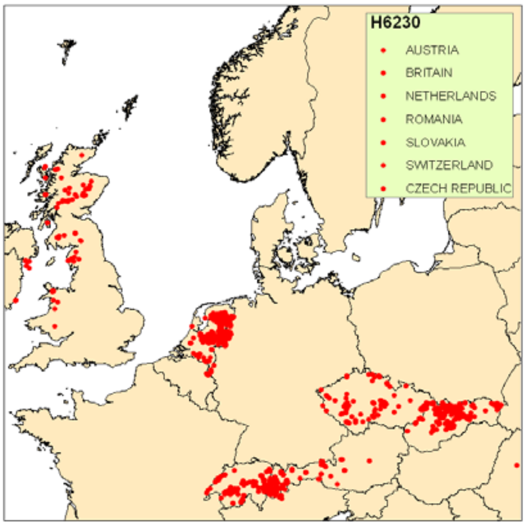

H4060
AUSTRIA
BRITAIN
SLOVAKIA
CZECH REPUBLIC


H4070
TJECHIA_etrs
SLOVAKIA_etrs
ROMANIA_etrs
AUSTRIA


H6150
AUSTRIA
BRITAIN
ROMANIA
SLOVAKIA
SWITZERLAND
CZECH REPUBLIC


H6170
SWITZERLAND_etrs
SLOVAKIA_etrs
ROMANIA_etrs
BRITAIN_etrs
AUSTRIA


H6210
CZECH REPUBLIC
AUSTRIA
BRITAIN
NETHERLANDS
SLOVAKIA
SWITZERLAND
CZECH REPUBLIC


H6230
AUSTRIA
BRITAIN
NETHERLANDS
ROMANIA
SLOVAKIA
SWITZERLAND
CZECH REPUBLIC

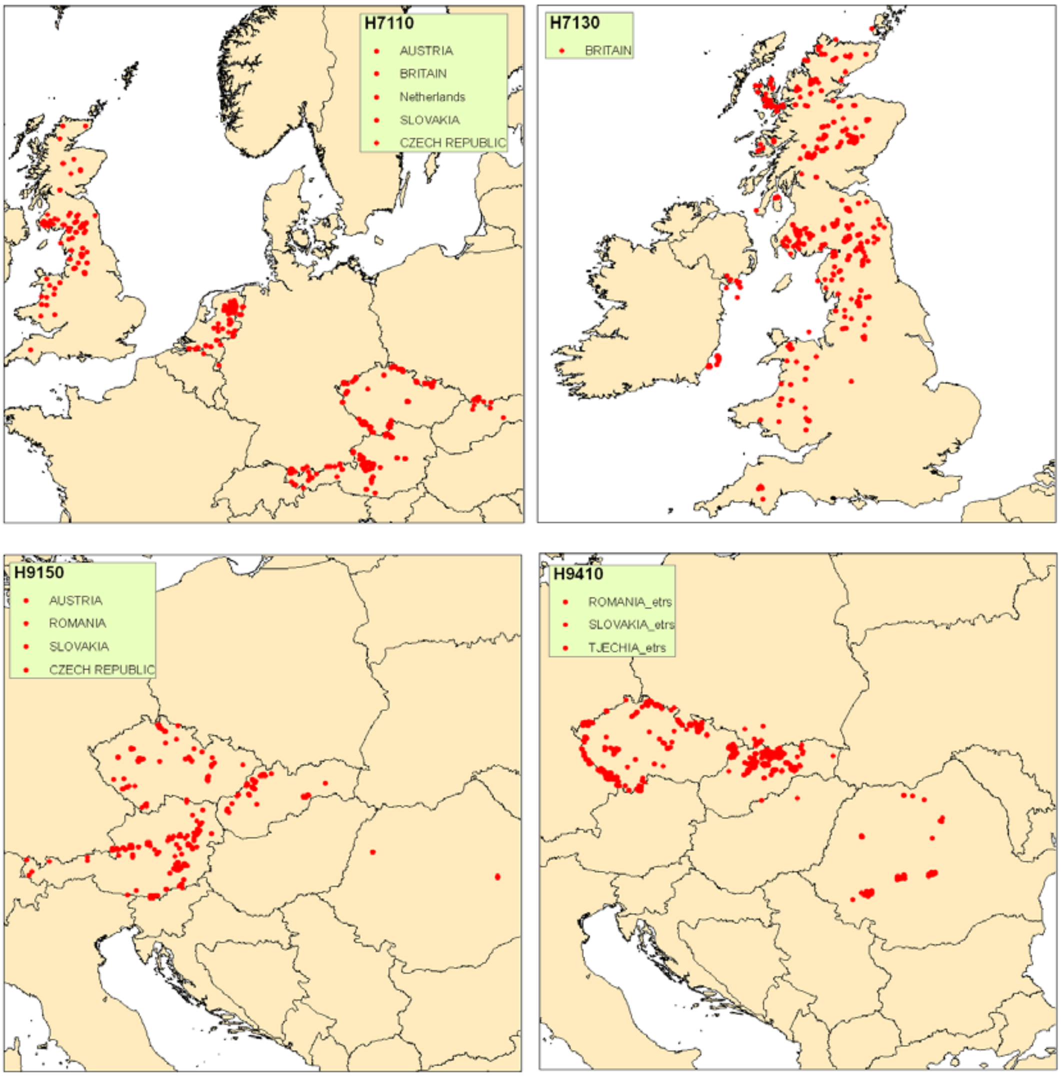


Figure 2 Locations of the collected vegetation relevés in relation to the specific habitat types.

3.3.2.2 Knowledge rules

A first formal relation between the Annex I habitats and CORINE land cover (CEC, 1994; Bossard et al, 2000; Büttner et al, 2004) was made in the PEENHAB project (Mücher et al., 2004, 2005). The relationship between CORINE land cover (CLC) and Natura 2000 habitats is now being improved per biogeographic region (Metzger et al. 2005) and additional rules are being created for topography. Next to important information about the threats and vegetation succession of the specific habitat type within the specific environmental region. Within the ECOCHANGE project the emphasis is on grassland and forest ecosystems. This means that habitats related to these ecosystems are being prioritized. Many detailed comments have been made on various sections of the text in order to provide the background to the rules. In some cases where species have been given the incorrect names and where the terms used are not in regular English scientific usage than interpretations have been made of their probable intended meaning. However, it is essential to point out that the interpreters are technically trained and that these details are unlikely to have influenced their interpretation of the satellite images in terms of land cover. In the long term it is essential that the variation in the land cover classes is assessed objectively to determine the actual proportions of different habitats on the ground. Such information will greatly enhance the value of the existing land cover databases and will extend the range of potential uses of the CLC. In this respect, also the EU project EBONE examined the possibilities of improving the matrices between the CLC and habitats in order to formalize these relationships. As Evans (2006) has shown phytosociology is the basis of many of the Annex I Habitat classes (and EUNIS classes) and also there have been different regional interpretations of their meaning. The following sources of information have been used in preparing the knowledge rules:

1. Interpretation Manual of European Union Habitats
2. EUNIS website (http://eunis.eea.europa.eu/index.jsp)
3. Tables of Annex 1 habitats by Biogeographic regions
4. Working Paper on CLC equivalents (Romao, Evans and Halada , 2006)
5. CORINE land cover technical report
6. PEENHAB report (Mücher et al., 2005)
7. Consultation with Doug Evans and some local experts

Evans (2006) described in detail how the Annex 1 Habitats were constructed. The Interpretation manual of European Union Habitats is a living document. Evans also indicates that the names are much more difficult to change than their descriptions. The present document is a scientific amplification and interpretation of those descriptions The Annex 1 and its Priority Habitats are determined by an ongoing series of meetings held under the auspices of the EU. There has been no intention to complete a land cover key with total coverage of the land surface of Europe nor to provide a hierarchy for the classes. There are many possibilities of refinement of the relationships identified in the present document especially by consultation with the available literature e.g. on tree lines and the range of altitudes occupied by different vegetation associations. Many of the terms used in Annex 1 are not defined which leads to differences in interpretation. For example Fennoscandia may include the Baltic coast of Germany or not whilst alpine and montane are notoriously difficult to define. Evans (2006) states that the names of Annex 1 Habitats can only be altered by a decision from the Council of Ministers, whereas the descriptions can be changed by agreement of the Habitats Committee.

Each of the Annex I habitats has the following description fields in this document:

1. Mapping rules: these mapping rules are constructed from the information provided in the Interpretation manual of European habitats on where the habitat occurs. This information is supplemented by field experience of the author and by discussions with. In due course literature could be consulted to confirm that the altitudinal ranges are correct. Consultation will also be held with Doug Evans of the Topic Centre in Paris to further check the descriptions.

2. Indicator species: the indicator species are in most cases a subset of the Annex I plant species. A subset has been made since the selected species are the most characteristic and stable species present within the habitat

3. GHC habitat classes. These are General Habitat Classes (GHC) as defined within the BIOHAB project. The basis of the General Habitat Categories is the classification of plant Life forms produced by the Danish botanist Raunkiaer early in the 20th Century. These Life forms e.g. annuals or trees. They are based on the scientific hypothesis that habitat structure is related to the environment. The BioHab General Habitat Categories cover the Pan-European region (except Turkey) with 130 GHC's derived from 16 Life Forms (Bunce et al., 2008) The Codes for the General Habitat Categories are in this document: **LHE** = leafy hemicryptophytes(herbs), **CHE** = caespitose hemicryptophytes (grasses), **SUC** = succulents, **THE** = therophytes (annuals), **HEL** =helophytes (marsh plants) **CRY** = mosses, liverworts and lichens, **DCH** = espaliers below 5cm, **SCH**=dwarf scrub 5-30cm, **LPH** = low scrub,30-60cm, **MPH** = mid scrub 60cm-2.0 m, **TPH** = tall scrub2m-5m., **FPH** = forest over 5 m, **CON** = conifer, **DEC** = deciduous, **EVR** = evergreen, **NLE** = non leafy evergreen, **SPI** = spiny/summer deciduous.

4. Field identification: comments on the probable ease of identification of the habitat in the field.

5. Occurrence: three categories are used: rare, where the habitat is present in isolated patches, usually small, common, where it is distributed widely but does not cover large areas in the landscape and abundant where it is not only widespread but is also dominant. These are qualified where necessary.

6. Direct threats: based on the knowledge of the vegetation and literature . The information could also be supplemented later by other experts.

7. Potential impacts of climate change: based on knowledge of the vegetation, literature and the change in Environmental Zones described by Metzger et al (2008).

8. Vegetation succession due to abandonment: conversion of the present composition into BioHab plant lifeform categories followed by an interpretation of likely successional changes together with possible timescales.

9. Distribution. This is the distribution of the specific habitat over the various Environmental Zones (Metzger et al., 2005). The codes, based on the BioHab handbook (Bunce et al 2005) are as follows for the Environmental Zones: **ALS** = Alpine South, **BOR** = Boreal, **NEM** = Nemoral, **ATN** = Atlantic North, **ATC** = Atlantic Central, **ALS** = Alpine South, **PAN** = Pannonian, **CON** = Continental, **LUS** = Lusitanean, **MDM**- Mediterranean Mountains, **MDN** = Mediterranean North, **MDS** = Mediterranean South. Distribution (sites) has been obtained directly from the Natura 2000 database intersected with the Environmental Zones. Distribution (Bunce) is based on expert knowledge from Bob Bunce. In the final version this will be one attribute. Besides, note that the code **CLC** refers to the CORINE land cover class. **Annex I** is standing for the Annex I of the Habitat Directive.

3.3.2.3 HABITAT DISTRIBUTION MODELLING & RESULTS

The following section will give one of the results of the habitat distribution modeling as an example. All models were implemented within ARGIS model builder. An example of such a model is given below. All resulting habitat distribution maps have a spatial resolution of 100 meters. Since this spatial resolution can be hardly visualised in this document for entire Europe, the results are also highlighted for specific details of the European habitat distribution maps.

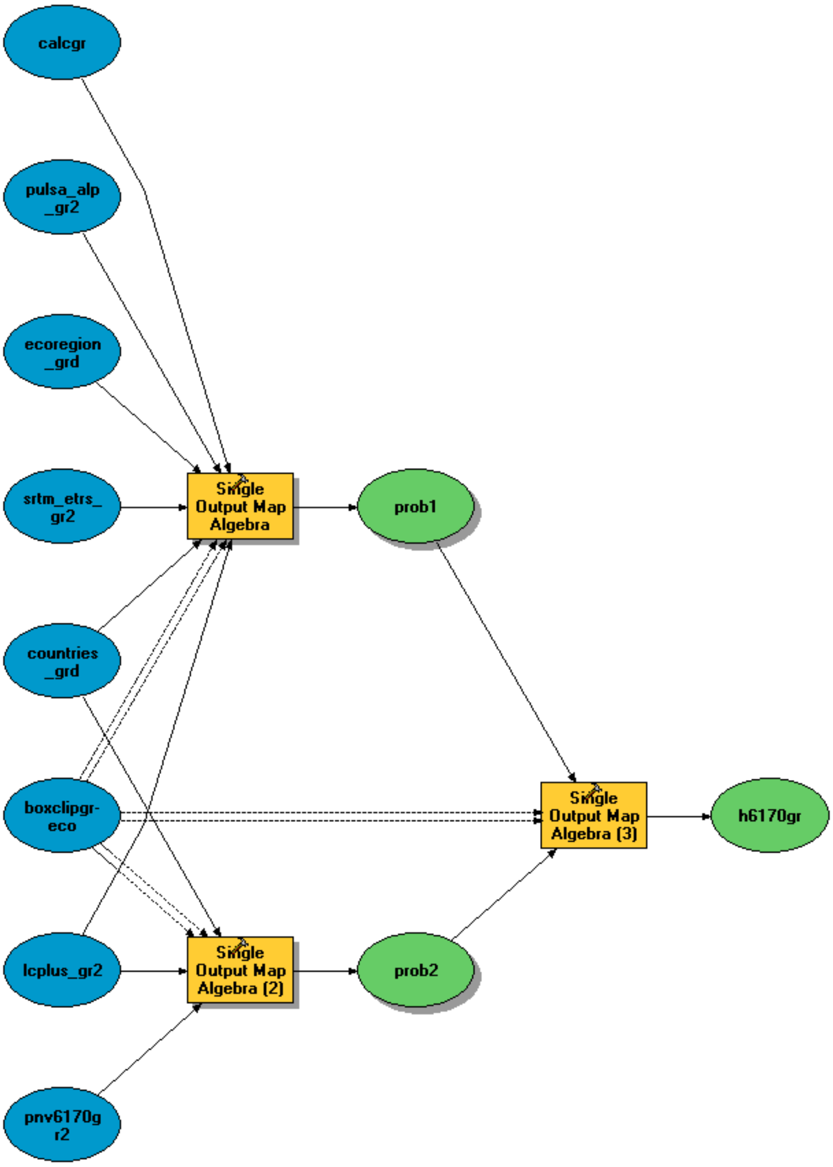


Figure 3 Example of the constructed ditribution model for Annex I habitat type H6170 "Alpine and subalpine calcareous grasslands" made with the modelbuilder in ARCGIS 9.2

As an example, the results are demonstrated for H9150 Medio-European limestone beech forests of the Cephalanthero-Fagion (EUNIS class G1.66).

3.3.3 conclusions & recommendations

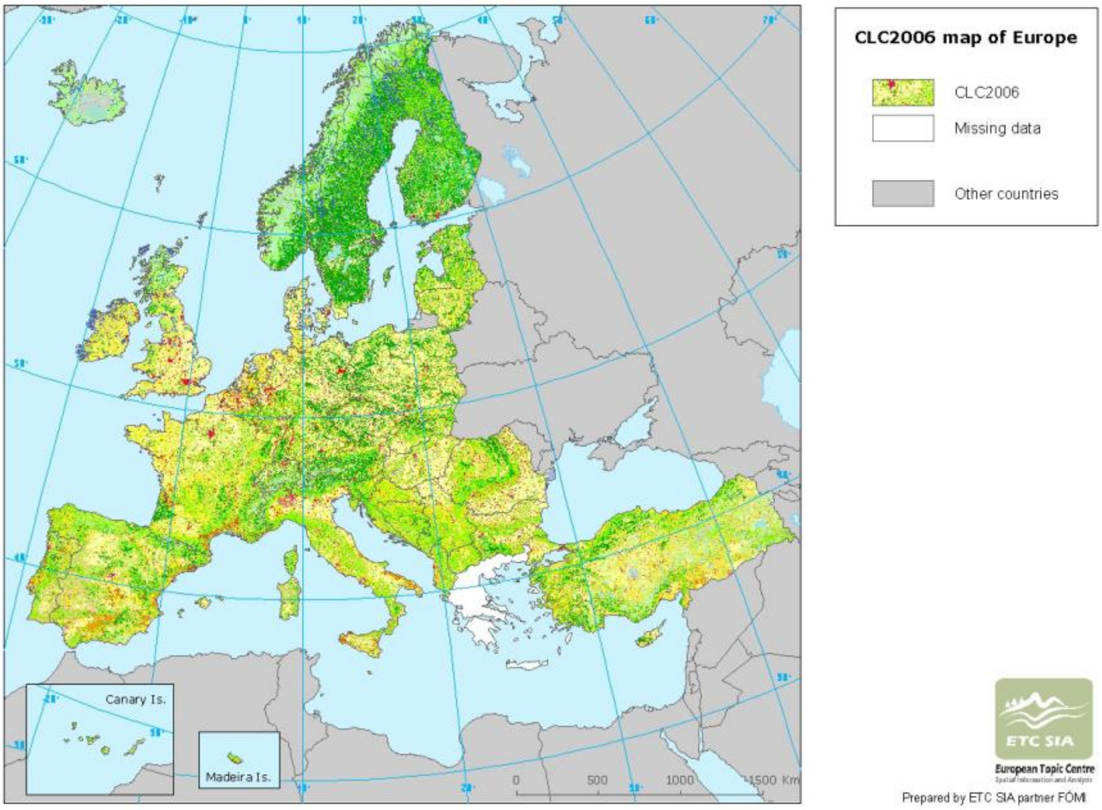
- Spatial modeling leads to probability maps of species, habitats and ecosystems.
- Probability maps of different classes can have a spatial overlap.
- Bottom-up modeling approach makes better use of vegetation relevés and is very suitable for species modeling.
- Vegetation relevés are not only crucial for species modeling but also for describing floristic composition (including frequency tables) of for example EUNIS classes.
- Only when the EUNIS classes are being well described in terms of floristic composition (and abiotic conditions), it is possible to model the spatial distribution of the EUNIS.
- The more vegetation relevés are being collected well distributed over Europe, the better the description of the EUNIS classes in terms of floristic composition and results of the spatial modeling.
- Species models can provide and interesting to the mapping of ecosystems services, once the traits of the species are well known.
- Combination of top-down and bottom-up approaches can lead to increased accuracies of the maps, but this still needs to be validated (e.g. using land cover information as a filter/mask on the species modeling).
- Floristic composition of all EUNIS habitat classes should be described.
- Earlier validations (e.g. Mucher et al., 2009) showed a large variation in the accuracy of the habitat distribution maps, not only depending on the clearness of the description of the specific habitat class, but also on the quality and availability of the environmental spatial data layers, and the complexity and rarity of the habitat class itself.

4 INPUT DATA SOURCES

4.1 LAND COVER DATA

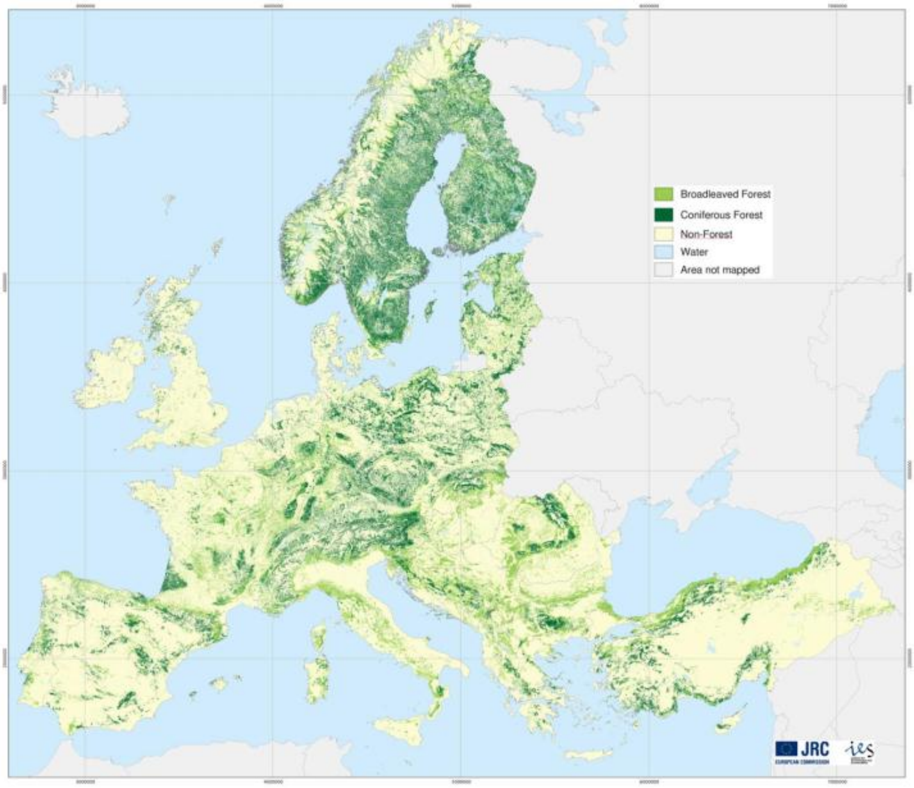
4.1.1 CORINE Land Cover

  - 100m Raster version
  - Version: 16
  - file: g100_06.zip
  - Source: EEA-dataservice, 4/2012
- Missing countries: Greece
  - Greece was replaced with CLC 2000 data, as this dataset represents the best available knowledge on European level



4.1.2 JRC Forest 2006

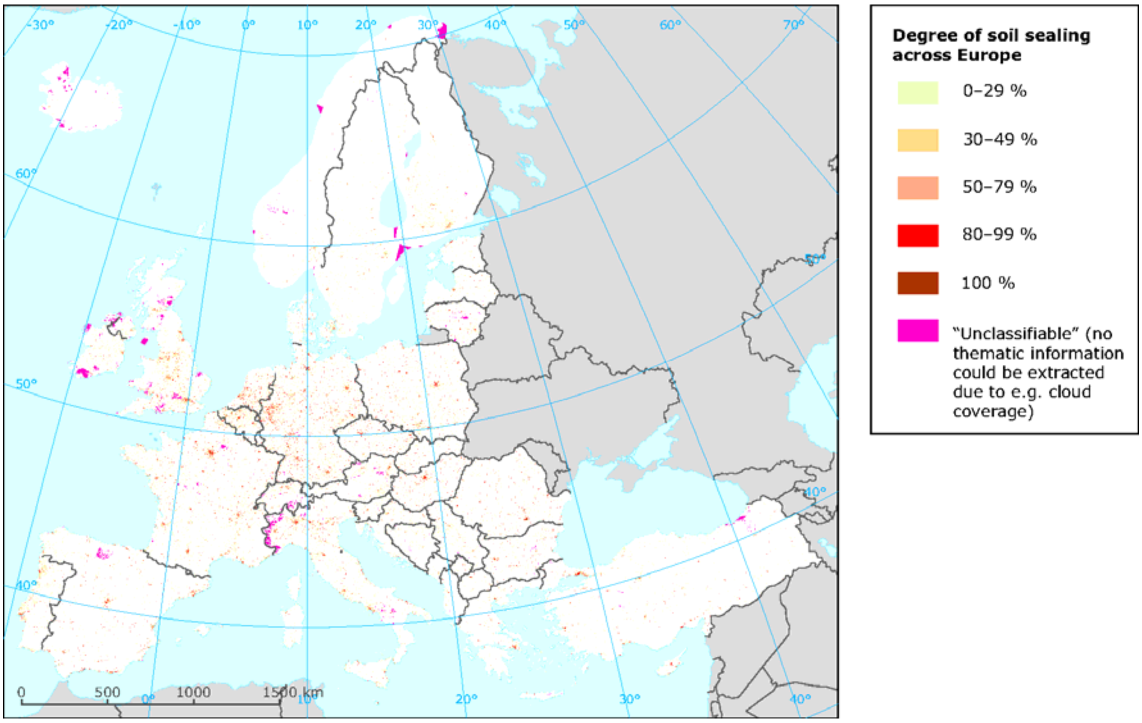
- 25m Raster version
- Files:
  - Forest TYPE MAP 2006
    - Broadleaved & coniferous
    - Water
- Other available data:
  - MSPA (morphological spatial pattern analysis)
    - Various landscape pattern characteristics
  - MAP
    - Forest/non-forest differentiation
- Reference year: 2006
- Source: WWW-Download: http://forest.jrc.ec.europa.eu/download/data/
  - 23 tiles



4.1.3 Soil Sealing

- HRL precursor soil sealing
- File:
  - 100m Raster
  - 20m Raster
- Reference year: 2006
- Version: 2
- Source: EEA dataservice

http://www.eea.europa.eu/data-and-maps/data/eea-fast-track-service-precursor-on-land-monitoring-degree-of-soil-sealing#tab-european-data



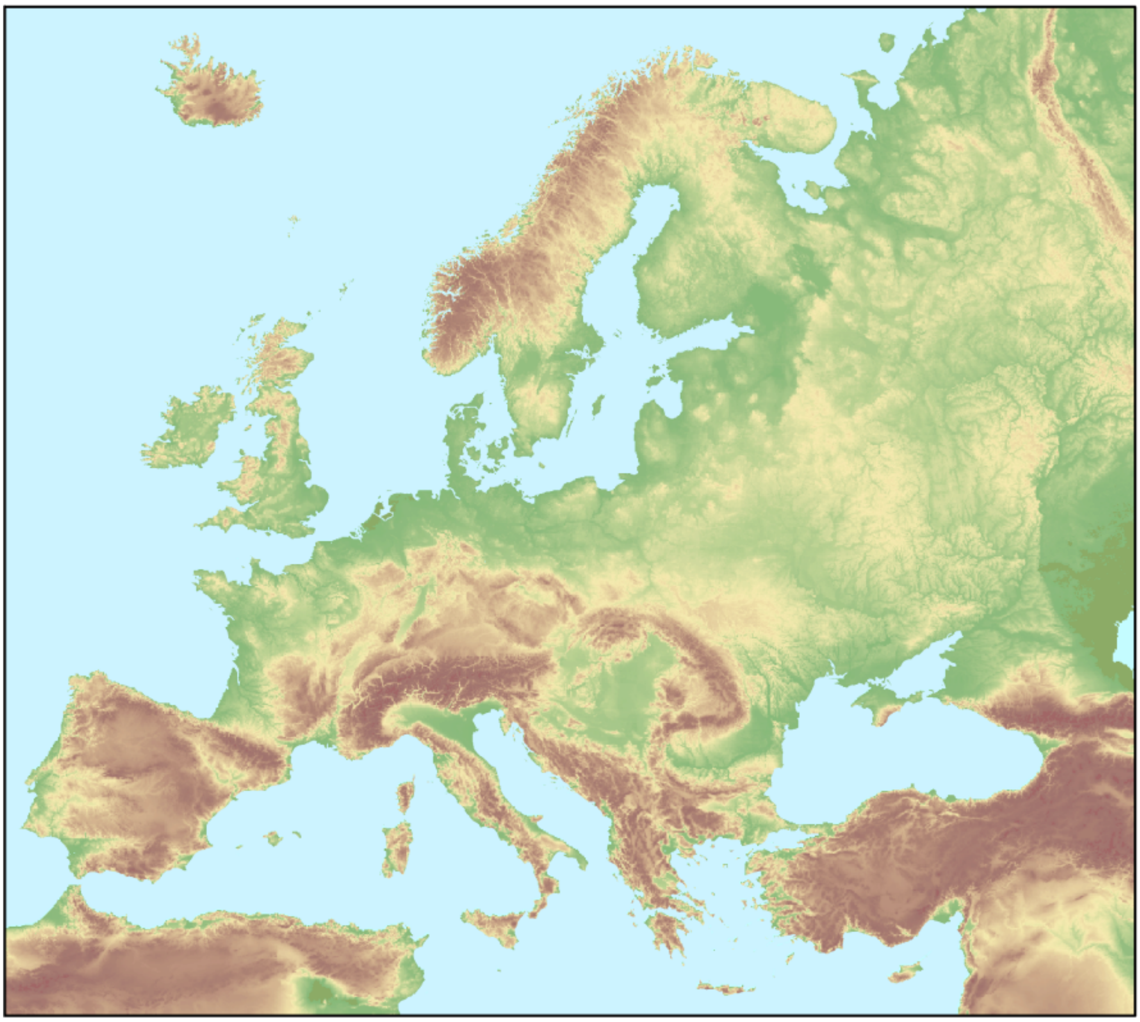
4.1.4 Open Street Map

- Lines: roads
- Polygons: land use
- Download date: 26. June 2013
- Source:
  - Europe (except Germany, France)
    - http://download.geofabrik.de/europe.html
  - Germany and France:
  - http://osmdata.thinkgeo.com/openstreetmap-data/europe/
- Selection and Conversion with FME

4.2 BASE DATA

4.2.1 EU-DEM

- File: dem_100_int
- Resolution: 100*100m
- Attributes: altitude, slope, aspect
- Source: UMA, EEA SDI via FTP, https://sdi.eea.europa.eu/
- Delivery: 19. March 2013



4.2.2 ECRINS/water framework directive

For differentiating water courses into rather natural ones and heavily modified water courses/bodies the information from the WFD is required.

For every water body the attribute “naturalness” is documented in the WFD with the following attributes:

- Natural
- Artificial
- Heavily modified

Depending on the country this information is available either in form of

- Points (X/Y coordinates)
- Lines or
- Polygons

The information is necessary to differentiate between normal water bodies C1 and C2 (semi-natural water bodies) and J5 heavily artificial man made waters.

Remark: Until Sept. 2013 it was not possible to receive this input data, therefore this data will be integrated in a later stage.

4.3 ENVIRONMENTAL STRATA

4.3.1 Environmental regions

- File: enz_v8
  - ENS…environmental strata (84 types)
  - ENZ…environmental zones (13 types) → used
- Source: direct contact to Marc Metzger (Johannes Peterseil)
  - Date: Jan. 2009
- Description:

Environmental zones based on the Environmental Stratification of Europe Version 8 (Metzger et al. 2005).

The environmental stratification does not cover Iceland and Cyprus and does not cover completely Turkey.

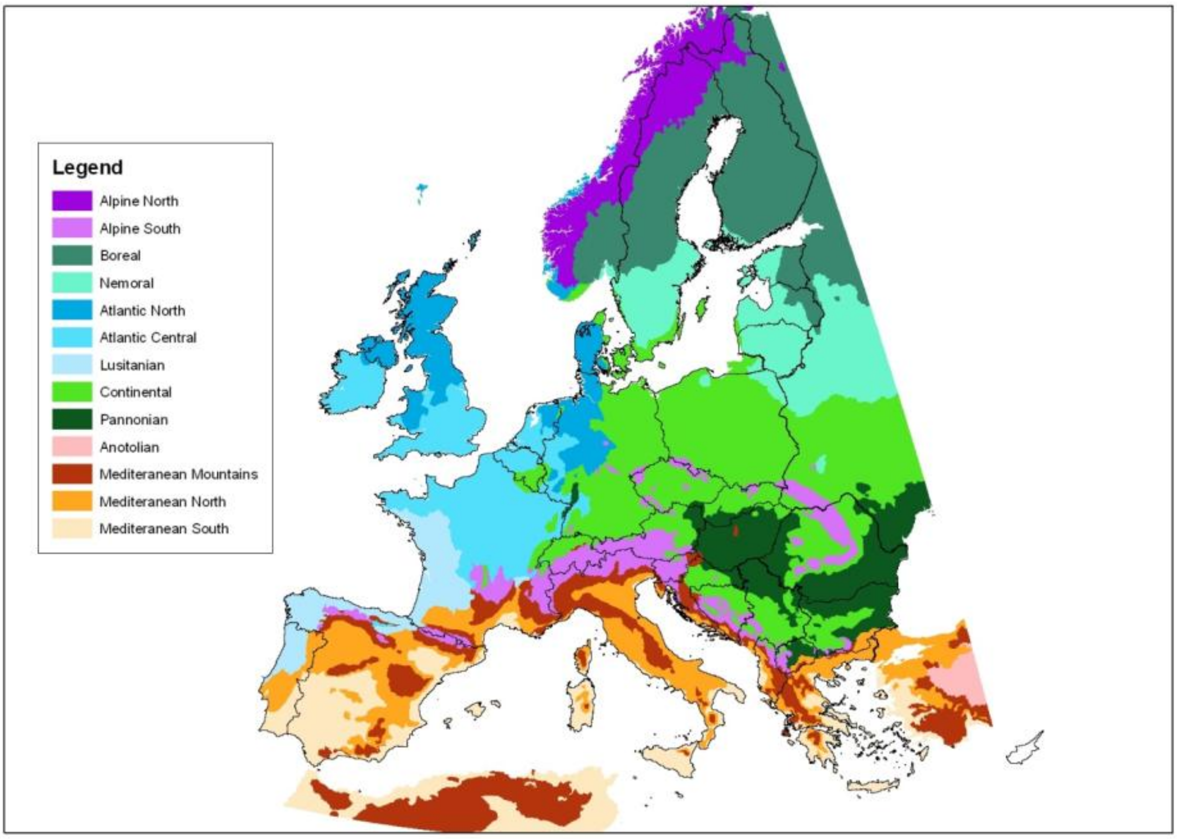
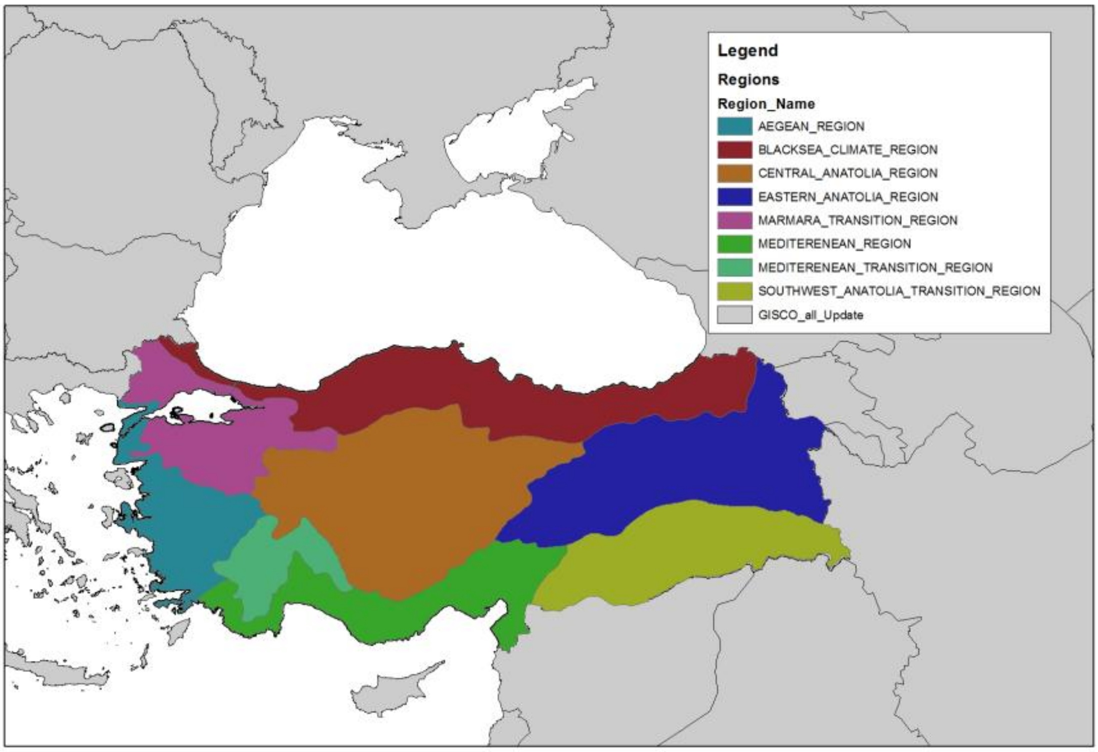


Figure 1: Environmental Zones in Europe

- European integration

- As Turkey was partly missing in the dataset of Environmental zones the file was amended with the Turkish environmental ecoregions
  - File: Turkey_Ecoregion.mdb
  - Source: EEA-project on HNV farmland
  - Attributes: The file contains the 8 major regions that are subdivided into 21 divisions

Figure: Environmental Ecoregions of Turkey

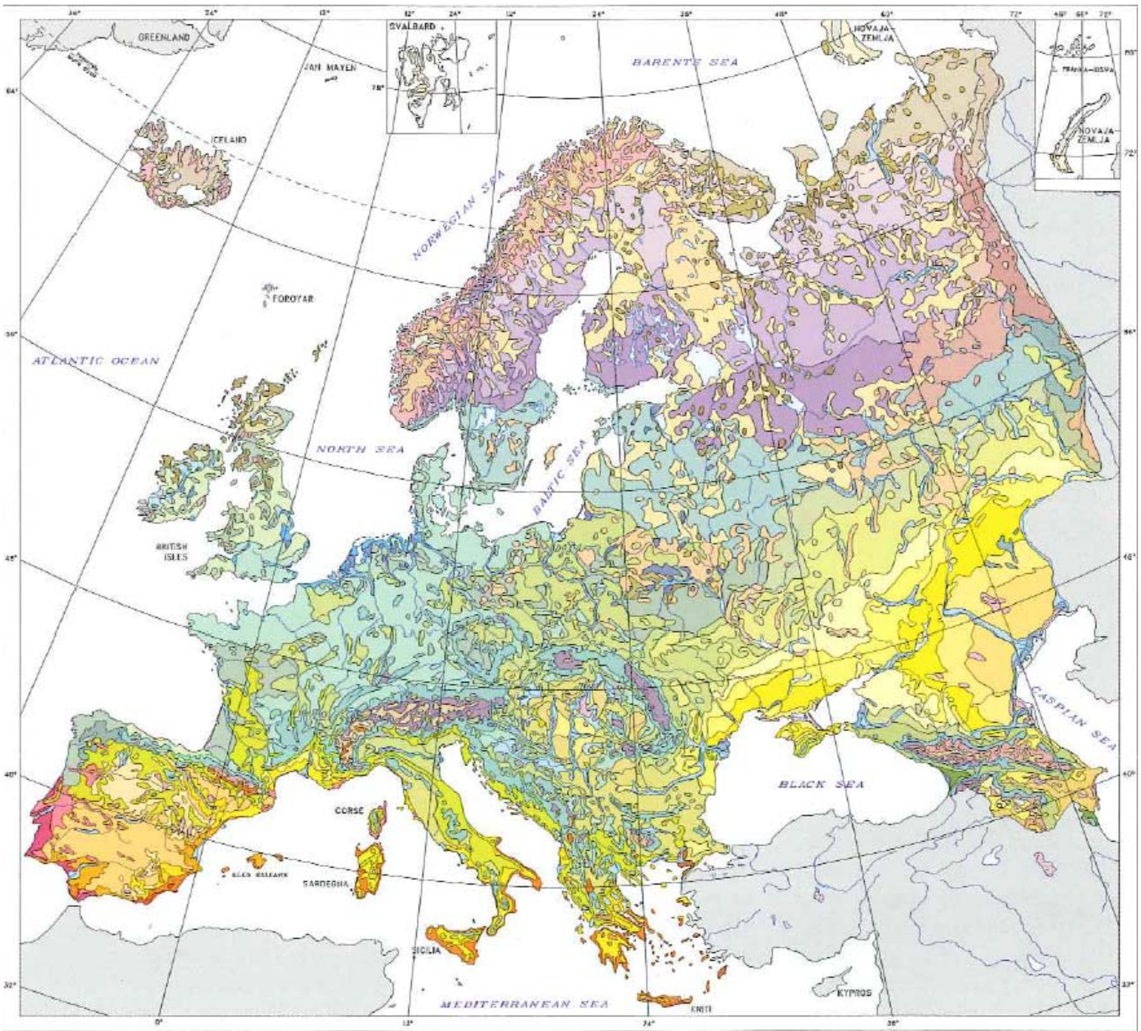


- Preprocessing:
  - The outline of the Turkish environmental zones were visually adapted to represent the CORIEN Land cover sea shore
  - The major regions are transformed into the classes of the comparable environmental zone.

Code	Environmental strata (Metzger)	Turkish ecoregions
MDM	mediterranean mountains	black sea region
		mediterranean transition region
MDS	mediterranean south	mediterranean region
ANA	anatolia	central anatolian region
		estern anatonlian region
		southwest anatolian transition region

- The global version of the environmental zones (GEnSv3_11012012) were tested, but lead to higher inaccuracies compared to the combined result of the two datasets above.

4.3.2 Potential natural vegetation

- Scale: 1:2,5 Mil
- Source: BfN, BOHN & NEUHÄUSL 2000/2003
  - 2004 , CD-ROM, ISDN: 3-7843-3848-8
- Download: EuroVegMap 2.0.6
  - http://www.floraweb.de/vegetation/dnld_eurovegmap.html
- Missing countries: turkey, Cyprus
- 

4.4 SOIL DATA

4.4.1 Top Soil organic carbon

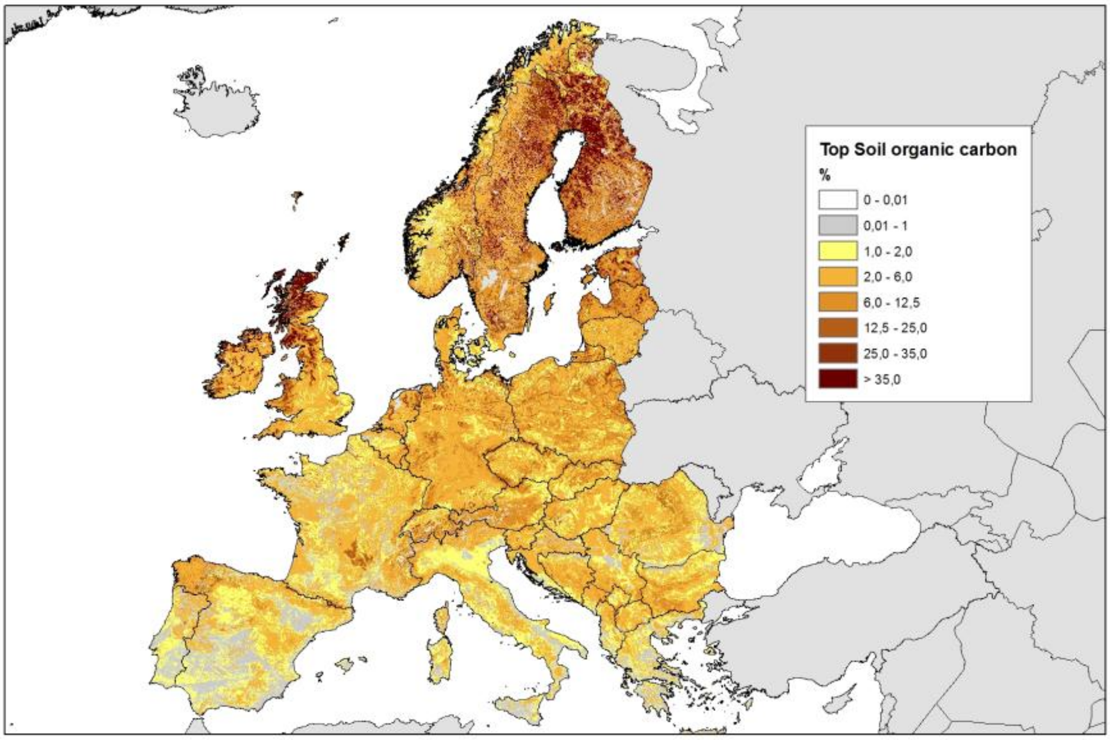
- File: octop_insp

- Format: INSPIRE-Grid, 1*1 km
- Attribute: percentage of organic carbon in top soil
- Source: JRC-download, April 2012

References:

1. Jones R.J.A., Hiederer R., Rusco E., Montanarella L. Estimating organic carbon in the soils of Europe for policy support (2005) European Journal of Soil Science, 56 (5), pp. 655-671.
2. Panagos, P., Van Liedekerke, M., Montanarella, L., Jones, R.J.A, Soil organic carbon content indicators and web mapping applications, Environmental Modelling & Software, Volume 23, Issue 9, September 2008, Pages 1207-1209.
3. Jones, R.J.A., Hiederer, R., Rusco, E., Loveland, P.J. and Montanarella, L. (2004). The map of organic carbon in topsoils in Europe, Version 1.2, September 2003: Explanation of Special Publication Ispra 2004 No.72 (S.P.I.04.72). European Soil Bureau Research Report No.17, EUR 21209 EN, 26pp. and 1 map in ISO B1 format. Office for Official Publications of the European Communities, Luxembourg.
4. Panagos P., Van Liedekerke M., Jones A., Montanarella L. European Soil Data Centre: Response to European policy support and public data requirements. (2012) Land Use Policy, 29 (2), pp. 329-338. doi:10.1016/ j.landusepol.2011.07.003

Figure: Top Soil organic carbon content (%)



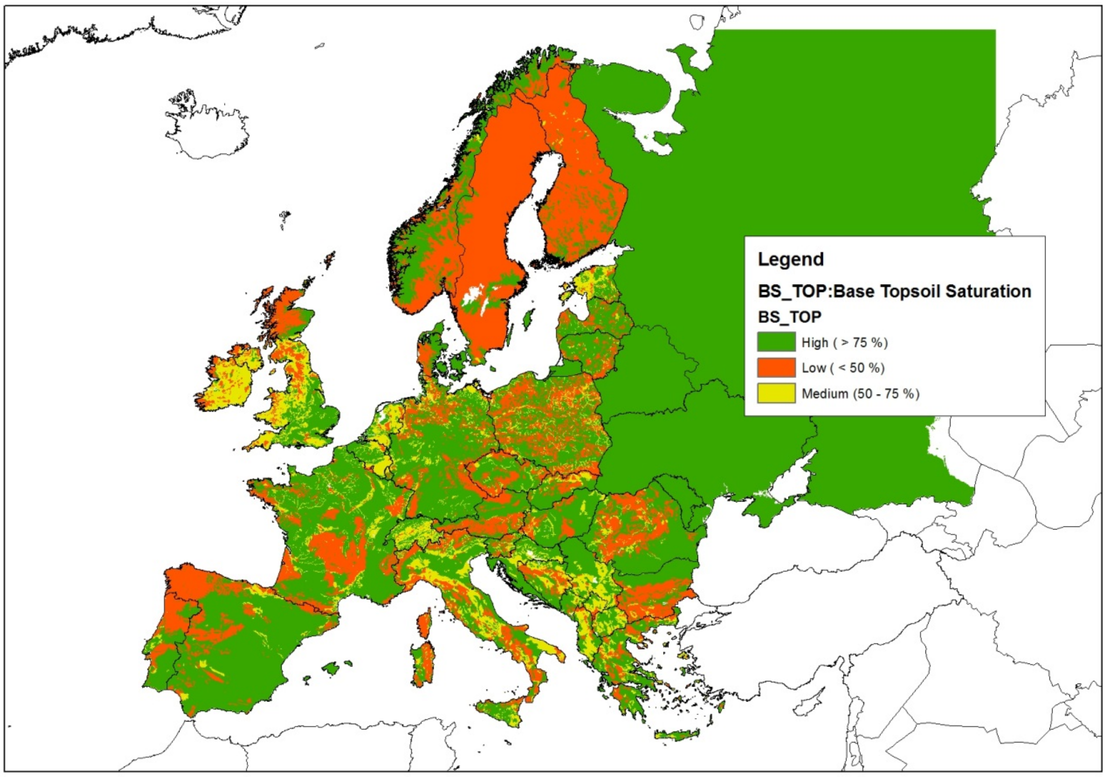
4.4.2 European Soil database (ESDB)

- File: ESDB v2 (1*1 km2)
- Format: INSPIRE-Grid, 1*1 km
- Attributes:

- Dominating parent material (DOMPAREM)
- Topsoil base saturation (BS_TOP)

- Source: JRC, download August 2013
    - http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDB_data_1k_raster_intro/ESDB_1k_raster_data_intro.html
- References:
    - Panagos P., Van Liedekerke M., Jones A., Montanarella L. European Soil Data Centre: Response to European policy support and public data requirements. (2012) Land Use Policy, 29 (2), pp. 329-338. doi:10.1016/j.landusepol.2011.07.003
    - ESDBv2 Raster Library - a set of rasters derived from the European Soil Database distribution v2.0 (published by the European Commission and the European Soil Bureau Network, CD-ROM, EUR 19945 EN); Marc Van Liedekerke, Arwyn Jones, Panos Panagos ; 2006.
    - Panagos Panos. The European soil database (2006) GEO: connexion, 5 (7), pp. 32-33.

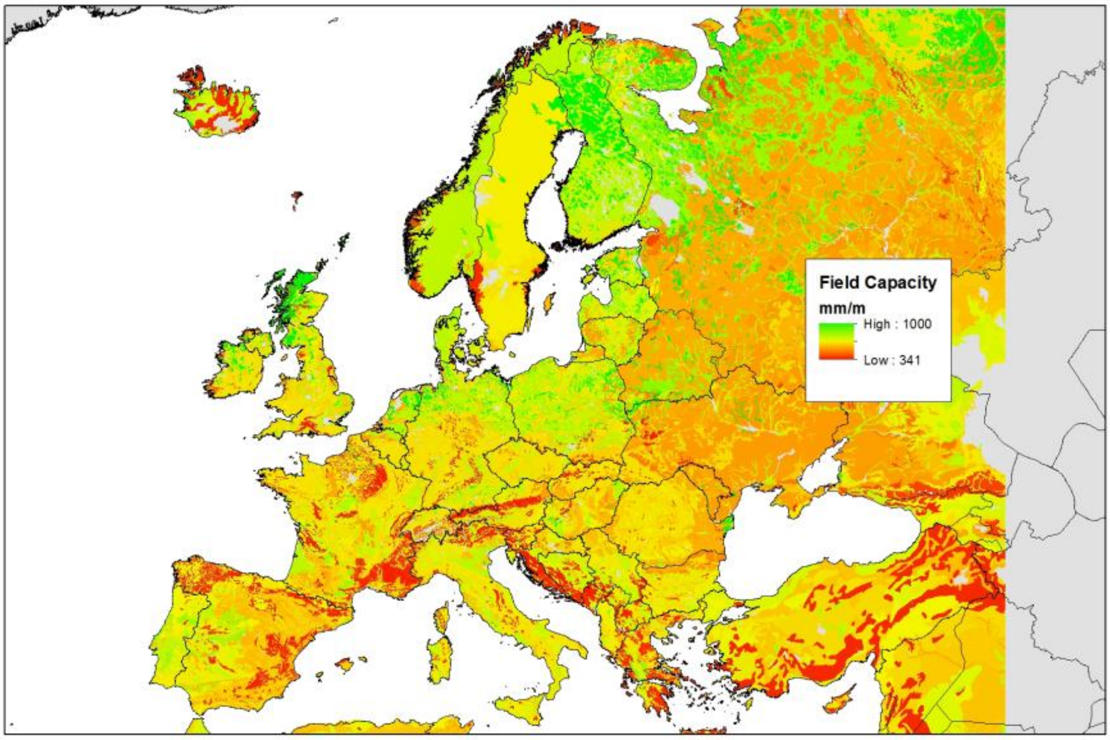
Figure: Top soil base saturation in three classes (High, medium, low)



4.4.3 Field capacity

- File: fieldcapacity.asc
- Format: INSPIRE-Grid, 1*1 km
- Attribute: field capacity (divide by 100 to get mm/m)
- Source: EEA via FTP-download, June 2013

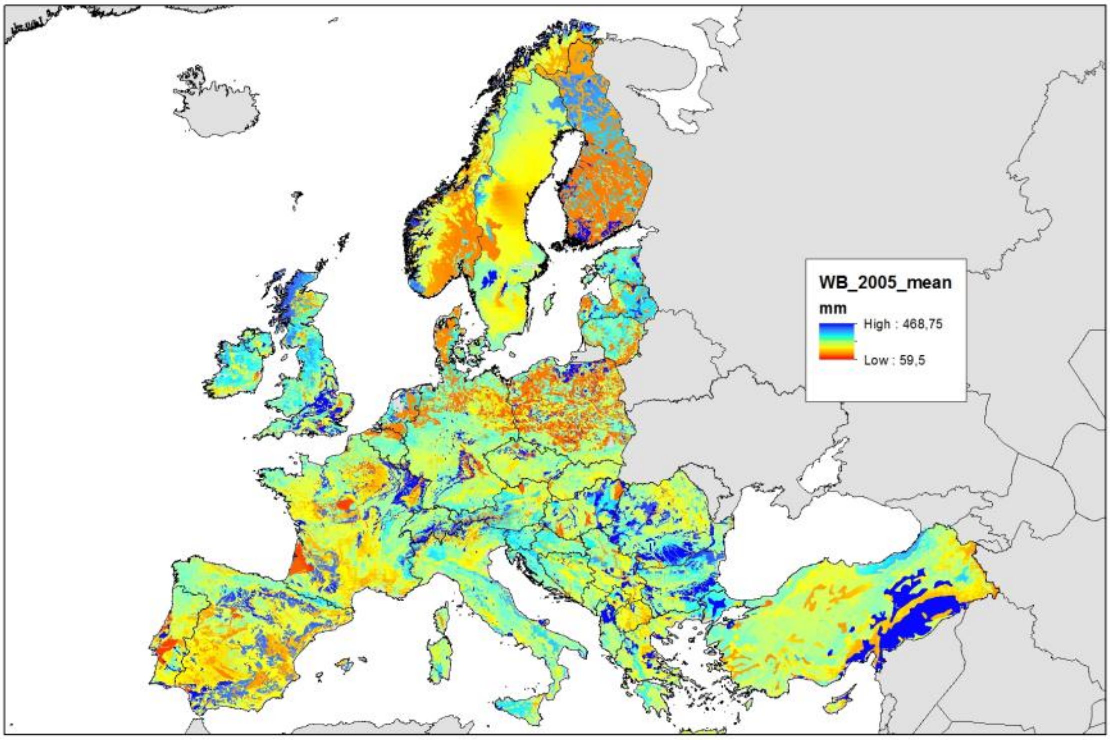
Figure: Field capacity in mm/m



4.4.4 Soil water balance

- Files: WB200501000.asc.gz → WB20071200.asc.gz
- Format: INSPIRE-Grid, 1*1 km
- Attribute: mm of water at the end of the month, monthly values years 2005-2007
- Source: EEA via FTP-download, June 2013
- Preprocessing:
  - Calculation of MEAN water balance per year
  - Selection of year 2005 as representative year for further processing

Figure: Mean soil water balance in 2005



4.5 ADDITIONAL REMOTE SENSING DATA

4.5.1 HANTS/MODIS

The temporal development of phonological indicators can be observed with remote sensing data providing a very high temporal resolution. Unless the SENTINEL 2 data are available the current freely available dataset are restricted in their spatial resolution to >= 250m pixel sizes. MODIS with a daily revisit time and a spatial resolution of 250meter is well suited for NDVI analysis. The seasonal cycle of the NDVI can be approximated by a limited number of frequeny components derived from a Fourier analysis. This principle is implemented in the HANTS algorithm (Harmonic Analysis of NDVI Time Series) which employs an interative routine to filter out poor NDVI estimates due to cloud dover or other disturbances from the NDVI cycle. The basic concept behind the algorithm is that the vegetation development as indicated by the NDVI has a strong seasonal effect in most parts of the worl which can be described using a series of low frequency sine functions with different phase, frequencies and amplitudes (Alterra report 2259, 2012).

The HANTS yearly data series is available

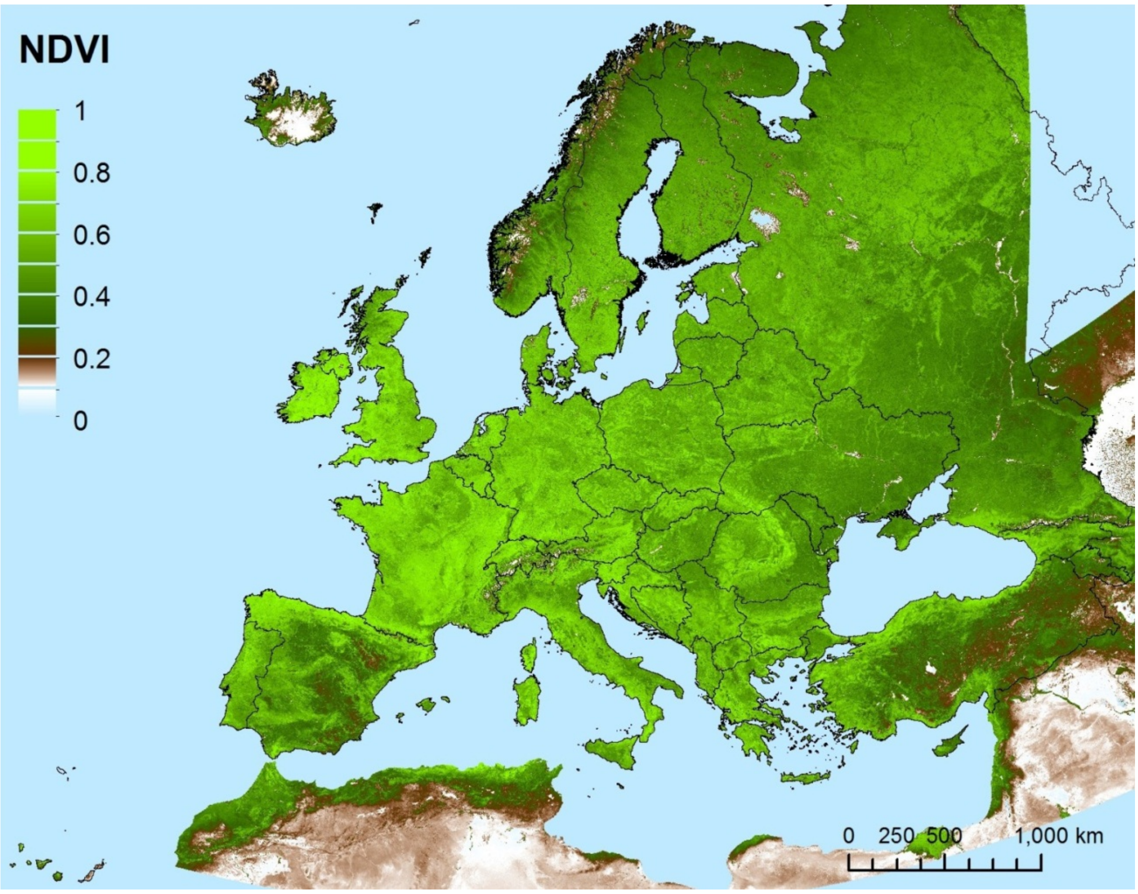
Phenological indicators:

NDVI: mean, maximum and minimum

Seasonal Dates: start of Season (SOS), peak of season (POS), End of season (EOS), Low of season (LOSI

Data preparation: ALTERRA, Gerbert Roerink

Figure: HANTS phenology: mean NDVI in 2011



5 DATA PREPROCESSING

All input data were rasterized to the standard 100*100m INSPIRE raster grid.

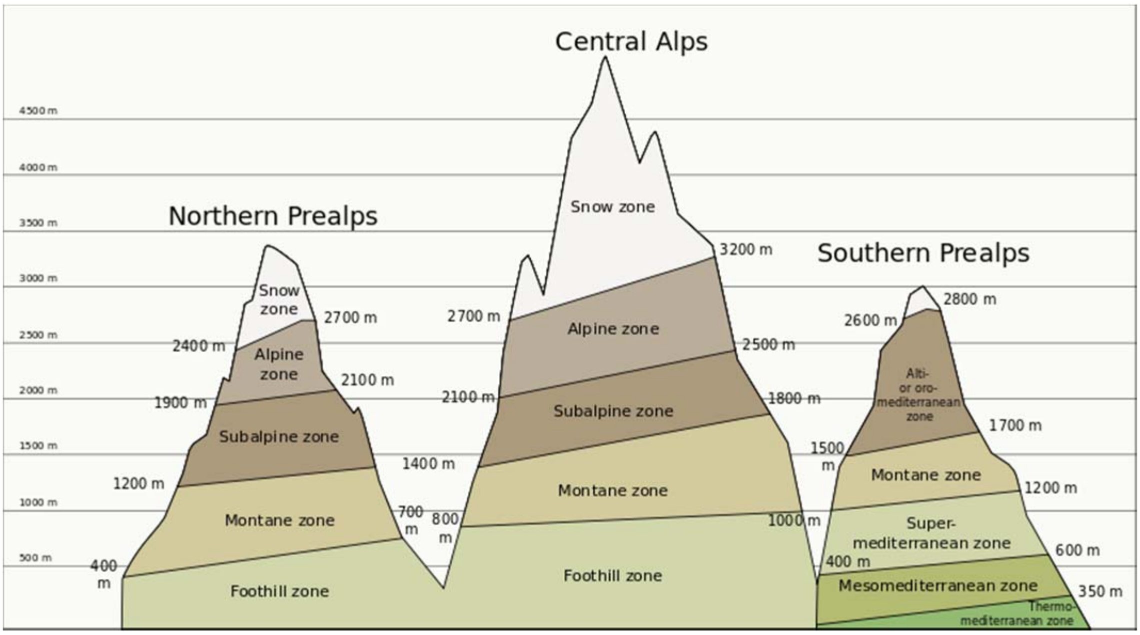
Various preprocessing steps were necessary to prepare the data for their integration into the ecosystem mapping workflow.

5.1 ELEVATION ZONE

Two ecosystem types are defined according to the alpine and subalpine elevation zone. However no European wide data existed for these elevation zones that are not strictly defined by the altitude but rather include complex altitudinal, geomorphological and climatic parameters.

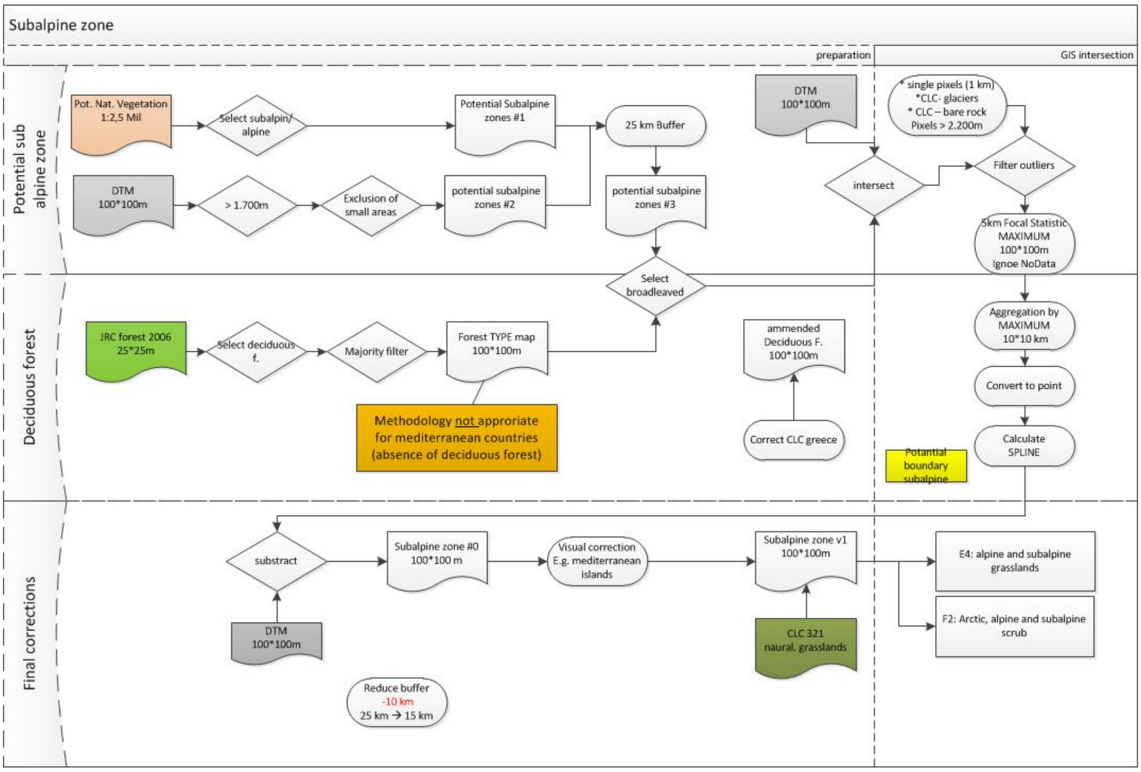
altitudinal zonation	height
planar	< 300m
colline	250-700 m
submontane	500-1000 m

montane	800-1400 m
high montane	1200-1800
subalpine	1500-2500 m
alpine	1700-2800m
nival	>2800 m



Source: http://en.wikipedia.org/wiki/Altitudinal_zonation

- *Fleurs de montagne*, Jean-Marie Polese, Artémis Editions 2008
- *Fleurs des Alpes, balade d'un botaniste des paines aux sommets*, François Couplan, Nathan, 2005
- *Author: Pethrus*

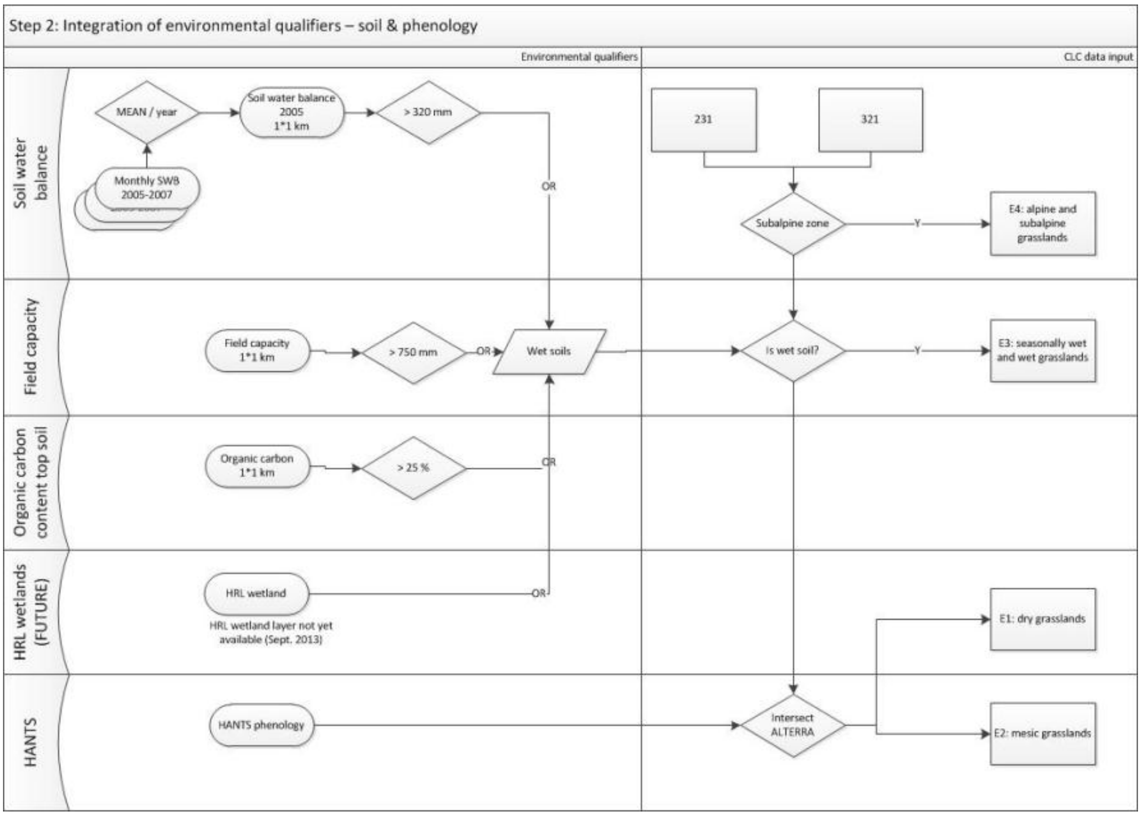


5.2 SOIL QUALIFIER

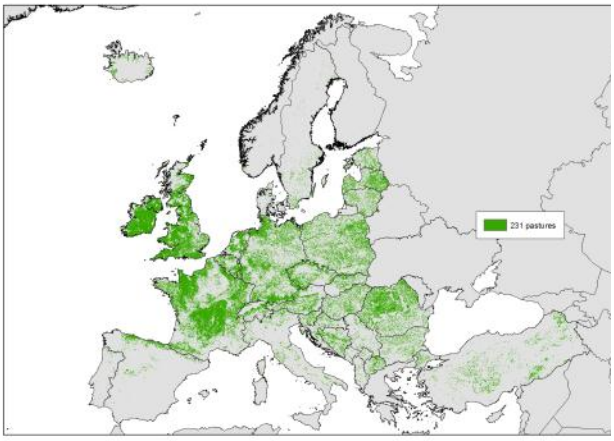
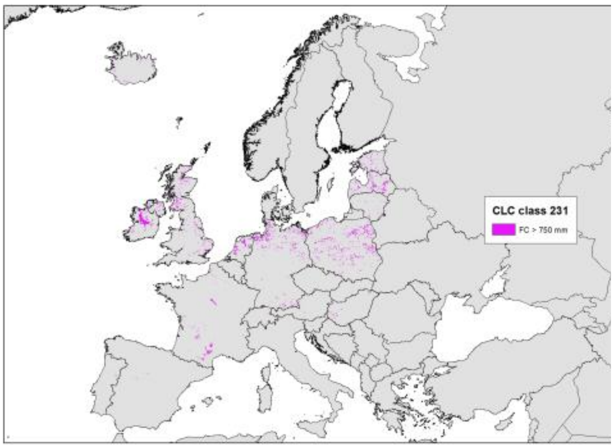
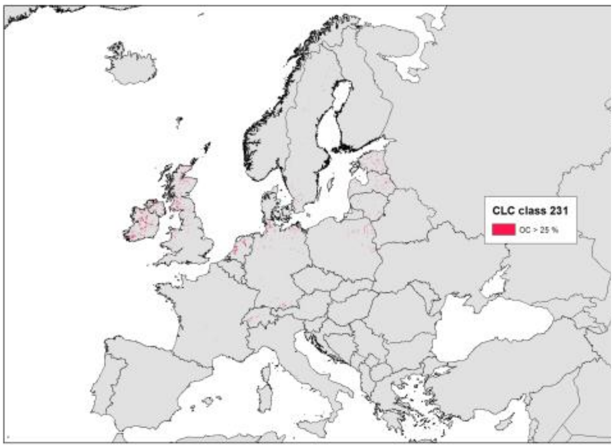
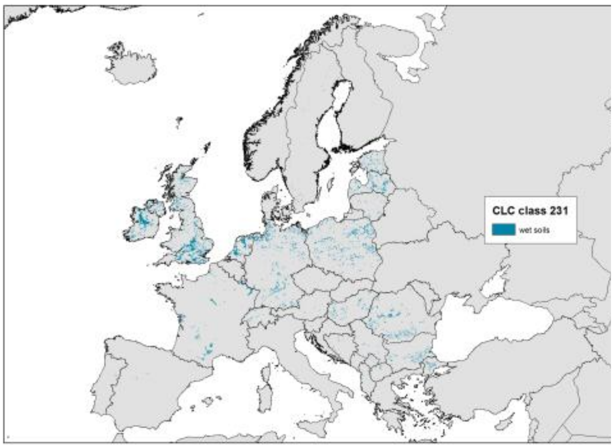
5.2.1 wetness

The workflow for differentiating grasslands includes the following environmental qualifiers

- Elevation zone
- Soil wetness
- Phenology



The environmental qualifier subalpine zone is described in detail in the sub-chapter and is used to differentiate the alpine grasslands from the CLC classes “231 pastures” and “321 natural grassland”. The wet grasslands are separated using soil information. As last part of the differentiation process the remaining grasslands are splitted into dry and mesic grasslands according to their phenological characteristics.

	
CLC classe 231 pastures	CLC classe 231 and field capacity > 750 mm/m
	
CLC classe 231 and soil water balance 2005 > 320 mm	CLC class 231 and organic content > 25%
	
CLC class 231 and combined wet soils	

Transformation table used for soil wetness:

soil_wetness VALUE	old VALUE	COUNT	FC_750	SWB_2005_320	OCTOP_25
0	1	13999558	0	0	-1
0	2	12646815	0	0	0
1	3	425976	1	0	-1
1	4	647033	1	0	0
1	5	180348	0	1	0
1	6	178476	0	0	1
1	7	114741	1	0	1
1	8	943	0	1	1
1	9	21	1	1	1
1	10	111	1	1	0
1	11	60570	0	1	-1

Description:

- Soil wetness value: VALUE in GRID "soil_wetness"
    - VALUE >0 ….wet soils
    - CODING: 100…field capacity, 10…soil water balance, 1…organic content
- Old VALUE: automatic value after COMBINE
- FC_750: field capacity > 750 mm
- SWB_2005_320; soil water balance 2005 > 320 mm
- OCTOP_25: top soil organic carbon > 25%

6.1.1 Acidity of soils

Temperate shrub heathland (F4) only occure on acid soils. As proxy indicator for acid soils the base saturation can be used. The direct relation between the base saturation and the pH-value of soils is given in the table below:

Table: relation between base saturation and ph-value[1]

Base saturation (BS)			pH – Value (CaCl2)
Code	Soil base-saturation	in %	
BS1	Very low	<5	<3,3
BS2	Low	5-<20	3,3-<3,8
BS3	intermediate	20-<50	3,8-<4,8
BS4	High	50-<80	4,8-<6,0
BS5	Very high	80-100	>=6,0

This relation is used to reclassify the chemical attribute "base saturation in top soils" of the European Soil database. A base saturation below 50% is regarded as acid and is used as additional criteria to differentiate F4 from other heathlands.

Table reclassification of Top soil base saturation in ESDB

ESDB-European soil database		Ecosystem mapping
Base saturation top soil	in %	Reclassification
Low	< 50 %	Acid
Medium	50-75 %	-
High	> 75%	-

6.2 OSM-ROADS AND LAND USE

The open street map data include more detailed than CORINE Land Cover the main roads and as well built-up areas. For roads only the main roads (highways) were selected, as they establish the main land cover per 100*100 pixel. The average percentage of a road in a 100*100m pixel can be estimated with 50-60% (4 lane or 6-lane road).

For land use the OSM data includes already delineated polygons for land cover. The dynamic of the dataset can be clearly demonstrated, as two years ago the land use in open street map was a simple copy of the CORINE Land cover dataset. But nowadays much smaller features than in CORINE Land Cover (25 ha MMU) are mapped. Therefore the relevant classes were extracted from the OSM land use

[1] Source: Ad-hoc-Working Group Soil: Bodenkundliche Kartieranleitung, Hrsg.: Bundesanstalt für Geowissenschaften und Rohstoffe in Zusammenarbeit mit den Staatlichen Geologischen Diensten, 5. Aufl., Hannover 2005. ISBN 3-510-95920-5

6.2.1 Road with and dominant land cover

The following OSM road types were selected from OSM.

FREQUENCY	TYPE	selected
153025	motorway	x
134031	motorway_link	x

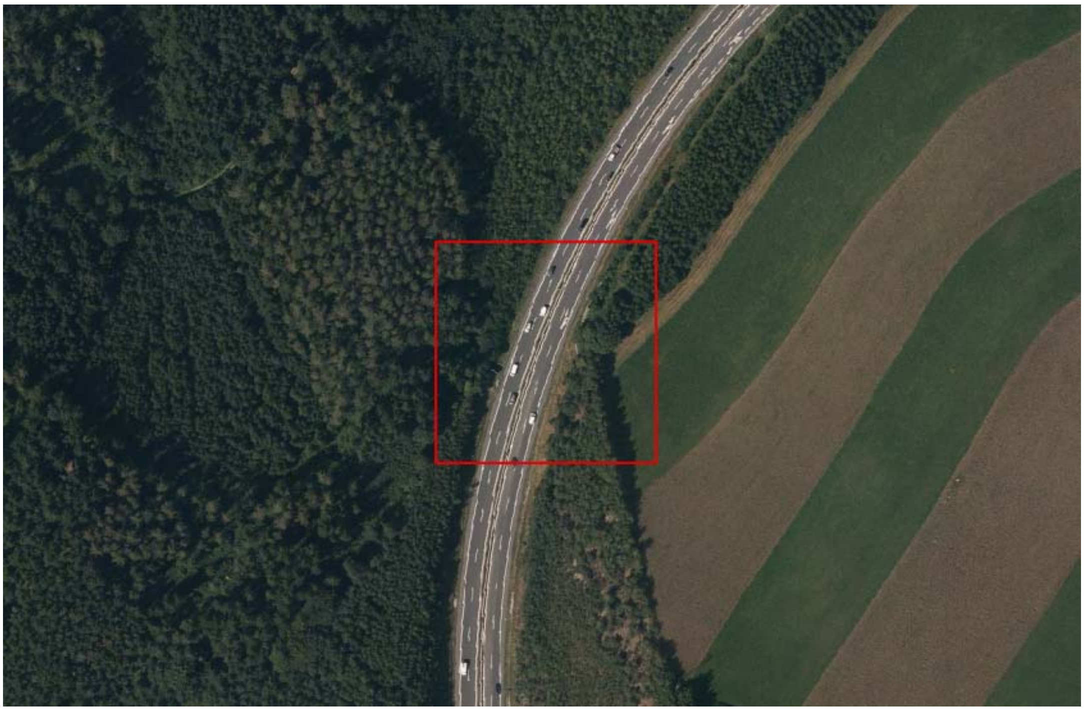
100 m pixel and dominant land cover

Normal Roads (2-lane), but dominant LC = agriculture

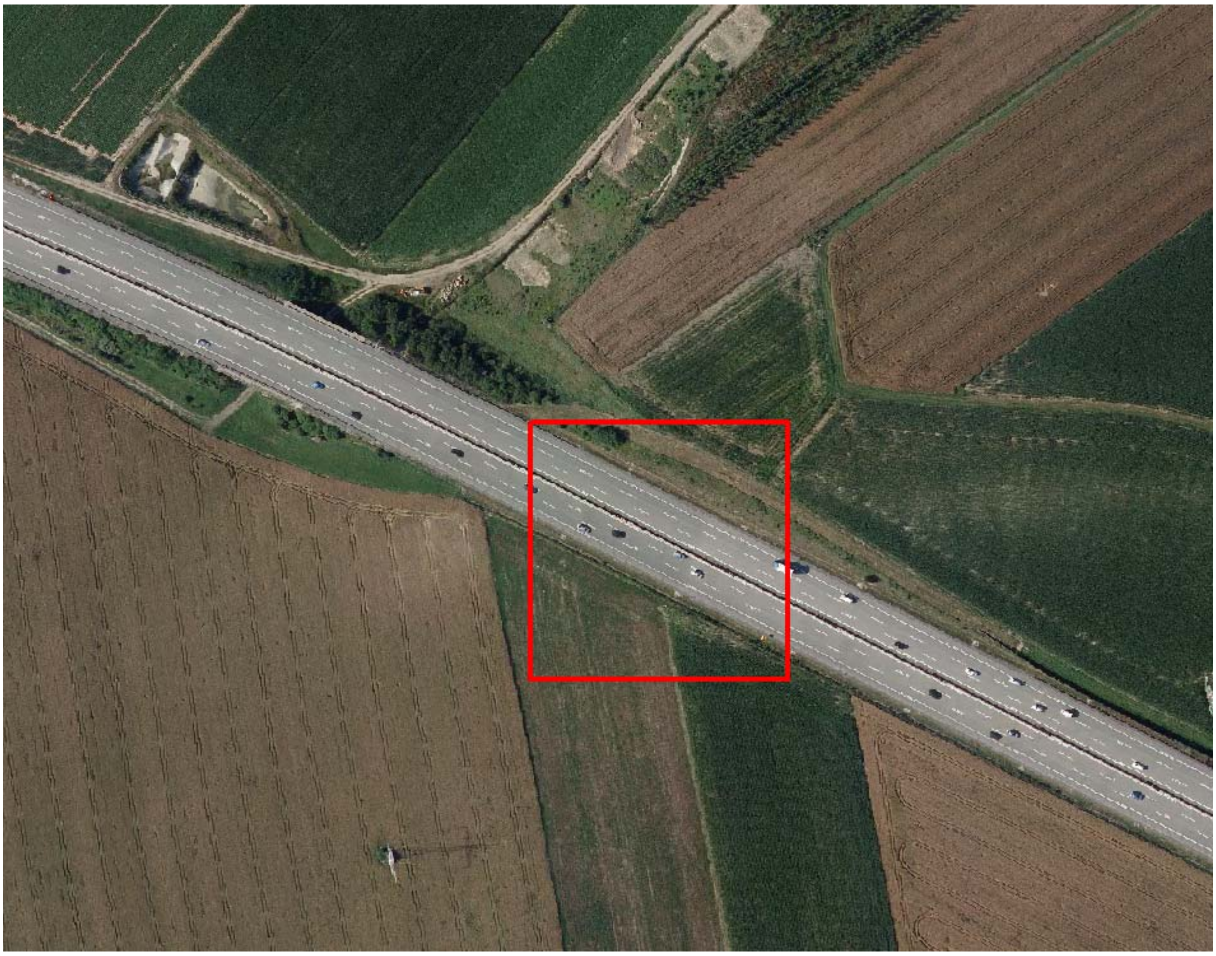
Roads and river included, but dominant LC = agriculture

Roads – highways

4-lane highway (width of lanes: 23 m, including side constructions: 40m, average sealing degree (100*100m: 10-50%))



6-lane highway (width of lanes: 33m, , including side constructions: 50m, average sealing degree: (100*100m) 30-60 %).



6.2.2 OSM and land use data

The following land use types were selected from OSM and mapped towards EUNIS classes:

TYPE	ID_ES_OS	EUNIS_L2	EUNIS_L3	Count
village_green	10	I2	I2.1	24608
park	10	I2	I2.2	73
cemetery	10	I2	I2.3	90452
retail	21	J1	J1.1	28087
residential	21	J1	J1.2	745046
industrial;retai	21	J1	J1.3	385
industrial	21	J1	J1.4	81570
commercial	21	J1	J1.5	21374
allotments	22	J2	J2.1	58054
industrial	23	J3	J3.1	32227
railway	24	J4	J4.1	4612

reservoir	25	J5	J5.1	107472

An evident problem in open street map is the varying quality of the data. The quality varies between countries and within the countries, even very locally different qualities of mapping can be found. But overall the quality has improved dramatically over the last two years.

Overall the geometric quality of the objects that are integrated in OSM is quite high, but the completeness is still beyond app. 85%.

OSM.-land use: very detailed delineation almost of single houses	OSM-land use: locally varying quality and completeness of built-up data
	

7 MAPPING RULES

7.1 THEMATIC RULES

7.1.1 D1, D3: Bogs and Mires (CLC 412)

D1	Raised and blanket bogs	Peatlands formed by ombrotrophic acid peat, which is (or was while actively growing) capable of growth fed by rainfall rather than by the inflow of water from higher ground in the vicinity.
D3	Aapa, palsa and polygon mires	Patterned mire complexes of the arctic, subarctic and northern boreal zones.

Main issue: differentiation between

- D1 Raised and blanket bogs
- D3 Aapa, palsa and polygon mires

These two types are summed up in the CLC class 412 (peatbogs)

Methodology:

1. The first step is based on biogeographic regions. D3 does not occur outside Boreal, ALPN (within the Scandinavian region and Arctic) region.
2. It means, outside FI, SE (and NO), the situation is clear, but in these countries the ancillary data should be used. These habitats occur in complexes where it will be difficult to distinguish them without detailed field data.
    a. Sweden:
        i. Blanked bogs are extremely rare in ALPN and their sites are probably well known – the map of Annex habitat type 7230 in SE improves the data situation.
        ii. The raised bogs in boreal zone of SE are quite sparse and the habitat maps of the Annex habitat type 7110 are of major help;
    b. Finland:
        i. FI is more complicated as both raised bogs and Aapa mires are quite widespread.
3. Option: One possibility that needs to be discussed with people that have personal experience with these habitat is possible use of the micro-and meso-relief (e.g. convex of raised bogs, concave of Aapa mires; and “grain” – dimension of relief structures). It looks, D3 contain bigger structures (like “ridges”, “hummocks”) than D1 but for these micro-climatic conditions a very detailed DEM from LIDAR is necessary (not available in Europe)

7.1.2 D2, D4, D5 and D6: mires

D2	Valley mires, poor fens and transition mires	Weakly to strongly acid peatlands, flushes and vegetated rafts formed in situations where they receive water from the surrounding landscape or are intermediate between land and water. Included are quaking bogs and vegetated non-calcareous springs. Excluded are calcareous fens (D4), and

		reedbeds (C3, D5).
D4	Base-rich fens and calcareous spring mires	Peatlands, flushes and vegetated springs with calcareous or eutrophic ground water, within river valleys, alluvial plains, or on hillsides. As in poor fens, the water level is at or near the surface of the substratum and peat formation depends on a permanently high watertable. Excluded are reedbeds (C3, D5).
D5	Sedge and reedbeds, normally without free-standing water	Sedge and reedbeds forming terrestrial mire habitats, not closely associated with open water. Excluded are reedbeds and sedges where they form emergent or fringing vegetation beside water bodies (C3.2).
D6	Inland saline and brackish marshes and reedbeds	Saline wetlands, with closed or open vegetation, which are the non-coastal analogue of coastal saltmarshes and saline reedbeds (A2.5). Drier saline habitats are classified as inland salt steppe (E6) or saline scrubland (F6.8).

Geology and/or soil maps can be used for distinguishing between D2 and D4:

- D4 are calcareous while D2 acid or neutral.
- For delineation of D2 and D4 against D5 and D6 see text to D5 and D6 below.

In main part of EU probably D2 and D4 are well mapped, so the ancillary data could be used. These units include Annex I habitats 7140, 7150 (both D2), 7230 and 7240 (both D4). Probably Annex I habitats cover better D4 than D2, but I am not able to estimate how big part of D2 and D4 distribution is in Annex I. But maps of Annex I habitats could be used at least for testing purposes.

Note: It is very probable that at least some /possibly majority or all/ patches of D2 and D4 were mapped in class 412. The definition of 411 clearly covers also D2 and D4, question is if the interpreters were able to distinguish between bogs and fens. The unit D2 is particularly problematic as it contains transitional mires that probably cannot be distinguished from bogs without the ancillary data. It would be more appropriate classification of units D1-D6 into 2 classes could be 412 Bog and fens containing D1-D4 and 411 Inland marshes containing D5 and D6. But it is not possible to change the definitions, CLC1990-2006 were mapped using existing definitions and thus our situation is more complicated. Let's suppose that 411 and 412 were classified correctly or if we found better approach to distinguishing between units, we can do/propose corrections.

1. D6 is existing only in very small and rare areas and can be approximated with the distribution of Art. 17 data
2. The next rare class is D5 and can as well be approximated with the Art. 17 data distribution
3. D2 within Art. 17 distribution without the occurrence of D4
4. D4 within Art. 17 distribution without the occurrence of D2

5.

7.1.3 E1-E4: Grassland (CLC 231)

E1	Dry grasslands	Well-drained or dry lands dominated by grass or herbs, mostly not fertilized and with low productivity. Included are [Artemisia] steppes. Excluded are dry mediterranean lands with shrubs of other genera where the shrub cover exceeds 10%; these are listed as garrigue (F6).
E2	Mesic grasslands	Lowland and montane mesotrophic and eutrophic pastures and hay meadows of the boreal, nemoral, warm-temperate humid and mediterranean zones. They are generally more fertile than dry grasslands (E1), and include sports fields and agriculturally improved and reseeded pastures.
E3	Seasonally wet and wet grasslands	Unimproved or lightly improved wet meadows and tall herb communities of the boreal, nemoral, warm-temperate humid, steppic and mediterranean zones.
E4	Alpine and subalpine grasslands	Primary and secondary grass- or sedge- dominated formations of the alpine and subalpine levels of boreal, nemoral, mediterranean, warm-temperate humid and Anatolian mountains.

Input: CLC 231+321

Main idea:

- Soil parameters are an indication for wet grassland

ADD the CLC mixed categories – differentiated according to cropland and grassland

0. Substract the subalpine and alpine grasslands using the subalpine height zone
1. Substract the WET grasslands
    a. Using soil data (combine parameters with OR)
        i. Soil water balance high
        ii. Field capacity high
        iii. Organic content in top soil high
        iv. Evtl. High SWB and low FC
2. Differentiate DRY and MED using HANTS

7.1.4 F3, F4: Temperate scrub and shrub heathland (CLC 322 and 331)

The temperate shrublands F3 and F4 belong to the exactly same CLC-class (322 and 331).

F4 is dominated mostly by ericoid plants, but not exclusively: dominants could be Erica, Vaccinium, Calluna, Ulex, Genista, but also e.g. Molinia, Pteridium

Potential vegetation of Europe can be used – the unit E "Atlantic dwarf shrub heaths" corresponds to F4. There is of course limitation of scale and the fact that this is potential vegetation - many heaths in Europe are of secondary origin.

The regional approach can help a little – F4 is distributed mostly in Atlantic region. More rarely it occurs outside Atlantic, in sub-Atlantic region, and here it can be found in quite large part of Europe – and this limits possibility to use regional approach.

With regard to soils pH is relevant, as F4 occurs exclusively on acid soils, this can be used as one of determinants of its distribution.

relevant Annex I habitats:

F3: 5110, 5120, 5130. Only small part of F3 is covered by Annex I habitats.

F4: 2310, 2320, 4010, 4020, 4030, 4040, 4050: quite large part of F4 is included in Annex I.

Remark: it has to be analyzed in which way the montane elevation zone within the Mediterranean strata might be used for differentiatin F3.

7.1.5 F5-F8: Maquis, Garrigue and Mediterranean heath (CLC 323)

F5	Maquis, arborescent matorral and thermo-Mediterranean brushes	Evergreen sclerophyllous or lauriphyllous shrub vegetation, with a closed or nearly closed canopy structure, having nearly 100% cover of shrubs, with few annuals and some vernal geophytes; trees are nearly always present, some of which may be in shrub form. Shrubs, sometimes tall, of [Arbutus], [Cistus], [Cytisus], [Erica], [Genista], [Lavandula], [Myrtus], [Phillyrea], [Pistacia], [Quercus] and [Spartium] are typical. Included is pseudomaquis, in which the dominants are mixed deciduous and evergreen shrubs.
F6	Garrigue	Evergreen sclerophyllous or lauriphyllous shrub vegetation, with an open canopy structure and some bare ground, usually with many winter annuals and vernal geophytes. Low shrubs of [Cistus], [Lavandula], [Rosmarinus] and [Stoechas] are usually present, and there may be some larger shrubs and scattered trees. Garrigue is found mostly in the Mediterranean, Macaronesian and Pontic regions, where it typically derives from degradation or regrowth of broad-leaved evergreen forests (G2), but it extends into deciduous forest areas in the supra-Mediterranean zone and sub-Mediterranean zones and into steppe areas in Anatolia. Includes scrubby land

		with mainly herbaceous vegetation and a large component of unpalatable non-vernal monocots ([Asphodelus], [Urginea]) and thistles, provided that shrub cover exceeds 10%.
F7	Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)	Shrublands with dominant low spiny shrubs, widespread in Mediterranean and Anatolian regions with a summer-dry climate, occurring from sea level to high altitudes on dry mountains.
F8	Thermo-Atlantic xerophytic scrub	Xerophytic scrub formations of the lower slopes of the Canary Islands and Madeira, rich in succulents, in particular cactiform or dendroid spurges [Euphorbia] spp., rosette-forming [Aeonium] spp. and composites.

These types are combined in CLC-classe 323 (sclerophyllus vegetation)

Main classes for differentiation:

EUNIS code	EUNIS name
B1	Coastal dunes and sandy shores
E5	Woodland fringes and clearings and tall forb stands
F5	Maquis, arborescent matorral and thermo-Mediterranean brushes
F6	Garrigue
F7	Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)
F8	Thermo-Atlantic xerophytic scrub

Methodology:

1. Differentiation according to potential natural vegetation
2. Characterization of degradation using JRC forest layer:
   a. The polygons with higher crown densities are regarded as Maquis (F5), the other ones as Garrigue (F6)

i. F5 is close, around 100% of shrub and trees cover, F6 is open
ii. CRITICAL Question is, if the high-resolution forest layer well classifies closed shrub stands of F5 as forest and open F6 stands as non-forest.
iii.

3. Identification of F7 from F5 and F6 remains problematic:
    a. Art. 17 Maps of 5410, 5420, 5430 and 4090 can provide picture about distribution of F7 (and thus could be useful for differentiation against F5 and Fb)
        i. not sure how big part of F7 is not covered by Annex I habitats

7.2 PHENOLOGICAL RULES (HANTS)

7.2.1 Background

For the ETC-SIA task "Ecosystem mapping" the CORINE classes don't match exactly the necessary classes for ecosystem mapping. Two classes need to be identifies:

- Dry grassland
- Evergreen deciduous forest

The objective of this study is to derive these classes from the existing CLC2006 land cover classes and the HANTS phenology dataset, which contains the following layers:

- Mean NDVI (NDVI value)
- Peak NDVI (NDVI value)
- Low NDVI (NDVI value)
- SOS - Start of Season (Day of the Year)
- EOS - End of Season (Day of the Year)
- POS - Peak of Season (Day of the Year)
- LOS - Low of Season (Day of the Year)

7.2.2 E1 Dry grassland

7.2.2.1 Definitions

The EUNIS definition of dry grassland is: "Well-drained or dry lands dominated by grass or herbs, mostly not fertilized and with low productivity. Included are [Artemisia] steppes. Excluded are dry mediterranean lands with shrubs of other genera where the shrub cover exceeds 10%; these are listed as garrigue (F6)."

In plant phenological terms it could be rewritten as: dry grassland is facing severe water deficits in the hot summer times and will die almost completely in that period; the grass becomes yellow/brown and has almost no photosynthetic activity left at that time.

In HANTS phenological terms it could be translated as: dry grassland has a LOS in summer time and the Low NDVI should have a value close to bare soil NDVI values in that period.

7.2.2.2 Method

The following steps are taken:

1. Mask the HANTS phenology 2006 dataset with the given CLC2006 map (where wet grassland is already excluded), so that all classes are masked except the grassland classes (pastures and natural grassland)

2. Run statistics on the HANTS phenology 2006 dataset of grassland and make histograms
3. Analyse the histograms and draft decision rules
4. Determine and finetune the threshold values for the decision rules
5. Run the decision rules and create the dry grassland mask

7.2.2.3 Results

After the masking procedure the histograms of all HANTS phenological parameters are made. Figure 1 shows them. On the left the mean, maximum and minimum NDVI histogram is shown, it covers a wide range of values. On the right the histograms of day number of start, end, peak and low of the season is shown. Each one shows two peaks. This is used to differentiate between grassland having a dip in winter (due to radiation and temperature limitations) or summer (due to water limitations); see Figure 2.

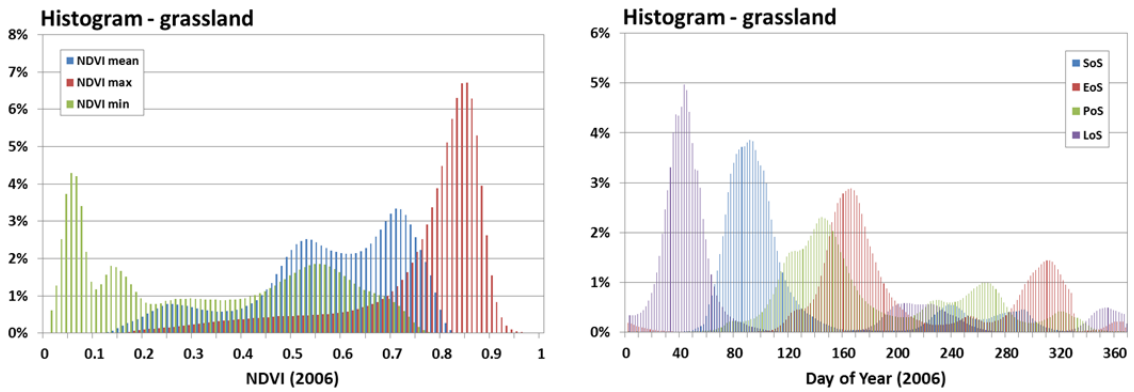


Figure 1 Histograms of the HANTS phenology 2006 for grassland

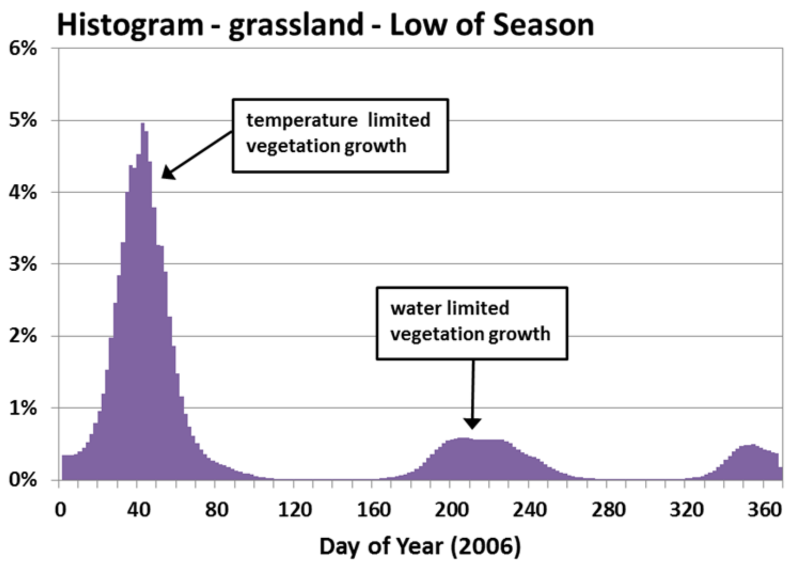


Figure 2 Histograms of HANTS phenology – Low of Season 2006 for grassland

Based on the two peaks in the histogram of LoS in figure 2, the dry grassland class is further limited to all grassland pixels having a LoS between day 150 and 290. This is occurring in the Mediterranean area and some parts of continental France. Statistics are run again on this grassland class and now the minimum NDVI is used to further define the dry grassland class.

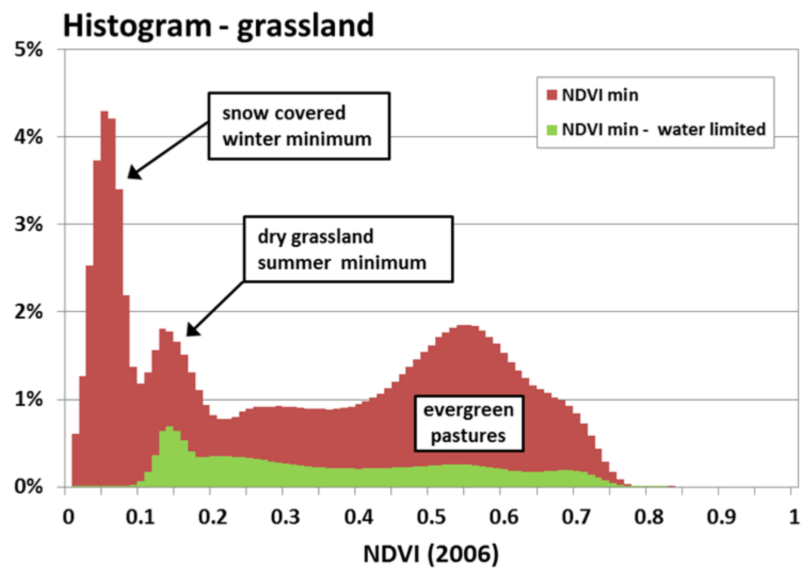


Figure 3 Histograms of HANTS phenology – Minimum NDVI 2006 for grassland and subclass water limited grassland

Figure 3 shows the histograms of the minimum NDVI of all grassland pixels and the water limited subclass (where 150<LoS<290, see Figure 2). The all grassland histogram has three peaks, the peak with the smallest NDVI values occur in winter time when pixels in Eastern and Northen Europe are covered with snow and ice. The second peak is slightly higher and has typical NDVI values for bare soil (NDVI between 0.1 and 0.2). What happened is that the vegetation in these pixels dies due to water stress, all photosynthetic activity stops and these pixels resemble bare soils NDVI values. The third peak is around minimum NDVI value of 0.55; these are the evergreen pastures in the Western part of Europe.

In the histogram of the water limited subclass the first peak disappeared. The second peak is still there and we define this peak as the dry grasslands. As there is no clear ending of this peak to the right, defining the threshold is a little arbitrary. With a trial and error method it is finally set at 0.25.

In short the following decision rules are used to define dry grassland:

- 150 < LoS < 290
- NDVI_min < 0.25

Critical remark 1: The NDVI_min threshold is set at 0.25; this threshold is defined arbitrary. If a validation dataset would be available the threshold could be defined properly on a scientific base.

Critical remark 2: A quick analysis of the resulting map made clear that in Turkey (Anatolia) there are large areas of grassland that have low NDVI values in summer due to water stress, but also in winter due to snow fall. In many parts the winter dip is lower than the summer dip so these areas have a LoS less than 150 and are wrongly excluded from being dry grassland. This can be solved by applying an additional set of decision rules for the Anatolian bio-geo region, not based on day number, but for example on mean NDVI (should be lower than threshold xxx).

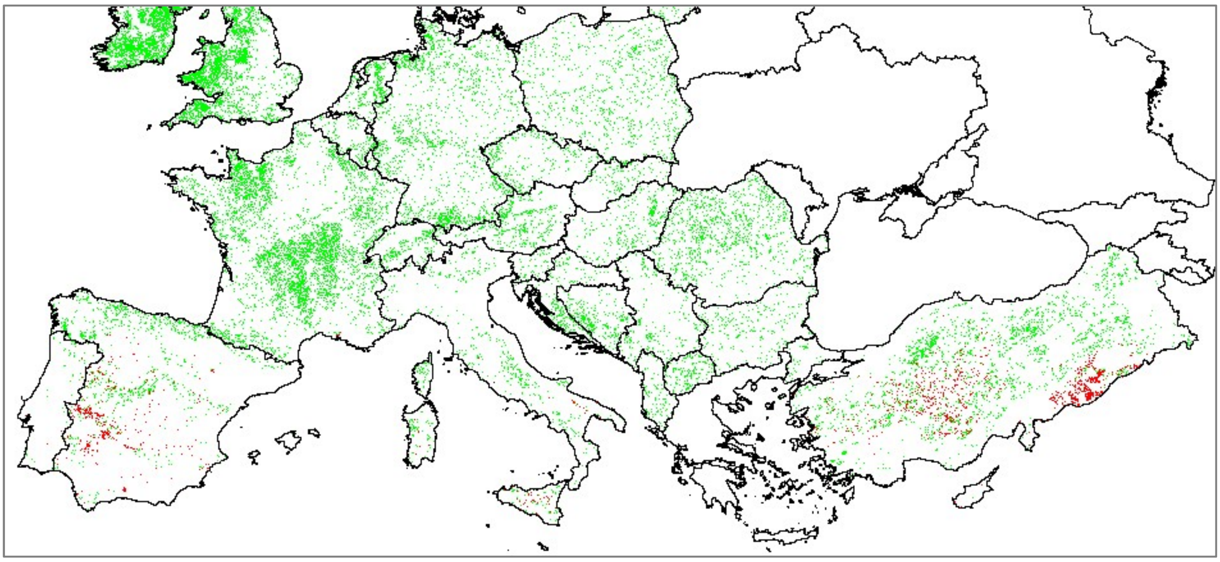


Figure 4 Map of dry grassland in Europe (red = dry grassland, green = other grassland)

7.2.3 G2 Broadleaved evergreen woodland

7.2.3.1 Definitions

The EUNIS definition of broad leaved evergreen woodland is: “Temperate forests dominated by broad-leaved sclerophyllous or lauriphyllous evergreen trees, or by palms. They are characteristic of the Mediterranean and warm-temperate humid zones.”

In plant phenological terms it could be rewritten as: Evergreen broadleaved forest has only a small seasonal difference as compared to deciduous broadleaved forest and occur only in the Mediterranean climate zone (in Europe).

In HANTS phenological terms it could be translated as: Evergreen broadleaved forest has a small difference between the maximum and minimum NDVI within a year and occur only in the Mediterranean climate zone (all other climate zones can be excluded from the analysis).

7.2.3.2 Method

The following steps are taken:

6. Mask the HANTS phenology 2006 dataset with the CLC2006 land cover map, where all classes are masked except broadleaved forest
7. Mask the HANTS phenology 2006 – broadleaved forest dataset with the given PotNatVeg climate map, where all classes are masked except the Mediterranean areas
8. Run statistics on the HANTS phenology 2006 dataset of Mediterranean broadleaved forest and make histograms
9. Analyse the histograms and draft decision rules
10. Determine and finetune the threshold values for the decision rules
11. Run the decision rules and create the evergreen broadleaved forest mask

7.2.3.3 Results

After the masking procedures in step 1 and 2 the histograms of all HANTS phenological parameters are made. Figure 5 shows them. On the left the mean, maximum and minimum NDVI histogram is shown, The mean NDVI shows two peaks; this is assumed to be coming from deciduous versus evergreen forest and is used as criteria for decision rule. On the right the histograms of day number of start, end, peak and low of the season is shown. Several peaks can be distinguished. However, analysis of the images shows that there is no relation between broadleaved forest type and peaks, so the information on day number is not used in this analysis.

Besides the mean NDVI (histogram in Figure 6) the seasonality is used to define the evergreen class. The seasonality is calculated as NDVI_max minus NDVI_min and the histogram is shown in Figure 7.

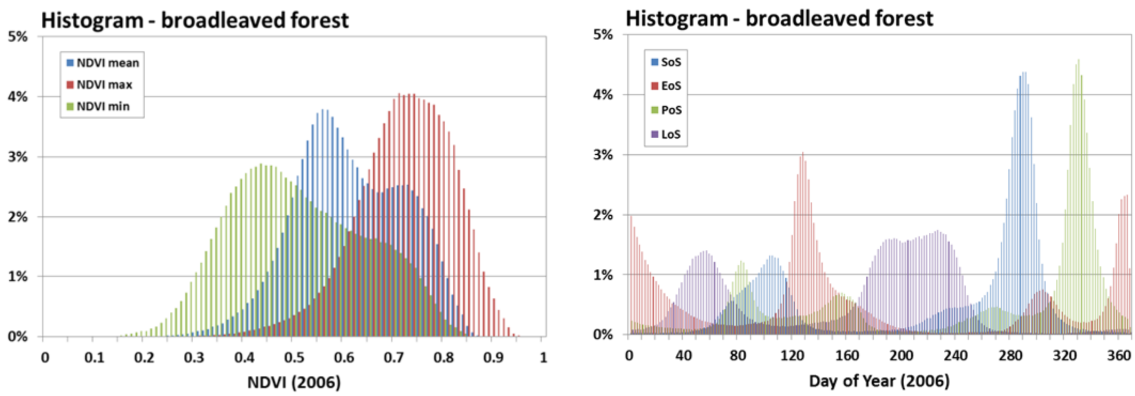


Figure 5 Histograms of the HANTS phenology 2006 for Mediterranean broadleaved forest

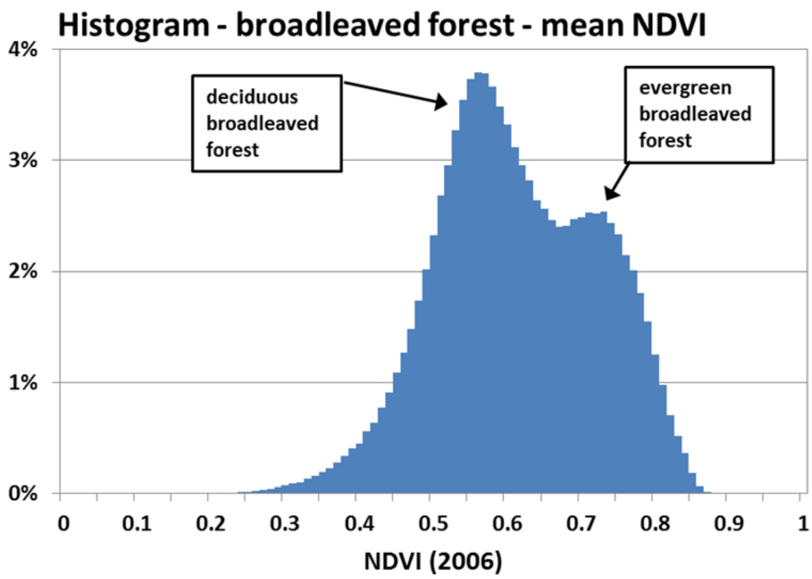


Figure 6 Histogram of HANTS phenology – Mean NDVI 2006 for Mediterranean broadleaved forest

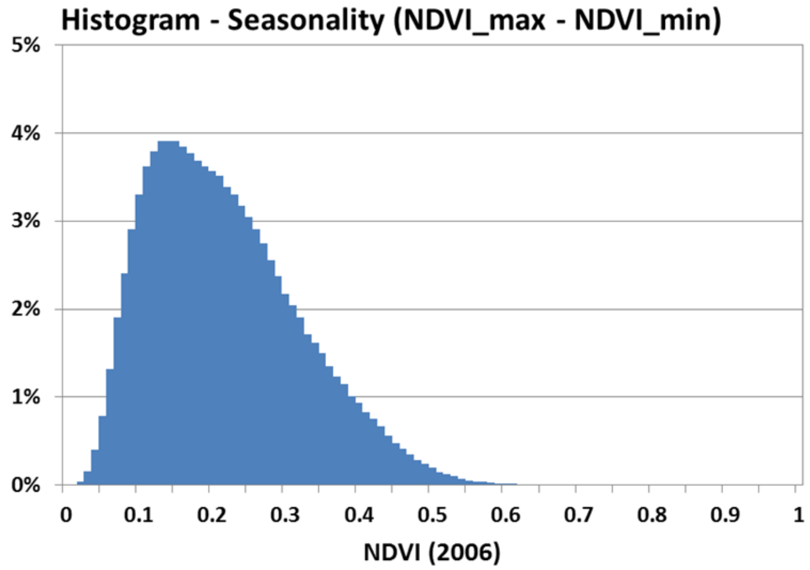


Figure 7 Histogram of HANTS phenology – Seasonality difference (NDVI_min – NDVI_max) for Mediterranean Broadleaved forest

The problem with the histograms in Figure 6 and 7 is that they have overlapping peaks. In figure 6 the two peaks are still visible, however in Figure 7 the difference between the first peak (at NDVI = 0.13) and the second peak, or better bending point in the curve (at NDVI = 0.23), is hardly visible. This can be explained by the fact that the transition from evergreen to deciduous forest is gradual and we are forced to set a threshold to separate both classes. A trial and error method gave the following set of decision rules:

- NDVI_mean > 0.63
- Seasonal difference: NDVI_max – NDVI_min < 0.22

Critical remark 1: The threshold values are not based on a scientific base. If a validation dataset would be available the threshold could be defined properly on a scientific base (perhaps the Andalucia forest dataset can be used for this, but I have to better understand the meaning of all classes in this dataset).

Critical remark2: Greece is missing in CLC2006. Should it be replaced by CLC 2000?

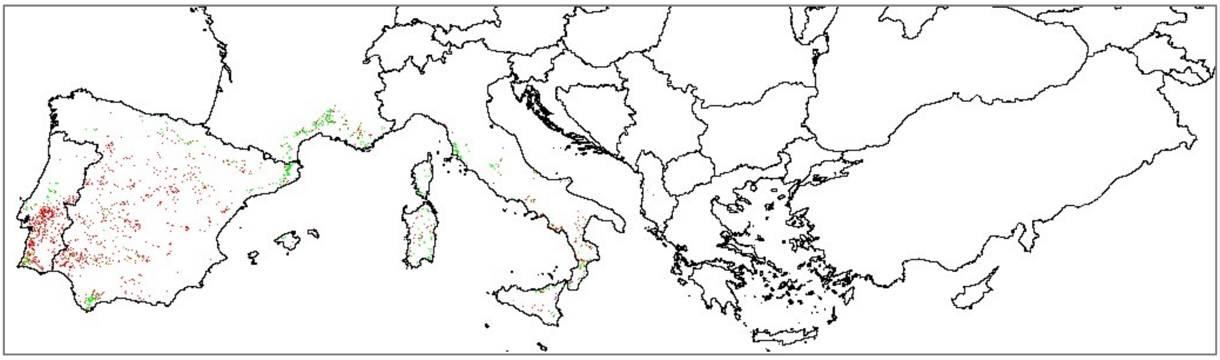


Figure 8 Map of Mediterranean evergreen broadleaved forest in Europe (green = Mediterranean evergreen broadleaved forest; red = Mediterranean deciduous broadleaved forest)

7.3 MIXED CLASSES (CLC 242 AND 243)

7.3.1 Background

The problem of the mixed CLC classes is that they have no direct crosswalk to any EUNIS class – therefore we have to split them up. Although there are relevant technical limitations of the MODIS HANTS dataset for such a task it is more important to demonstrate the method to contribute to the ecosystem mapping.

The objective of this case study is to derive arable land and grassland classes from the existing CLC2006 land cover classes 242 and 243 using HANTS dataset, which contains the following layers:

- Mean NDVI (NDVI value)
- Peak NDVI (NDVI value)
- Low NDVI (NDVI value)
- SOS - Start of Season (Day of the Year)
- EOS - End of Season (Day of the Year)
- POS - Peak of Season (Day of the Year)
- LOS - Low of Season (Day of the Year)

7.3.2 Definitions

The requirement is to "dismantle" the mixed CLC classes 242 (complex cultivation patterns) and 243 (Land principally occupied by agriculture, with significant areas of natural vegetation) into purely arable land and grassland classes by medium resolution MODIS time series processed into HANTS components.

A/ Initial assumptions:

1. Group: smoother NDVI dynamics -> grassland (E1, E2, E3)
2. Group: abrupt changes in NDVI -> arable land (I1)

This assumption is not fully valid as in case of intensively managed grasslands there are abrupt changes in the vegetation cover (EO signal) after grass cutting.

B/ Another assumption:

Crops grown on arable land have typically higher amplitude (from bare soil to maximum vegetation stage) than grasses. This assumption is partly linked to the first one.

7.3.3 Case study the Czech Republic

Initially a case study on AOI the Czech Republic has been performed as there are available detailed very high resolution agriculture data with classification of arable land and grassland (LPIS – Land Parcel Identification System).

Analysis:

1. Statistical analysis (zonal statistics) of arable land and grassland share under the mixed CLC classes
2. Test of arable land classification accuracy on AWiFS time series (assumption B)
3. Test on supervised arable land and grassland classification
4. Accuracy assessment

Results

1. **Zonal statistics**

The share of arable land and grassland under the mask of mixed CLC classes (242 and 243) has been calculated over the area of the Czech Republic by means of LPIS (Table 1). It is clear that there is low share of arable land and grasslands registered in LPIS. This statistical result is documented in Figure 1. There is a possible explanation; the non-productive agriculture areas are not included in LPIS. It can be assumed that these areas are covered by extensively used (not catted) grasslands, shrubs and trees under which we would find mostly herbaceous plant species including grasses.

Table 1: Share of LC classes under mixed CLC classes in the Czech Republic

Class	Share under 242+243 [%]
Arable land	6.9 %
Grassland	27.4 %
Permanent crops	0.7 %
Other LC	65.0 %

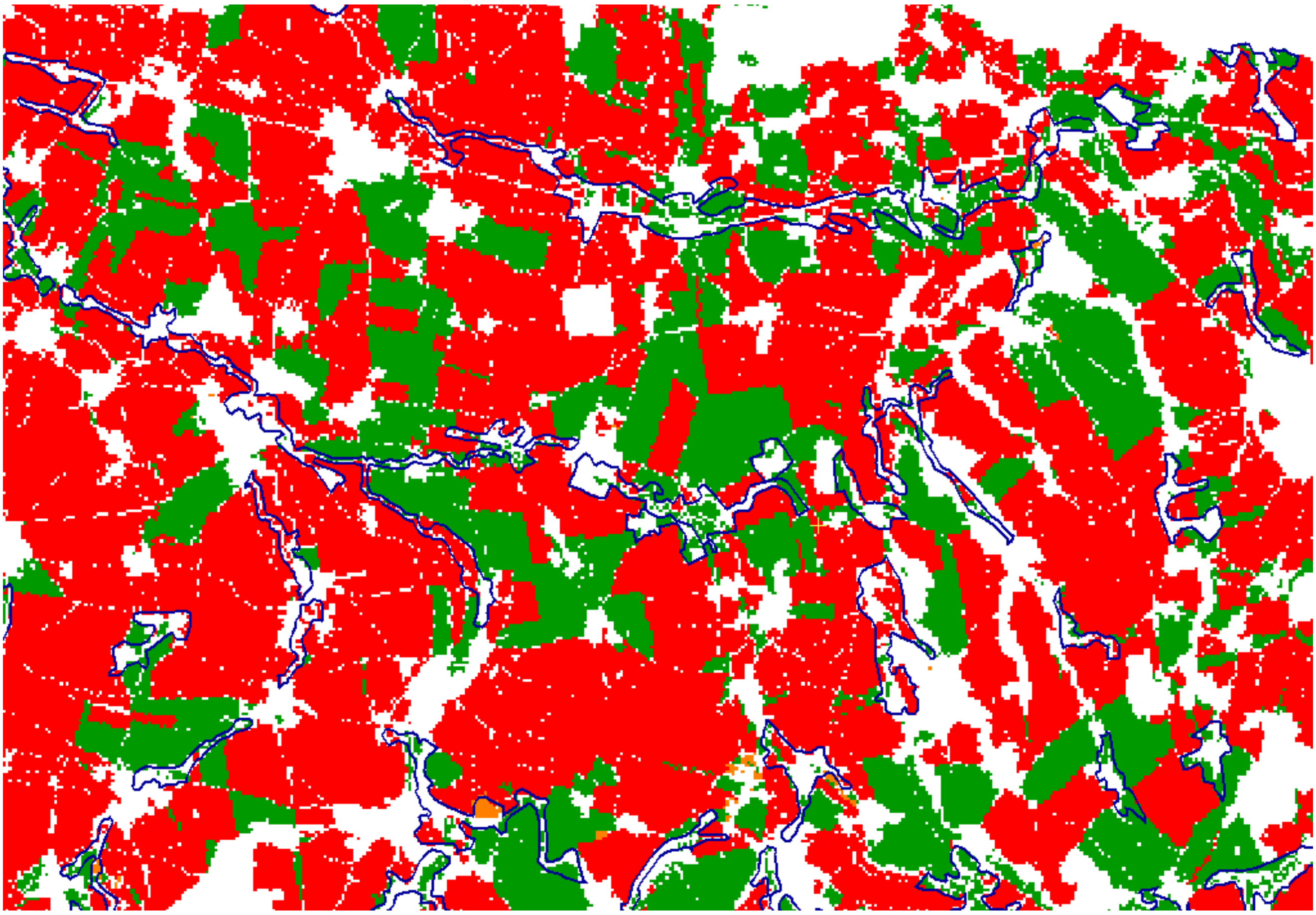


Figure 1: Map of mixed CLC classes (blue line) and LPIS in the Czech Republic (arable land – red, grassland – green)

2. Arable land classification accuracy on AWiFS time series

This presented test was performed within Geoland-2 under the Grassland subtask of Euroland. Only short summary is here provided.

Five multi-temporal AWiFS images with spatial resolution 60m (nominal 56 m) we used in time series analysis, while amplitude was used to separate arable land from other LC classes. Biophysical parameter fCover (ASTRIUM FR product) was used instead of NDVI index. The AWiFS temporal fCover composite of amplitude analysis (Figure 2a) was used as input to arable land classification over the transect Dresden – Prague – Linz. LPIS (Figure 2b) was used as reference for accuracy assessment. The overall accuracy achieved at spatial resolution 60 m was 93 % for arable land when using all five AWiFS images. This test followed a sensitivity analysis that can be found in Brodsky et al. (2012).

Additionally, we have tested the same approach with MERIS time series (Figure 2c). Initially we have identified high similarity to results of AWiFS in the time series. The accuracy of arable land classification lowered to XX %. The same procedure was tested on HANTS data but up to now not successfully, hence, another procedure – supervised classification - on HANTS components was evaluated.

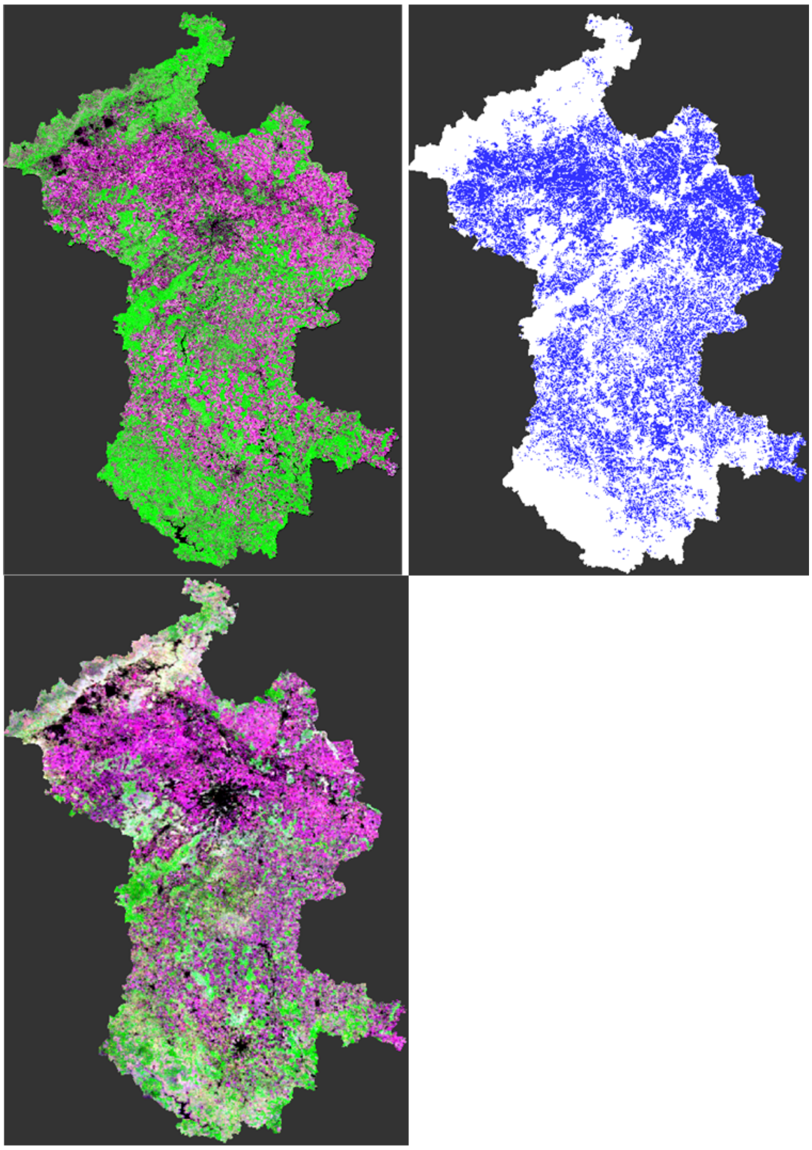
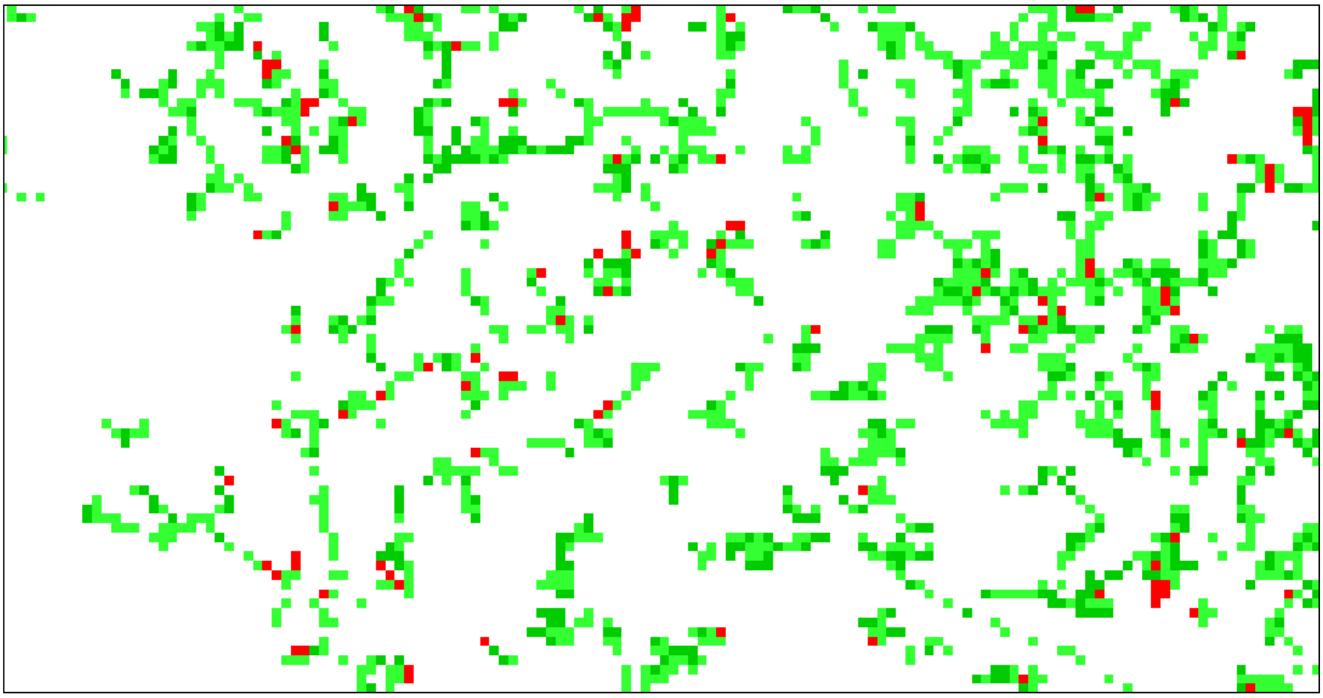


Figure 2: a/ AWiFS time series of fCover composite (arable land – violet), b/ LPIS reference map of arable land (arable land – blue), c/ MERIS time series of fCover composite (arable land – violet)

3. Test on supervised arable land and grassland classification under 242+243

Supervised classification of arable land and grassland under the mask of mixed CLC classes has been performed. Initially LPIS was used as reference for training. Later we used CLC instead, while LPIS was used in the accuracy assessment. HANTS components were used as signatures in Maximum Likelihood Classifier (MLC) to distinguish arable land and grassland. Given the situation that 65% of mixed CLC classes are other than arable land and other, while we can identify shrub and trees as elements of the class other, it is highly probable that these land cover elements would be classified as grass land cover. Preview to the classification is visualized in Figure 3.



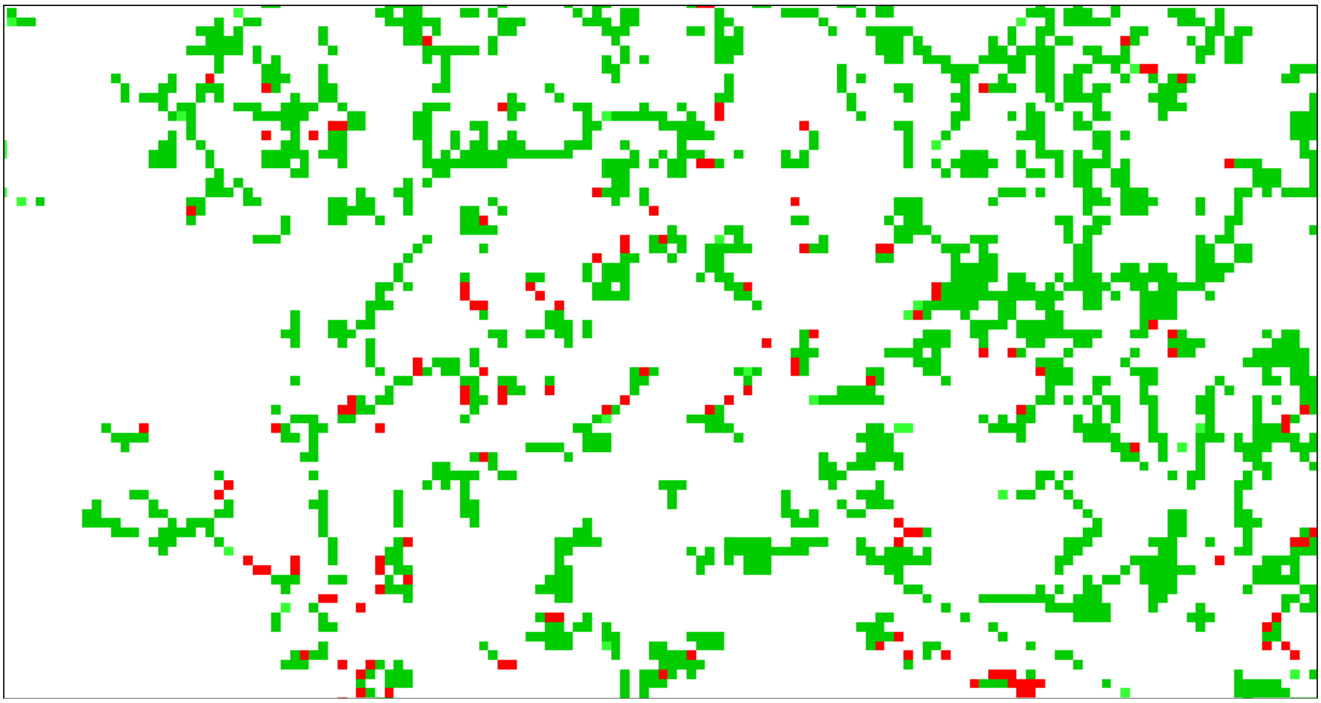


Figure 3: Preview to mixed CLC classes classification into arable land (red) and grassland (green), based on LPIS reference (top) and supervised classification (down)

4. Accuracy assessment

Accuracy assessment was performed on the MLC classification against the LPIS reference. This assessment could be only done under the spatial intersection of mixed CLC classes mask and LPIS agriculture region. Table 2 provides quantitative accuracy assessment of MLC classification of mixed CLC classes into arable land and grassland in the Czech Republic. It is clear that arable land classification is very low, below acceptable level. The arable land classification of mixed CLC classes on medium resolution (250 m) is more than difficult due to high proportion of mixing (Figure 4). This result partly confirms the initial test of transferring the highly accurate procedure form 60 m AWiFS into 300m resolution of MERIS.

On the other hand, the grassland classification with accuracy 77 % is acceptable result. This result can be probably expected as the mixed CLC classes are typically covered by surfaces with grass-similar spectral signatures.

Table 2: Accuracy assessment of MLC classification of mixed CLC classes into arable land and grassland in the Czech Republic

Class	Accuracy
Arable land	46.9 %
Grassland	77.0 %

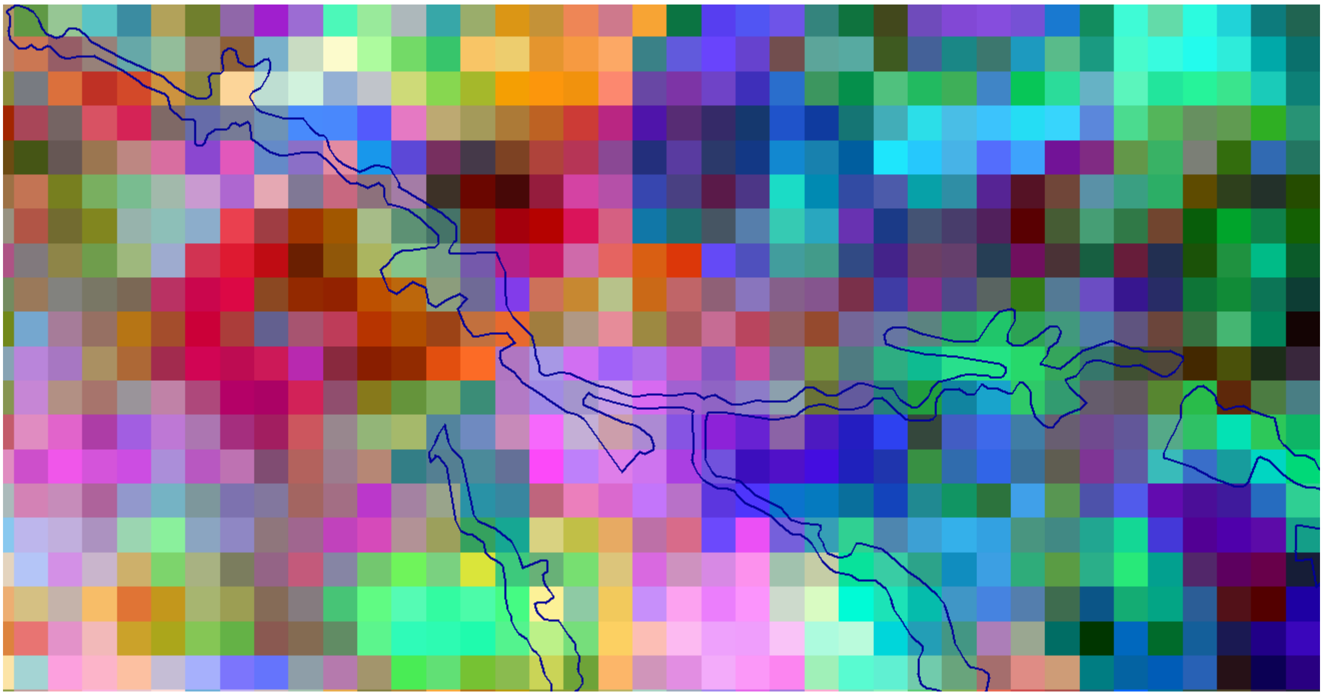


Figure 4: Preview to mixed CLC classes (blue line) over HANTS RGB (NDVI low – NDVI mean – NDVI peak)

7.4 EUROPEAN SCALE MAPPING

The procedure tested on the AOI of the Czech Republic has been transferred to the continental level of Europe where CLC 2006 and HANTS were available.

7.4.1 Materials and Method

Input data:

- CORINE Land Cover 2006 (mask of mixed classes 242, 243; arable land and grassland classes for classification procedure training)
- HANTS dataset 2006 (phenology components and NDVI low, mean and peak)
- EEA Bio-geographical regions for stratification (Figure 5)
- NUTS2 regions for finer stratification

Algorithm:

- Maximum Likelihood Classifier approach
- Constrained to different bio-geographical regions (Alpine region in Scandinavia has been separated from Alps)

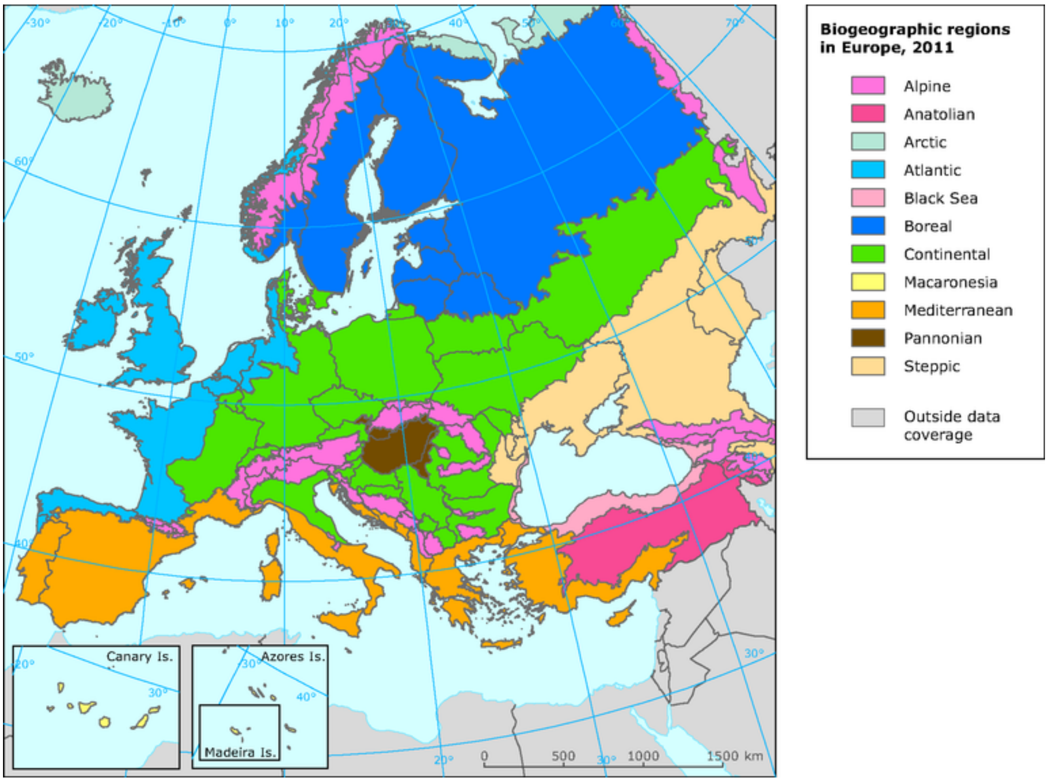


Figure 5: Bio-geographical regions of Europe used for stratification in the classification procedure

7.4.2 Results:

The results proved mostly the expected result. The spatial structure seems to be highly scattered. It is needed to say that have to have such structure. This proved the test with very high resolution LPIS (0.5 m product), Figure 3a. The accuracy of grassland class seems to be better than the arable land.

The classification result is provided in binary form (arable land / grassland), while the classification express how similar is the 250 m mixed pixel to arable land or grassland based on spectro-temporal HANTS signature of these two classes. In the procedure we attempt to classify 250 m pixel objects with large spetro-temporal mixing that are actually heterogeneous already in original 30 (20) m pixels of Landsat / SPOT / IRS during the visual interpretation.

7.4.3 Critical remark:

- Spatial resolution 250 m is a major limitation in the classification of the mixed classes

7.4.4 Conclusions:

- The results proved the expectations – limit of spatial resolution 250m;
- It provides demonstration of a method that can be applied to let the mixed classes reclassify into general LC elements as arable land and grassland, however, with high limit of accuracy due to spatial resolution. With this procedure we attempt to classify 250 m pixel objects that are actually heterogeneous in original 30 (20) m pixels during the visual interpretation!
- High accuracy of grassland classification (higher than expected) marks potential of the HANTS data set. However, it should be noted that there is high proportion of grass surfaces in the area of CLC classes 242 and 243, which improves the classification result;

- Certainly good results can be achieved with coming Sentinel-2 or even now with freely available and easily accessible Landsat-8; more investigation on Landsat 8 should be done;
- Other option, more straightforward, would be the use of GIO HR-layers for the task instead but then arable land layer would be missing.

7.5 INTEGRATING OTHER LAND COVER DATA

The previously described datasets added additional thematic value for the discrimination of CORIEN Land cover classes. Within this section those datasets are described that provide an geometric added value as they improve the rather score CORIEN Land Cover mapping unit of 25 ha.

7.5.1 Forest layer

As the current GMES/Copernicus layer on forest types is still under production. The JRC forest layer from 2006 is a good alternative for this kind of integrated data. The JRC forest layer is produced with the original resolution of 25m pixels in the two categories:

- Coniferous forest
- Broadleaved forest

The original resolution is generalized to 100*100m with the following differentiation:

- Coniferous forest (coniferous percentage > 75%)
- Mixed forest (25% < coniferous percentage < 75%)
- Deciduous forest (coniferous percentage < 25%)

Forest type	Percentage coniferous	EUNIS Level 2 category
Coniferous	> 75%	G3 Coniferous woodland
Mixed	< 75% AND > 25%	G4 mixed deciduous and coniferous woodland
Deciduous	< 25 %	G1 broadleaved deciduous woodland

For the analysis only those forest pixels are analysed that are outside of the CORINE Land cover classes 311, 312 and 313.

From this dataset it is not possible to map the class G2 broadleaved evergreen woodland.

REMARK:

The class “water” is as well mapped in the JRC forest layer. But due to quality limitations at the current stage we have decided not to integrate this class in the final ecosystem mapping. One obvious error is the misclassification of water in urban areas. For example almost the whole city of Vienna is covered by “water” pixels. A more careful analysis of the quality would maybe leed to certain rules, in which areas the quality is sufficient to be integrated in the final ecosystem map and in which areas not.

7.6 OSM DATA

Open Street Map data provide more and more a reliable data source. What has started several years ago as spatially very localized project on digitizing roads has grown over the years to a world wide database of geographic features.

Due to the heterogeneity of the data only the following OSM data are extracted

- Main Roads (highways)
- Land use features with sealing percentage > 25%

7.6.1 OSM road integration

The major roads from Open Street Map are integrated as EUNIS class

- J4 Transport networks and other constructed hard-surfaced areas

7.6.2 OSM land use integration

The land use data in OSM represent polygon features with varying quality. Therefore the HRL imperviousness was used as an additional dataset to increase the reliability of this data.

Only pixels with a sealing degree > 25 % were used.

TYPE	ID_OSM	GRID_Code	EUNIS_L2	EUNIS_L2
village_green	10	53	I2	Cultivated areas of gardens and parks
park	10	53	I2	Cultivated areas of gardens and parks
cemetery	10	53	I2	Buildings of cities, towns and villages
retail	21	54	J1	Buildings of cities, towns and villages
residential	21	54	J1	Buildings of cities, towns and villages
industrial;retai	21	54	J1	Buildings of cities, towns and villages
industrial	21	54	J1	Buildings of cities, towns and villages
commercial	21	54	J1	Buildings of cities, towns and villages
allotments	22	55	J2	Low density buildings
industrial	23	56	J3	Extractive industrial sites

railway	24	57	J4	Transport networks and other constructed hard-surfaced areas
reservoir	25	58	J5	Highly artificial man-made waters and associated structures

8 Definition of Accuracy/Reliability

For a complex mapping approach as implemented with this ecosystem mapping it is necessary to document the reliability of the results. The resulting map is a mixture of various input data and depending on the input data the reliability/accuracy of the maps can be improved either geometrically or thematically.

These two parameters are considered as reliability measures. Each input data set is evaluated according to the information content. Some datasets provide an enhancement in geometrical terms and some in thematical terms.

The improvement potential and thus the reliability of each of the two parameters is estimated by expert-judgment for each input data source in a range of [1-10]. A very high reliability is coded with 10 points, whereas no improvement or not reliability is coded with 1 point.

8.1 Geometrical reliability

Although the mapping is conducted on a 100*100m pixel scale, the original minimum mapping unit (MMU) of CORINE Land Cover with 25 ha (=25 pixels) has to be considered. This means that every dataset that delivers information beyond this MMU improves the result geometrically.

The grade of the geometric reliability depends on the original resolution of the input data. Therefore it is necessary to know the MMU, scale, resolution and production logic of the input data. The high resolution layers e.g. provide a large reliability and thus improvement potential on a 100*100m grid, as they are produced in the original resolution of 20*20m. Whereas the soil maps do not provide an adequate improvement of reliability, as their original scale is 1:1 Mil. The lowest geometric reliability is attached to the Art. 17 distribution data, as they are only given in a 10*10 km2 raster (in addition we know that some countries e.g. France and Finland report even on larger entities).

Table: Some examples of geometric improvement are given in the table below:

reliability	**Geometric reliability**	example 1	example 2
1	Very low	Art. 17 data (10*10 km)	
2		potNatVeg (1:1 Mil.)	ESDB-geology (1*1 km)

3		soil wettness (1*1 km)	JRC riparian (1*1 km)
4			WFD info as point
5	intermediate	CLC 25 ha MMU as reference (500*500m)	
6		HANTS (250*250m)	WFD info as line
7		alpine zone (DHM 30m+potNatVeg)	
8		OSM land use, HRL-layers (25m - Forest)	WFD info as polygon
9		HRL-layers (20m)	
10	Very high	OSM-roads (line accuracy)	

8.2 THEMATIC RELIABILITY

The thematic reliability describes to which grade the mapping results can be improved in thematic sense. This means it improves the differentiation between closely related classes.

The Article 17 distribution data are one good example. If they broadly cover all subtypes (on EUNIS level 3) of a specific ecosystem class, than they provide a very large reliability for the results, although their spatial resolution is quite coarse.

Table: Some examples of thematic improvement are given in the table below:

reliability	**Thematic reliability**	example 1	example 2	example 3
1	very low	unclear CLC relation		1:6 or 1:7 relation with CLC
2		geology from ESBD		1:4 or 1:5 relation with CLC
3		soil wetness indicator	HRL sealing	1:3 relation with CLC
4		Art. 17 with minor coverage of all subtypes		1:2 relation with CLC
5	intermediate		JRC riparian	1:1 relation with CLC
6		Art. 17 with good coverage of all subtypes		
7		OSM land use	potNatVeg	HANTS-dry grasslands

8		Art. 17 with complete coverage of all subtypes	alpine zone (better resolution - 20m, results only valid outside MED-area)	HANTS - evergreen broadleaved
9			WFD info on naturalness	
10	very high	OSM-roads		

8.3 COMBINED RELIABILITY

In case where more than one dataset are used within a rule, the maximum of the reliability/accuracy is taken as reference values, as the technical rules are always combined with AND. This means that the higher reliability of one datasets overrules the lower reliability of another dataset.

An exemption of the rule is the usage of Article 17 data, as this dat is regarded to be of high quality. Therefore the thematic quality of another dataset can not overrule the thematic quality of Article 17 data.

Example: 231 pastures are mapped to E7 sparsely wooded land under the following conditions:

- Forest cover percentage > 10% AND
- Potential natural vegetation = 9 (forest steppes) OR 10 (sclerophyllus forest)

Accuracy	Forest cover	Potential natural vegetation	Aggregated reliability (MAX)
Geometric	8	2	8
Thematic	6	7	7

For this specific combined rule the geometric reliability is 8 and the thematic reliability is 7, which is a substantial improvement to the pure usage of CORINE Land cover alone (geometric reliability 5 and thematic reliability in maximum 5).

VERSION 1 - Note: Due to time constraints the geometric and thematic reliability could not be processed with fully correct values in the ecosystem map V.1. It will be fully amended in Version 2.

9 TECHNICAL IMPLEMENTATION

This chapter describes the technical implementation of the rules using EXCEL and ArcGIS Software.

9.1 MAIN INPUT: CROSSWALK CLC-EUNIS

As starting point for the rules the crosswalk between CORINE Land Cover and the EUNIS classes developed by the ETC-BD is used. This crosswalk illustrates that the relation between CLC-classes and EUNIS classes is a m:n relation.

Over all groups the 1:n, m:1 and m:n relations are distributed as given in the following table:

Table: overview on types of relation in the cross-walk between CLC and EUNIS (e.g. a 1:3 relation between CLC and EUNIS means, that in 3 different EUNIS classes are linked to one CORINE class. And this 1:3 relationship is documented for 4 different CLC classes)

CLC: EUNIS	Count
1:1	22
1:2	9
1:3	4
1:4	2
1:5	-
1:6	6
1:7	1
Sum of classes	44

EUNIS : CLC	Count
1:1	30
1:2	13
1:3	8
1:4	3
1:5	1
1:6	1
1:7	-
Sum of classes	56

The complete crosswalk between CLC and EUNIS is given in the Annex.

9.2 EUNIS HABITAT COMPLEXES (X)

A specific problem in the crosswalk are the habitat complexes (for a full list see Annex). They are still formulated as draft proposal in EUNIS, but they correspond to a range of CORINE classes. They have not been subjected to rigorous scrutiny to ensure consistency. Some of these complexes seme very promising to be mapped to CORINE Land cover classes e.g.:

X0	X06	Crops shaded by trees	Crops, meadows or pastures developed under orchards or other cultivated tree plantations. The component habitat types may include elements of I1, E2.6 and FB.

X06 “crops shaded by trees” can preferably be linked to the CLC-class:

- 241 Annual crops associated with permanent crops

9.3 Refinement of M:N relations

All relations originating from the crosswalk between CORINE Land Cover an dEUNIS Level 2 were imported in EXCEL. The ambiguous relations were resolved using ancillary data as described in the previous chapters.

Each relations is captured in one EXCEL-line of one common spreadsheet. From these lines the relevant Python-Scripts were extracted and serve as interface to the ArcGIS implementation.

The Python-Scripts are available as ArcGIS module.

Beside the class-label according to the ecosystem class the following attributes are recorded for each pixel (except the marine ecosystems):

- Geometric reliability
- Thematic reliability
- Rule number

The geometric and thematic realiability are accuracy measures as explained in the previous chapter. The rule number improves the tracebility of the GIS procedure an relates each pixel with the corresponding rule in the EXCEL-file.

10 Results

Note: for Version 1 the marine and terrestrial ecosystem types are delivered as separate files.

10.1 Version history

Table: Version numbers of ecosystem map

Version	Description	Date	Comments
V 1.1	First draft map	6. Oct. 2013	Errors due to overlap of classes, aggregated CODE values not correct
V 1.3	First quality checked results	25. October 2013	First wall-to-wall map, main errors removed; Consultation meeting with Lubos Halada
V 1.4	Inclusion of Greece	3. December 2013	Greece included with CLC 2000, refinement of thematic rules,

10.2 Map of ecosystem types

Dominating EUNIS Level 2 type within 100*100m Grid.

10.3 Statistic

Area coverage in [km2] for EUNIS Level 2 classes within EEA 39 countries. For detailed country statistics see Annex.

ID	Level 1 types	Code	EUNIS_name	EEA-39 [km2]	percent_total
			total EEA 39	**5.834.871**	**100,0%**
			no class	6.981	0,1%
1	A **Marine** habitats	A1	Littoral rock and other hard substrata	1.018	0,0%
2		A2	Littoral sediment		0,0%
3		A3	Infralittoral rock and other hard substrata		0,0%
4		A4	Circalittoral rock and other hard substrata		0,0%
5		A5	Sublittoral sediment		0,0%
6		A6	Deep-sea bed		0,0%
7		A7	Pelagic water column		0,0%
8		A8	Ice-associated marine habitats		0,0%
9		X1	Estuaries	1.108	0,0%
10		X2_3	Coastal lagoons	3.193	0,1%
11	B **Coastal** habitats	B1	Coastal dunes and sandy shores	5.912	0,1%
12		B2	Coastal shingle	3	0,0%
13		B3	Rock cliffs, ledges and shores, including the supralittoral	863	0,0%
14	C Inland surface **waters**	C1	Surface standing waters	123.055	2,1%
15		C2	Surface running waters	12.686	0,2%
16		C3	Littoral zone of inland surface waterbodies	157	0,0%
17	D **Mires**, bogs and fens	D1	Raised and blanket bogs	37.992	0,7%
18		D2	Valley mires, poor fens and transition mires	1.675	0,0%
19		D3	Aapa, palsa and polygon mires	61.198	1,0%
20		D4	Base-rich fens and calcareous spring		0,0%

			mires	561	
21		D5	Sedge and reedbeds, normally without free-standing water	6.064	0,1%
22		D6	Inland saline and brackish marshes and reedbeds	65	0,0%
23	E **Grasslands** and land dominated by forbs, mosses or lichens	E1	Dry grasslands	284.433	4,9%
24		E2	Mesic grasslands	751.626	12,9%
25		E3	Seasonally wet and wet grasslands	66.571	1,1%
26		E4	Alpine and subalpine grasslands	55.095	0,9%
27		E5	Woodland fringes and clearings and tall forb stands		0,0%
28		E6	Inland salt steppes	2.919	0,1%
29		E7	Sparsely wooded grasslands	32.010	0,5%
30	**F Heathland**, scrub and tundra	F1	Tundra	9.866	0,2%
31		F2	Arctic, alpine and subalpine scrub	113.410	1,9%
32		F3	Temperate and mediterranean-montane scrub	123.564	2,1%
33		F4	Temperate shrub heathland	682	0,0%
34		F5	Maquis, arborescent matorral and thermo-Mediterranean brushes	66.808	1,1%
35		F6	Garrigue	7.368	0,1%
36		F7	Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)	17.365	0,3%
37		F8	Thermo-Atlantic xerophytic scrub	7.957	0,1%
38		F9	Riverine and fen scrubs	140	0,0%
39		FA	Hedgerows		0,0%
40		FB	Shrub plantations	68.252	1,2%
41	G Woodland, **forest** and other wooded land	G1	Broadleaved deciduous woodland	667.206	11,4%
42		G2	Broadleaved evergreen woodland	53.243	0,9%
43		G3	Coniferous woodland	835.807	14,3%
44		G4	Mixed deciduous and coniferous woodland	344.095	5,9%
45		G5	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	27.974	0,5%
46	H Inland **unvegetated** or sparsely vegetated	H1	Terrestrial underground caves, cave systems, passages and waterbodies		0,0%
47		H2	Screes	7.420	0,1%

48	habitats	H3	Inland cliffs, rock pavements and outcrops	106.697	1,8%
49		H4	Snow or ice-dominated habitats	15.605	0,3%
50		H5	Miscellaneous inland habitats with very sparse or no vegetation	119.594	2,0%
51		H6	Recent volcanic features		0,0%
52	I Regularly or recently cultivated **agricultural**, horticultural and domestic habitats	I1	Arable land and market gardens	1.528.049	26,2%
53		I2	Cultivated areas of gardens and parks	11.369	0,2%
54	J Constructed, industrial and other **artificial** habitats	J1	Buildings of cities, towns and villages	112.705	1,9%
55		J2	Low density buildings	107.925	1,8%
56		J3	Extractive industrial sites	7.554	0,1%
57		J4	Transport networks and other constructed hard-surfaced areas	17.337	0,3%
58		J5	Highly artificial man-made waters and associated structures	626	0,0%
59		J6	Waste deposits	1.069	0,0%

EUNIS L2	ID	Level 1 types	Code	EUNIS_name	EEA-39 [km2]	rcent_tot
				total EEA 39	**5.834.871**	**100,0%**
				no class	6.981	0,1%
A1	1	A **Marine** habitats	A1	Littoral rock and other hard substrata	1.018	0,0%
A2	2		A2	Littoral sediment		0,0%
A3	3		A3	Infralittoral rock and other hard substrata		0,0%
A4	4		A4	Circalittoral rock and other hard substrata		0,0%
A5	5		A5	Sublittoral sediment		0,0%
A6	6		A6	Deep-sea bed		0,0%
A7	7		A7	Pelagic water column		0,0%
A8	8		A8	Ice-associated marine habitats		0,0%
X1	9		X1	Estuaries	1.108	0,0%
X2_3	10		X2_3	Coastal lagoons	3.193	0,1%
B1	11	B **Coastal** habitats	B1	Coastal dunes and sandy shores	5.912	0,1%
B2	12		B2	Coastal shingle	3	0,0%
B3	13		B3	Rock cliffs, ledges and shores, including the supralittoral	863	0,0%
C1	14	C Inland surface **waters**	C1	Surface standing waters	123.055	2,1%
C2	15		C2	Surface running waters	12.686	0,2%
C3	16		C3	Littoral zone of inland surface waterbodies	157	0,0%
D1	17	D **Mires**, bogs and fens	D1	Raised and blanket bogs	37.992	0,7%
D2	18		D2	Valley mires, poor fens and transition mires	1.675	0,0%
D3	19		D3	Aapa, palsa and polygon mires	61.198	1,0%
D4	20		D4	Base-rich fens and calcareous spring mires	561	0,0%
D5	21		D5	Sedge and reedbeds, normally without free-standing water	6.064	0,1%
D6	22		D6	Inland saline and brackish marshes and reedbeds	65	0,0%
E1	23	E **Grasslands** and land dominated by forbs, mosses or lichens	E1	Dry grasslands	284.433	4,9%
E2	24		E2	Mesic grasslands	751.626	12,9%
E3	25		E3	Seasonally wet and wet grasslands	66.571	1,1%
E4	26		E4	Alpine and subalpine grasslands	55.095	0,9%
E5	27		E5	Woodland fringes and clearings and tall forb stands		0,0%
E6	28		E6	Inland salt steppes	2.919	0,1%
E7	29		E7	Sparsely wooded grasslands	32.010	0,5%
F1	30	**F Heathland**, scrub and tundra	F1	Tundra	9.866	0,2%
F2	31		F2	Arctic, alpine and subalpine scrub	113.410	1,9%
F3	32		F3	Temperate and mediterranean-montane scrub	123.564	2,1%
F4	33		F4	Temperate shrub heathland	682	0,0%
F5	34		F5	Maquis, arborescent matorral and thermo-Mediterranean brushes	66.808	1,1%
F6	35		F6	Garrigue	7.368	0,1%
F7	36		F7	Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)	17.365	0,3%
F8	37		F8	Thermo-Atlantic xerophytic scrub	7.957	0,1%
F9	38		F9	Riverine and fen scrubs	140	0,0%
FA	39		FA	Hedgerows		0,0%
FB	40		FB	Shrub plantations	68.252	1,2%
G1	41	G Woodland, **forest** and other wooded land	G1	Broadleaved deciduous woodland	667.206	11,4%
G2	42		G2	Broadleaved evergreen woodland	53.243	0,9%
G3	43		G3	Coniferous woodland	835.807	14,3%
G4	44		G4	Mixed deciduous and coniferous woodland	344.095	5,9%
G5	45		G5	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	27.974	0,5%
H1	46	H Inland **unvegetated** or sparsely vegetated habitats	H1	Terrestrial underground caves, cave systems, passages and waterbodies		0,0%
H2	47		H2	Screes	7.420	0,1%
H3	48		H3	Inland cliffs, rock pavements and outcrops	106.697	1,8%
H4	49		H4	Snow or ice-dominated habitats	15.605	0,3%
H5	50		H5	Miscellaneous inland habitats with very	119.594	2,0%

10.4 DELIVERY FILES

EiONET Forum:

http://forum.eionet.europa.eu/etc-sia-consortium/library/2013_subvention/222_5_1_ecosystem_mapping/data/data_ecosystem_types_100_100m_v_1_4

10.4.1 EXCEL files

The rule set is delivered as MS EXCEL file with the spreadsheets defined in the table below.

File: ES_mapping_rules_v1_4_export.xlsx

Table: Definition of spreadsheets for rule sets stored in EXCEL.

spreadsheet	description
EUNIS_to_CLC_2	Original crosswalk CLC--> EUNIS; © ETC-BD, extraction of EUNIS Level 2 classes
Rules_CLC_rows_v1_4	rules to refine the m:n relation between CLC and EUNIS, including rule ID; Version of rule set is attached to spread sheet name
Grids	additional data grids necessary for rule implementation
potNatVeg_Codes	Aggregation of potential natural vegetation zones that are useful for rule definition and implementation
Annex_I	relation between EUNIS and Annex I habitats (habitat directive), used as Input for Art. 17 data selection
Reliability	Accuracy/reliability definitions for input data (geometric and thematic reliability)
Reliability_HRL	high resolution databases - definition of reliability and rule ID
LUT_CLC	look up table for CORINE Land Cover
LUT_EUNIS_Codes	look up table for EUNIS Level 2 classes

10.4.2 GRID-files

The output contains four different grid files.

- One grid files holds the ecosystem type values, and the
- two grid files contain information on the quality (geometric and thematic) and
- one grid file contains information on the appropriate rule that lead to the final ecosystem type.

The exact definition is given in the table below.

Table: Acronyms used in GIS file naming conventions

Acronym	Name	Description
…c	**Class**	**Ecosystem types (classes) with GRID-code value according to typology**
…g	Geometry	Geometrical reliability between 1 (lowest) and 10 (highest)
…t	Thematic	Thematic reliability between 1 (lowest) and 10 (highest)
…r	rule	Identification of rule and datasets used for ecosystem class creation

<u>Naming of GRID-files:</u>

- **es_all_c_v1_4**
  - es ecosystem types
  - all combined dataset based on CLC-approach AND other land cover data (OSM, HRL)
  - c type of grid according to table above (c..class)
  - v1_4 Version of dataset (e.g. 1.4)

10.4.3 Python Scripts

The python scripts necessary for conducting the calculation are copied to the EiONET Forum.

11 RECOMMENDATIONS

11.1 GENERAL APPROACH

The mapping of ecosystem types on European scale is feasible within the limitation of scale (top down approach). The approach presented is based on an integrated analysis of European data infrastructure. It combines land cover data with additional spatially explicit environmental qualifiers (or stratifiers). This enables to bridge the gap from land cover to habitat classes. The shortcomings of the CORINE Land cover data due to the minimum mapping unit of 25 ha can be improved using the high resolution layers (MMU 1 ha). Although the HRLs (imperviousness and forest) improve the geometric dimension, they have to be accompanied with information to map also the relevant level of thematic detail – which is currently still a limiting factor.

The mapping on European scale can be enhanced in spatial and thematic detail using a bottom-up approach with nationally available data (vegetation mapping).

The mapping of ecosystem types have to be accompanied by information on the ecosystem status. Spatially explicite information on ecosystem status is however quite limited. It has to be tested, in which way the future information on phonological development of ecosystem type using multi-temporal SENTINEL-2 data might contribute to this issue.

11.2 Technical issues (work programme 2014)

- Refinement of decision rules
    - Discussion with ETC-BD
- Main information deficite: differentiation between arable land and grassland
    - Usage of LPIS data would improve the situation substantially
    - Analyse to which extent the HRL grassland can improve the mapping
    - Usage of SENTINEL-2 will definitely improve the situation
        - Phenoplogical indicators have proved to be very useful
- Integration of already existing, but not yet available spatial datasets
    - Refinement of riparian areas (100*100m instead of 1*1 km)
    - Usage of WFD attribute “naturalness”
- Improving the spatial resolution and thematic quality of reporting data
    - New Art. 17 report under Natura 2000 due in Dec. 2013
- Integration of national/regional habitat mapping data
    - Vegetation mapping, Turboveg
    - E.g. Czech Habitat mapping programme
- Integration of inventories for nature conservation
    - Dry grasslands (e.g. eastern European grassland mapping)
    - Wet grasslands
    - Wetlands/bogs/mires
- Comparing the results of bottom-up and top-down approach in various countries (e.g. Austria, Slovak Republic)

12 Planning

What	***Who***	***When***
Inception report	EAA	5. April 2013
Differentiation of agricultural areas into arable land and	ALTERRA &	May

grassland using HANTS data/methods	GISAT	2013
Work on mapping of marine ecosystems	UAB/UMA	June 2013
First draft map of Europes ecosystem and brief explanatory description of ecosystem quality parameters	EAA	15. May 2013
Map of Europe’s ecosystems (dataset) and brief explanatory description of exemplary quality parameters (draft assessment)	EAA	30. Sept. 2013

13 Appendix

13.1 Typology of ecosystems (EUNIS Level 2) and GRID Code

Level 1 types	EUNIS_L2_ID	ID_Grid_L2	EUNIS_name
A **Marine** habitats	A1	1	Littoral rock and other hard substrata
	A2	2	Littoral sediment
	A3	3	Infralittoral rock and other hard substrata
	A4	4	Circalittoral rock and other hard substrata
	A5	5	Sublittoral sediment
	A6	6	Deep-sea bed
	A7	7	Pelagic water column
	A8	8	Ice-associated marine habitats
Transition zone	X1	9	Estuaries
	X2_3	10	Coastal lagoons
B **Coastal** habitats	B1	11	Coastal dunes and sandy shores
	B2	12	Coastal shingle
	B3	13	Rock cliffs, ledges and shores, including the supralittoral
C Inland surface **waters**	C1	14	Surface standing waters
	C2	15	Surface running waters
	C3	16	Littoral zone of inland surface waterbodies
D **Mires**, bogs and fens	D1	17	Raised and blanket bogs
	D2	18	Valley mires, poor fens and transition mires
	D3	19	Aapa, palsa and polygon mires
	D4	20	Base-rich fens and calcareous spring mires
	D5	21	Sedge and reedbeds, normally without free-standing water
	D6	22	Inland saline and brackish marshes and reedbeds
E **Grasslands** and land dominated by forbs, mosses or lichens	E1	23	Dry grasslands
	E2	24	Mesic grasslands
	E3	25	Seasonally wet and wet grasslands
	E4	26	Alpine and subalpine grasslands
	E5	27	Woodland fringes and clearings and tall forb stands

	E6	28	Inland salt steppes
	E7	29	Sparsely wooded grasslands
F Heathland, scrub and tundra	F1	30	Tundra
	F2	31	Arctic, alpine and subalpine scrub
	F3	32	Temperate and mediterranean-montane scrub
	F4	33	Temperate shrub heathland
	F5	34	Maquis, arborescent matorral and thermo-Mediterranean brushes
	F6	35	Garrigue
	F7	36	Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)
	F8	37	Thermo-Atlantic xerophytic scrub
	F9	38	Riverine and fen scrubs
	FA	39	Hedgerows
	FB	40	Shrub plantations
G Woodland, **forest** and other wooded land	G1	41	Broadleaved deciduous woodland
	G2	42	Broadleaved evergreen woodland
	G3	43	Coniferous woodland
	G4	44	Mixed deciduous and coniferous woodland
	G5	45	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice
H Inland **unvegetated** or sparsely vegetated habitats	H1	46	Terrestrial underground caves, cave systems, passages and waterbodies
	H2	47	Screes
	H3	48	Inland cliffs, rock pavements and outcrops
	H4	49	Snow or ice-dominated habitats
	H5	50	Miscellaneous inland habitats with very sparse or no vegetation
	H6	51	Recent volcanic features
I Regularly or recently cultivated **agricultural**, horticultural and	I1	52	Arable land and market gardens
	I2	53	Cultivated areas of gardens and parks

domestic habitats			
J Constructed, industrial and other **artificial** habitats	J1	54	Buildings of cities, towns and villages
	J2	55	Low density buildings
	J3	56	Extractive industrial sites
	J4	57	Transport networks and other constructed hard-surfaced areas
	J5	58	Highly artificial man-made waters and associated structures
	J6	59	Waste deposits

13.2 EUNIS LEVEL 2 CLASS DESCRIPTIONS

Group 2	EUNIS name	Description
A1	Littoral rock and other hard substrata	Littoral rock includes habitats of bedrock, boulders and cobbles which occur in the intertidal zone (the area of the shore between high and low tides) and the splash zone. The upper limit is marked by the top of the lichen zone and the lower limit by the top of the laminarian kelp zone. There are many physical variables affecting rocky shore communities - wave exposure, salinity, temperature and the diurnal emersion and immersion of the shore. Wave exposure is most commonly used to characterise littoral rock, from 'extremely exposed' on the open coast to 'extremely sheltered' in enclosed inlets. Exposed shores tend to support faunal-dominated communities of barnacles and mussels and some robust seaweeds. Sheltered shores are most notable for their dense cover of fucoid seaweeds, with distinctive zones occurring down the shore. In between these extremes of wave exposure, on moderately exposed shores, mosaics of seaweeds and barnacles are more typical.

A2	Littoral sediment	Littoral sediment includes habitats of shingle (mobile cobbles and pebbles), gravel, sand and mud or any combination of these which occur in the intertidal zone. Littoral sediment is defined further using descriptions of particle sizes - mainly gravel (16-4 mm), coarse sand (4-1 mm), medium sand (1-0.25 mm), fine sand (0.25-0.063 mm) and mud (less than 0.063 mm) and various admixtures of these (and coarser) grades - muddy sand, sandy mud and mixed sediment (cobbles, gravel, sand and mud together). Littoral sediments support communities tolerant to some degree of drainage at low tide and often subject to variation in air temperature and reduced salinity in estuarine situations. Very coarse sediments tend to support few macrofaunal species because these sediments tend to be mobile and subject to a high degree of drying when exposed at low tide. Finer sediments tend to be more stable and retain some water between high tides, and therefore support a greater diversity of species. Medium and fine sand shores usually support a range of oligochaetes, polychaetes, and burrowing crustaceans, and even more stable muddy sand shores also support a range of bivalves. Very fine and cohesive sediment (mud) tends to have a lower species diversity, because oxygen cannot penetrate far below the sediment surface. A black, anoxic layer of sediment develops under these circumstances, which may extend to the sediment surface and in which few species can survive. Some intertidal sediments are dominated by angiosperms, e.g. eelgrass ([Zostera noltii]) beds on the mid and upper shore of muddy sand flats, or saltmarshes which develop on the extreme upper shore of sheltered fine sediment flats. Situation: Littoral sediments are found across the entire intertidal zone, including the strandline. Sediment biotopes can extend further landwards (dune systems, marshes) and further seawards (sublittoral sediments). Sediment shores are generally found along relatively more sheltered stretches of coast compared to rocky shores. Muddy shores or muddy sand shores occur mainly in very sheltered inlets and along estuaries, where wave exposure is low enough to allow fine sediments to settle. Sandy shores and coarser sediment (gravel, pebbles, cobbles) shores are found in areas subject to higher wave exposures. Temporal variation: Littoral sediment environments can change markedly over seasonal cycles, with sediment being eroded during winter storms and accreted during calmer summer months. The particle size structure of the sediment may change from finer to coarser during winter months, as finer

		sediment gets resuspended in seasonal exposed conditions. This may affect the sediment infauna, with some species only present in summer when sediments are more stable. These changes are most likely to affect sandy shores on relatively open shores. Sheltered muddy shores are likely to be more stable throughout the year, but may have a seasonal cover of green seaweeds during the summer period, particularly in nutrient enriched areas or where there is freshwater input.
A3	Infralittoral rock and other hard substrata	Infralittoral rock includes habitats of bedrock, boulders and cobbles which occur in the shallow subtidal zone and typically support seaweed communities. The upper limit is marked by the top of the kelp zone whilst the lower limit is marked by the lower limit of kelp growth or the lower limit of dense seaweed growth. Infralittoral rock typically has an upper zone of dense kelp (forest) and a lower zone of sparse kelp (park), both with an understorey of erect seaweeds. In exposed conditions the kelp is [Laminaria hyperborea] whilst in more sheltered habitats it is usually [Laminaria saccharina]; other kelp species may dominate under certain conditions. On the extreme lower shore and in the very shallow subtidal (sublittoral fringe) there is usually a narrow band of dabberlocks [Alaria esculenta] (exposed coasts) or the kelps [Laminaria digitata] (moderately exposed) or [L. saccharina] (very sheltered). Areas of mixed ground, lacking stable rock, may lack kelps but support seaweed communities. In estuaries and other turbid-water areas the shallow subtidal may be dominated by animal communities, with only poorly developed seaweed communities.

A4	Circalittoral rock and other hard substrata	Circalittoral rock is characterised by animal dominated communities (a departure from the algae dominated communities in the infralittoral zone). The circalittoral zone can itself be split into two sub-zones; upper circalittoral (foliose red algae present but not dominant) and lower circalittoral (foliose red algae absent). The depth at which the circalittoral zone begins is directly dependent on the intensity of light reaching the seabed; in highly turbid conditions, the circalittoral zone may begin just below water level at mean low water springs (MLWS). The biotopes identified in the field can be broadly assigned to one of three energy level categories: high, moderate and low energy circalittoral rock (used to define the habitat complex level). The character of the fauna varies enormously and is affected mainly by wave action, tidal stream strength, salinity, turbidity, the degree of scouring and rock topography. It is typical for the community not to be dominated by single species, as is common in shore and infralittoral habitats, but rather comprise a mosaic of species. This, coupled with the range of influencing factors, makes circalittoral rock a difficult area to satisfactorily classify; particular care should therefore be taken in matching species and habitat data to the classification.
A5	Sublittoral sediment	Sediment habitats in the sublittoral near shore zone (i.e. covering the infralittoral and circalittoral zones), typically extending from the extreme lower shore down to the edge of the bathyal zone (200 m). Sediment ranges from boulders and cobbles, through pebbles and shingle, coarse sands, sands, fine sands, muds, and mixed sediments. Those communities found in or on sediment are described within this broad habitat type.
A6	Deep-sea bed	The sea bed beyond the continental shelf break. The shelf break occurs at variable depth, but is generally over 200 m. The upper limit of the deep-sea zone is marked by the edge of the shelf. Includes areas of the Mediterranean Sea which are deeper than 200 m but not of the Baltic Sea which is a shelf sea. Excludes caves in the deep sea which are classified in A4.71 irrespective of depth.
A7	Pelagic water column	The water column of shallow or deep sea, or enclosed coastal waters. Note that because of the strong temporal nature of the pelagic environment, the water column at a given location will be classified differently at different times of the year.
A8	Ice-associated marine habitats	Sea ice, icebergs and other ice-associated marine habitats.

B1	Coastal dunes and sandy shores	Sand-covered shorelines of the oceans, their connected seas and associated coastal lagoons, fashioned by the action of wind or waves. They include gently sloping beaches and beach-ridges, formed by sands brought by waves, longshore drift and storm waves, as well as dunes, formed by aeolian deposits, though sometimes re-fashioned by waves.
B2	Coastal shingle	Beaches of the oceans, of their connected seas and of their associated coastal lagoons, covered by pebbles, or sometimes boulders, usually formed by wave action.
B3	Rock cliffs, ledges and shores, including the supralittoral	Rock exposures adjacent to the oceans, their connected seas and associated coastal lagoons, or separated from them by a narrow shoreline. The faces, ledges and caves of sea-cliffs and the expanses of rocky shore are important as reproduction, resting and feeding sites for seabirds, sea-mammals and a few groups of terrestrial birds. Sea-cliffs may also harbour highly distinctive, specialised salt-tolerant vegetation with associated terrestrial fauna.
C1	Surface standing waters	Lakes, ponds and pools of natural origin containing fresh (i.e. nonsaline), brackish or salt water. Manmade freshwater bodies, including artificially created lakes, reservoirs and canals, provided that they contain seminatural aquatic communities.
C2	Surface running waters	Running waters, including springs, streams and temporary water courses.
C3	Littoral zone of inland surface waterbodies	Reedbeds and other water-fringing vegetation by lakes, rivers and streams; exposed bottoms of dried up rivers and lakes; rocks, gravel, sand and mud beside or in the bed of rivers and lakes.
D1	Raised and blanket bogs	Peatlands formed by ombrotrophic acid peat, which is (or was while actively growing) capable of growth fed by rainfall rather than by the inflow of water from higher ground in the vicinity.
D2	Valley mires, poor fens and transition mires	Weakly to strongly acid peatlands, flushes and vegetated rafts formed in situations where they receive water from the surrounding landscape or are intermediate between land and water. Included are quaking bogs and vegetated non-calcareous springs. Excluded are calcareous fens (D4), and reedbeds (C3, D5).
D3	Aapa, palsa and polygon mires	Patterned mire complexes of the arctic, subarctic and northern boreal zones.
D4	Base-rich fens and calcareous spring mires	Peatlands, flushes and vegetated springs with calcareous or eutrophic ground water, within river valleys, alluvial plains, or on hillsides. As in poor fens, the water level is at or near the surface of the substratum and peat formation depends on a permanently high watertable. Excluded are

		reedbeds (C3, D5).
D5	Sedge and reedbeds, normally without free-standing water	Sedge and reedbeds forming terrestrial mire habitats, not closely associated with open water. Excluded are reedbeds and sedges where they form emergent or fringing vegetation beside water bodies (C3.2).
D6	Inland saline and brackish marshes and reedbeds	Saline wetlands, with closed or open vegetation, which are the non-coastal analogue of coastal saltmarshes and saline reedbeds (A2.5). Drier saline habitats are classified as inland salt steppe (E6) or saline scrubland (F6.8).
E1	Dry grasslands	Well-drained or dry lands dominated by grass or herbs, mostly not fertilized and with low productivity. Included are [Artemisia] steppes. Excluded are dry mediterranean lands with shrubs of other genera where the shrub cover exceeds 10%; these are listed as garrigue (F6).
E2	Mesic grasslands	Lowland and montane mesotrophic and eutrophic pastures and hay meadows of the boreal, nemoral, warm-temperate humid and mediterranean zones. They are generally more fertile than dry grasslands (E1), and include sports fields and agriculturally improved and reseeded pastures.
E3	Seasonally wet and wet grasslands	Unimproved or lightly improved wet meadows and tall herb communities of the boreal, nemoral, warm-temperate humid, steppic and mediterranean zones.
E4	Alpine and subalpine grasslands	Primary and secondary grass- or sedge- dominated formations of the alpine and subalpine levels of boreal, nemoral, mediterranean, warm-temperate humid and Anatolian mountains.
E5	Woodland fringes and clearings and tall forb stands	Stands of tall herbs or ferns, occuring on disused urban or agricultural land, by watercourses, at the edge of woods, or invading pastures. Stands of shorter herbs forming a distinct zone (seam) at the edge of woods.
E6	Inland salt steppes	Saline land with dominant salt-tolerant grasses and herbs. Excludes saline scrubland, listed under F6.8 xero-halophile scrubs.
E7	Sparsely wooded grasslands	Grasslands with a wooded overstorey that normally has less than 10% cover.
F1	Tundra	Vegetated land with graminoids, shrubs, mosses or macrolichens overlying permafrost. European tundras are limited to Spitzbergen and northern Russia. Vegetation with the same species also occurs on boreal mountains and in the low arctic remote from the main permafrost region, notably in Fennoscandia and Iceland; these oroboreal and low arctic habitats are listed

		under alpine and subalpine grassland E4 or arctic, alpine and subalpine scrub F2.
F2	Arctic, alpine and subalpine scrub	Scrub occurring north of or above the climatic tree limit, but outside the permafrost zone. Scrub occurring close to but below the climatic tree limit, where trees are suppressed either by late-lying snow or by wind or repeated browsing.
F3	Temperate and mediterranean-montane scrub	Shrub communities of nemoral affinities. They include deciduous and evergreen scrubs or brushes of the nemoral zone, and deciduous scrubs of the submediterranean and supramediterranean zones. Excluded are heathlands with dominant [Ericaceae] F4, and the typically mediterranean maquis F5, garrigue F6 and phrygana F7.
F4	Temperate shrub heathland	Shrub communities of nemoral affinities, in which [Ericaceae] are dominant or at least prominent. Such heaths are best developed on acid soils in the Atlantic zone and also in sub-Atlantic Europe.
F5	Maquis, arborescent matorral and thermo-Mediterranean brushes	Evergreen sclerophyllous or lauriphyllous shrub vegetation, with a closed or nearly closed canopy structure, having nearly 100% cover of shrubs, with few annuals and some vernal geophytes; trees are nearly always present, some of which may be in shrub form. Shrubs, sometimes tall, of [Arbutus], [Cistus], [Cytisus], [Erica], [Genista], [Lavandula], [Myrtus], [Phillyrea], [Pistacia], [Quercus] and [Spartium] are typical. Included is pseudomaquis, in which the dominants are mixed deciduous and evergreen shrubs.
F6	Garrigue	Evergreen sclerophyllous or lauriphyllous shrub vegetation, with an open canopy structure and some bare ground, usually with many winter annuals and vernal geophytes. Low shrubs of [Cistus], [Lavandula], [Rosmarinus] and [Stoechas] are usually present, and there may be some larger shrubs and scattered trees. Garrigue is found mostly in the Mediterranean, Macaronesian and Pontic regions, where it typically derives from degradation or regrowth of broad-leaved evergreen forests (G2), but it extends into deciduous forest areas in the supra-Mediterranean zone and sub-Mediterranean zones and into steppe areas in Anatolia. Includes scrubby land with mainly herbaceous vegetation and a large component of unpalatable non-vernal monocots ([Asphodelus], [Urginea]) and thistles, provided that shrub cover exceeds 10%.

F7	Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)	Shrublands with dominant low spiny shrubs, widespread in Mediterranean and Anatolian regions with a summer-dry climate, occurring from sea level to high altitudes on dry mountains.
F8	Thermo-Atlantic xerophytic scrub	Xerophytic scrub formations of the lower slopes of the Canary Islands and Madeira, rich in succulents, in particular cactiform or dendroid spurges [Euphorbia] spp., rosette-forming [Aeonium] spp. and composites.
F9	Riverine and fen scrubs	Riversides, lakesides, fens and marshy floodplains dominated by woody vegetation less than 5 m high.
FA	Hedgerows	Woody vegetation forming strips within a matrix of grassy or cultivated land or along roads, typically used for controlling livestock, marking boundaries or providing shelter. Hedgerows differ from lines of trees (G5.1) in being composed of shrub species, or if composed of tree species then being regularly cut to a height less than 5 m.
FB	Shrub plantations	Plantations of dwarf trees, shrubs, espaliers or perennial woody climbers, mostly cultivated for fruit or flower production, either intended to have permanent cover of woody plants when mature, or else for wood or small tree production with a regular whole-plant harvesting regime.
G1	Broadleaved deciduous woodland	Woodland, forest and plantations dominated by summer-green non-coniferous trees that lose their leaves in winter. Includes woodland with mixed evergreen and deciduous broadleaved trees, provided that the deciduous cover exceeds that of evergreens. Excludes mixed forests (G4) where the proportion of conifers exceeds 25%.
G2	Broadleaved evergreen woodland	Temperate forests dominated by broad-leaved sclerophyllous or lauriphyllous evergreen trees, or by palms. They are characteristic of the Mediterranean and warm-temperate humid zones.
G3	Coniferous woodland	Woodland, forest and plantations dominated by coniferous trees, mainly evergreen ([Abies], [Cedrus], [Picea], [Pinus], [Taxus], Cupressaceae) but also deciduous [Larix]. Excludes mixed forests (G4) where the proportion of broadleaved trees exceeds 25%.

G4	Mixed deciduous and coniferous woodland	Forest and woodland of mixed broad-leaved deciduous or evergreen and coniferous trees of the nemoral, boreal, warm-temperate humid and mediterranean zones. They are mostly characteristic of the boreonemoral transition zone between taiga and temperate lowland deciduous forests, and of the montane level of the major mountain ranges to the south. Neither coniferous, nor broadleaved species account for more than 75% of the crown cover. Deciduous forests with an understorey of conifers or with a small admixture of conifers in the dominant layer are included in unit G1. Conifer forests with an understorey of deciduous trees or with a small admixture of deciduous trees in the dominant layer are included in unit G3.
G5	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	Stands of trees greater than 5 m in height or with the potential to achieve this height, either in more or less continuous narrow strips or in small (less than about 0.5 ha) plantations or small (less than about 0.5 ha) intensively-managed woods. Woodland and coppice that is temporarily in a successional or non-woodland stage but which can be expected to develop into woodland in the future. Excludes parkland (E7.1, E7.2).
H1	Terrestrial underground caves, cave systems, passages and waterbodies	Natural caves, cave systems, underground waters and subterranean interstitial spaces. Caves and their associated waters harbour varied, but paucispecific, communities of animals, fungi and algae that are restricted to them (troglobiont organisms), or are physiologically and ecologically capable of conducting their entire life cycle within them (troglophile organisms), or are dependent on them for part of the life cycle (subtroglophile organisms). Underground waters not associated with caves (stygon) and interstitial spaces harbour distinctive faunas.
H2	Screes	Accumulations of boulders, stones, rock fragments, pebbles, gravels or finer material, of non-aeolian depositional origin, unvegetated, occupied by lichens or mosses, or colonized by sparse herbs or shrubs. Included are screes and scree slopes produced by slope processes, moraines and drumlins originating from glacial deposition, sandar, eskers and kames resulting from fluvio-glacial deposition, block slopes, block streams and block fields constructed by periglacial depositional processes of downslope mass movement, ancient beach deposits constituted by former coastal constructional processes. Deposits originating from aeolian depositional processes (dunes) or from eruptive volcanic activity are not included; they are included in H5 and H6 respectively. High mountain, boreal and mediterranean unstable screes are colonized by highly specialised plant communities. They or their constituting species may also inhabit moraines

		and other depositional debris accumulations in the same areas. A very few communities form in lowland areas elsewhere.
H3	Inland cliffs, rock pavements and outcrops	Unvegetated, sparsely vegetated, and bryophyte- or lichen-vegetated cliffs, rock faces and rock pavements, not presently adjacent to the sea, and not resulting from recent volcanic activity. Parts of seacliffs free from the influence of wave or wind transported marine salt are included. Rock accumulations resulting from depositional processes are excluded and listed under H2 or H5.
H4	Snow or ice-dominated habitats	High mountain zones and high latitude land masses occupied by glaciers or by perennial snow. They may be inhabited by algae and invertebrates.
H5	Miscellaneous inland habitats with very sparse or no vegetation	Miscellaneous bare habitats, including glacial moraines, freeze-thaw features, inland sand dunes, burnt ground and trampled areas. Vegetation, if present, is dominated by algae, lichens or bryophytes, with vascular plants absent or very sparse.
H6	Recent volcanic features	Hard rock surfaces, rock jumbles, loose material deposits, soils, water bodies resulting from recent or present volcanic activity, unvegetated, occupied by lichens or mosses, or colonized by specialised, relatively sparse herb- or shrub-dominated communities.
I1	Arable land and market gardens	Croplands planted for annually or regularly harvested crops other than those that carry trees or shrubs. They include fields of cereals, of sunflowers and other oil seed plants, of beets, legumes, fodder, potatoes and other forbs. Croplands comprise intensively cultivated fields as well as traditionally and extensively cultivated crops with little or no chemical fertilisation or pesticide application. Faunal and floral quality and diversity depend on the intensity of agricultural use and on the presence of borders of natural vegetation between fields.
I2	Cultivated areas of gardens and parks	Cultivated areas of small-scale and large-scale gardens, including kitchen gardens, ornamental gardens and small parks in city squares. Excludes allotment gardens (I1.2).

J1	Buildings of cities, towns and villages	Buildings in built-up areas where buildings, roads and other impermeable surfaces occupy at least 30% of the land. Includes agricultural building complexes where the built area exceeds 1 ha.
J2	Low density buildings	Buildings in rural and built-up areas where buildings, roads and other impermeable surfaces are at a low density, typically occuping less than 30% of the ground. Excludes agricultural building complexes where the built area exceeds 1 ha (J1.4).
J3	Extractive industrial sites	Sites in which minerals are extracted. Includes quarries, open-cast mines and active underground mines. Excludes disused underground mines (H1.7).
J4	Transport networks and other constructed hard-surfaced areas	Includes roads, car parks, railways, paved footpaths and hard-surfaced areas of airports, water ports and recreational areas.
J5	Highly artificial man-made waters and associated structures	Inland artificial waterbodies with wholly-constructed beds or heavily contaminated water, and their associated conduits and containers. Includes saltworks by the coast. Excludes man-made but semi-natural waterbodies (C1, C2, C3).
J6	Waste deposits	Tips, landfill sites and slurries produced as byproducts, usually unwanted, of human activity.

13.3 EUNIS HABITAT COMPLEXES

X	X	Habitat complexes	The listed habitat complexes represent preliminary draft proposals. They have not been subjected to rigorous scrutiny to ensure consistency.
X0	X01	Estuaries	Downstream part of a river valley, subject to the tide and extending from the limit of brackish waters. River estuaries are coastal inlets where there is generally a substantial freshwater influence. The mixing of freshwater and sea water and the reduced current flows in the shelter of the estuary lead to deposition of fine sediments, often forming extensive intertidal sand and mud flats. In addition to herbs, they can also be colonised by shrubs creating thickets (e.g. [Tamarix] spp.). Where the tidal currents are faster than flood tides, most sediments deposit to form a delta at the mouth of the estuary. Baltic river mouths, considered as an estuary subtype, have brackish water and no tide, with helophytic wetland vegetation and luxurious aquatic vegetation in shallow water areas. Littoral and sublittoral habitat types typical of estuaries are included in A2 and A5, although many other habitat types including tidal rivers may occur in estuaries. Includes Transitional waters as defined by the Water Framework Directive.
X0	X02	Saline coastal lagoons	Lagoons are expanses of shallow coastal salt water, of varying salinity and water volume, wholly or partially separated from the sea by sand banks or shingle, or, less frequently, by rocks. Salinity may vary from brackish water to hypersalinity depending on rainfall, evaporation and through the addition of fresh seawater from storms, temporary flooding of the sea in winter or tidal exchange. With or without vegetation of seagrasses or charophytes. Habitat types typical of lagoons are included in A5, although many other habitat types may also occur in lagoons.
X0	X03	Brackish coastal lagoons	Lagoons are expanses of shallow coastal salt water, of varying salinity and water volume, wholly or partially separated from the sea by sand banks or shingle, or, less frequently, by rocks. Fully saline coastal lagoons are classified as X02. Flads and gloes, considered a Baltic variety of lagoons, are small, usually shallow, more or less delimited water bodies still connected to the sea or cut off from the sea very recently by land upheaval. Characterised by well-developed reedbeds and luxuriant submerged vegetation and having several morphological and botanical development stages in the process whereby sea becomes land.

			Mediterranean lagoons may host the [Ruppietum] community with halophytic vegetation, while at sites with a fresh water supply, plant communities of [Juncetum] and [Phragmitetum] can develop. [Sarcocornia perennis] and [Arthrocnemum macrostachyum] may occur here.
X0	X04	Raised bog complexes	Raised bogs are highly oligotrophic, strongly acidic, domed peatlands, whose peat is composed mainly of sphagnum remains and whose surface derives moisture and nutrients only from rainfall (ombrotrophic). Raised bog complexes may include elements of the main mire surface (D1.1) comprising a complex of low hummocks, small pools and their associated vegetation, together with larger pools (C1.46), a marginal lagg (C1.47), pre-woods (G5.64) and other associated habitat types.
X0	X05	Snow patches	Areas that retain late-lying snow, including vegetated and unvegetated areas. Vegetated habitat types typical of snow patches are included in E4.1 and (rarely) F2.1, and unvegetated snow patches in H4.1.
X0	X06	Crops shaded by trees	Crops, meadows or pastures developed under orchards or other cultivated tree plantations. The component habitat types may include elements of I1, E2.6 and FB.
X0	X07	Intensively-farmed crops interspersed with strips of natural and/or semi-natural vegetation	'Intensively-grown crops interspersed with strips of natural and/or semi-natural vegetation. The semi-natural vegetation, which may consist of ruderal and pioneer species colonising uncultivated land, may be allowed to develop on broad headlands at arable field margins.
X0	X09	Pasture woods (with a tree layer overlying pasture)	Pasture woods are the products of historic land management systems, and represent a vegetation structure rather than being a particular plant community. Typically this structure consists of large, open-grown or high forest trees (often pollards) at various densities, in a matrix of grazed grassland, heathland and/or woodland floras. This habitat is most common in southern Britain, but scattered examples occur throughout the UK. Outgrown wood-pasture and mature high forest remnants occur in northern and central Europe, but the number and continuity of ancient (veteran) trees with their associated distinctive saproxylic (wood-eating) fauna and epiphytic flora are more abundant in Britain than elsewhere. Component habitat types include beech and yew woodland (G1.6 and G3.97), heathland (F4) and dry acid grassland (E1.7). A range of native species usually predominates amongst the old trees but there may be non-native species which have been planted or regenerated

			naturally.
X1	X10	Mosaic landscapes with a woodland element (bocages)	Landscapes consisting of a network of small linear, insular and semi-insular wooded habitats, tree-lines, hedgerows, closely interwoven with grassy or cultivated habitats. Component habitat types may include elements of G5, FA, E2 and I1. Characteristic of the British Isles, southern Fennoscandia, the Germano-Baltic plain, the northern piedmont of the Alps, western France, Galicia, Romania.
X1	X11	Large parks	Large, varied green spaces within towns and cities, usually > 5ha. They may include small woods (G5), mown lawns (E2.64), water bodies (which may be semi-natural or artificial), flower beds and shrubberies (I2.1), and semi-natural grassland or woodland enclaves.
X1	X13	Land sparsely wooded with broadleaved deciduous trees	Land in which the woodland element comprises broadleaved deciduous trees, with a canopy cover less than 5%.
X1	X14	Land sparsely wooded with broadleaved evergreen trees	Land in which the woodland element comprises broadleaved evergreen trees, with a canopy cover less than 5%.
X1	X15	Land sparsely wooded with coniferous trees	Land in which the woodland element comprises coniferous trees, with a canopy cover less than 5%.
X1	X16	Land sparsely wooded with mixed broadleaved and coniferous trees	Land in which the woodland element comprises mixed broadleaved and coniferous trees, with a canopy cover less than 5%.

X1	X18	Wooded steppe	The transition zone between forests and the middle Eurasian, Irano-Anatolian or Saharo-Mediterranean steppes, occurring in a vast swath extending from Pannonia to the Far East, south of and inland from the boreal and nemoral forest belts, in regions of reduced summer humidity, as well as in areas adjacent to, or under the influence of the Mediterranean and warm-temperate humid zones, represented by a macromosaic of steppe and connected, contiguous, disjunct or widely spaced woodland stands, the latter usually with a very developed grassy understorey, or by a scattering of trees within a steppe environment. The forest elements are often located on porous or slightly raised ground, valley sides or slopes, the grasslands occupying less well drained soils and lower places. Component habitat types include those of E1.2 in combination with G1.7.
X1	X19	Wooded tundra	The transition zone between taiga and tundra, characterised by a scattering of stunted coniferous trees or deciduous shrubs within a tundra environment, or by a macromosaic of tundra with scattered islands of forest, or by forest with scattered treeless tundra patches. They occur in a broad belt, up to several hundreds of kilometres wide, across the north of the Eurasian continent and in a narrow ecotone in Siberian mountains. Component habitat types include those of F1 in combination with G3.A, G3.B, G3.C or G4.2.
X2	X20	Treeline ecotones	Formations of the timberline of mountains, in which subalpine forests give way to alpine or boreal heaths and scrubs, or to alpine grasslands; they are characterised by a scattering of stunted, gnarled trees punctuating an alpine shrub or grassland environment, by a macromosaic of alpine shrub and grass formations with scattered islands of forest, or by open or clear forest with an undergrowth composed of alpine elements such as ericaceous shrubs. They occupy a narrow belt, varying in altitudinal location according to latitude, exposure and other climatic or edaphic conditions. Component habitats include those of F2 and E4.
X2	X22	Small city centre non-domestic gardens	Small gardens or other green spaces, usually < 0.5 ha, often partitioned by walls, located inside city blocks and completely or almost completely surrounded by continuous architectural structures (J1.1). May include mown lawns and flower beds (I2.2), native or ornamental trees.
X2	X23	Large non-domestic gardens	Large non-domestic gardens or other green spaces, more restricted in area and diversity than large parks (X11), typically 0.5 - 5 ha. Usually located within urban areas and completely or almost completely surrounded by continuous architectural structures (J1.1) or roads (J4.1). May include mown lawns and flower beds (I2.23), native or ornamental trees.

X2	X24	Domestic gardens of city and town centres	Domestic gardens, usually small in area, usually < 0.5 ha, often with very mixed species-rich flora and fauna (crops, lawns, shrubs, flowerbeds etc., frequently interspersed with paths and small buildings) in close proximity to human dwellings, urban green spaces (usually species-poor) and parks. The component habitat types comprise combinations of several level 1 units.
X2	X25	Domestic gardens of villages and urban peripheries	Domestic gardens, usually small in area, usually < 0.5 ha, often with very mixed species-rich flora and fauna (crops, lawns, shrubs, flowerbeds etc., frequently interspersed with paths and small buildings) in close proximity to human dwellings, agricultural land, natural or semi-natural habitats. The component habitat types comprise combinations of several level 1 units.
X2	X27	Machair complexes	Machair complexes are characterised by the effects of wind-blown calcareous sand with a predominance of shell fragments, a low proportion of sand-binding vegetation and a long history of agricultural use. Machair in its strict sense (B1.9) refers to short-turf grassland on relatively flat and low-lying sand plains formed by dry or wet (seasonally waterlogged) sandy soil above peat or impermeable bedrock. Machair complexes (X27) correspond to machair in the broad sense, including the beach zone (B1.2), mobile and semi-fixed foredunes (B1.3), dune-slack pools (C1.16), fens (D4.1), lochs (C1), some of them brackish, and saltmarsh (A2.5), as well as machair grassland (B1.9) and land cultivated on a strip rotation (I1).
X2	X28	Blanket bog complexes	Blanket bogs are ombrotrophic, strongly acidic peatlands, formed on flat or gently sloping ground with poor surface drainage, in oceanic climates with high rainfall. Blanket bog complexes include dystrophic pools (C1.4) and acidic flushes (D2.2), as well as the main mire surface (D1.2).
X2	X29	Salt lake islands	Permanently or usually emergent features of inland saline lakes and of permanent or temporary saline lakes or ponds.

14 ANNEX

14.1 STATISTIC PER COUNTRY (ECOSYSTEME TYPES EUNIS LEVEL 2)

Level 1 types	EUNIS L2	ID	EUNIS_name	constraint	AD	AL	AT	BA	BE	BG	CH	CS	CY	CZ	DE	DK	EE	ES	FI	FR
			total		465	28.531	83.929	51.275	30.663	110.797	41.288	77.437	9.248	78.865	357.678	43.359	45.330	505.981	337.798	549.170
			no-class		220	36	0	14	6	27	0	1	19	0	31	85	30	285	399	80
A **Marine** habitats	A1	1	Littoral rock and other hard substrata		-	0	0	0	2	0	0	0	0	0	83	17	0	23	0	88
	A2	2	Littoral sediment		-															
	A3	3	Infralittoral rock and other hard substrata		-															
	A4	4	Circalittoral rock and other hard substrata		-															
	A5	5	Sublittoral sediment		-															
	A6	6	Deep-sea bed		-															
	A7	7	Pelagic water column		-															
	A8	8	Ice-associated marine habitats		-															
	X1	9	Estuaries		-	0	0	0	41	0	0	0	0	0	171	0	0	90	0	118
	X2_3	10	Coastal lagoons		-	51	0	0	0	1	0	0	0	0	54	336	10	75	0	758
B **Coastal** habitats	B1	11	Coastal dunes and sandy shores		0	28	0	7	1	4	0	0	138	0	61	4	0	309	10	357
	B2	12	Coastal shingle		-	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
	B3	13	Rock cliffs, ledges and shores, including the supralittoral		-	0	0	0	0	0	0	0	5	0	0	0	0	67	16	12
C Inland surface **waters**	C1	14	Surface standing waters		-	446	449	183	87	619	1.374	248	15	484	3.097	374	2.043	2.438	29.452	1.902
	C2	15	Surface running waters		-	52	195	130	47	330	30	589	0	38	698	0	31	421	615	1.040
	C3	16	Littoral zone of inland surface waterbodies		-	0	0	0	0	2	0	0	0	0	0	0	0	11	0	36
D **Mires**, bogs and fens	D1	17	Raised and blanket bogs		-	0	14	0	46	12	0	0	0	35	801	218	1.171	5	549	38
	D2	18	Valley mires, poor fens and transition mires		-	0	28	0	20	0	0	0	0	41	122	95	285	1	231	32
	D3	19	Aapa, palsa and polygon mires		-	0	0	0	0	0	0	0	0	0	0	0	54	0	20.669	0
	D4	20	Base-rich fens and calcareous spring mires		-	0	17	0	0	0	0	0	0	0	20	72	117	1	0	25
	D5	21	Sedge and reedbeds, normally without free-standing water		-	18	29	19	1	42	13	164	4	2	221	96	210	165	1	569
	D6	22	Inland saline and brackish marshes and reedbeds		-	0	0	0	0	0	0	0	0	2	42	3	0	0	0	7
E **Grasslands** and land dominated by forbs, mosses or lichens	E1	23	Dry grasslands		3	2.901	131	3.309	83	5.188	30	3.233	466	967	1.242	559	2.369	40.674	35.751	8.479
	E2	24	Mesic grasslands		5	5.310	10.596	13.085	7.460	13.968	3.706	15.180	625	10.596	54.580	1.287	3.398	49.365	174	128.947
	E3	25	Seasonally wet and wet grasslands		-	404	120	229	121	1.341	223	148	63	66	7.498	146	917	1.548	13	2.398
	E4	26	Alpine and subalpine grasslands		68	274	5.210	140	0	307	3.332	2	0	28	207	0	0	1.646	35	2.999
	E5	27	Woodland fringes and clearings and tall forb stands*	too small	-															
	E6	28	Inland salt steppes		-	16	0	0	4	0	0	0	20	0	101	284	4	240	45	654
	E7	29	Sparsely wooded grasslands		-	0	1	0	0	0	0	0	0	0	0	0	0	24.426	0	1
F Heathland, scrub and tundra	F1	30	Tundra		-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F2	31	Arctic, alpine and subalpine scrub		43	260	3.935	190	0	315	2.330	0	0	19	210	0	0	1.302	3.024	2.508
	F3	32	Temperate and mediterranean-montane scrub		-	143	557	60	126	43	199	0	0	0	331	424	132	7.197	1.967	2.937
	F4	33	Temperate shrub heathland		-	0	0	0	0	0	0	0	0	0	0	48	0	5	0	8
	F5	34	Maquis, arborescent matorral and thermo-Mediterranean brushes		0	2.901	0	798	0	0	0	0	1.308	0	0	0	0	25.608	0	2.819
	F6	35	Garrigue		-	0	0	0	0	0	0	0	0	0	0	0	0	6.898	0	193
	F7	36	Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)		-	0	0	0	0	0	0	0	0	0	0	0	0	11.565	0	1.417
	F8	37	Thermo-Atlantic xerophytic scrub		-	9	111	26	0	33	15	47	0	3	29	17	65	3.555	0	0
	F9	38	Riverine and fen scrubs		-	0	0	0	3	0	0	0	0	0	2	0	1	19	17	18
	FA	39	Hedgerows*	too small	-															
	FB	40	Shrub plantations		-	174	690	52	76	2.053	170	192	287	448	2.268	5	20	16.689	0	12.558
G Woodland, **forest** and other wooded land	G1	41	Broadleaved deciduous woodland		2	6.865	4.897	17.995	3.362	25.185	2.084	22.808	7	3.771	32.223	1.269	5.940	43.847	10.880	101.216
	G2	42	Broadleaved evergreen woodland		-	409	0	0	0	0	0	0	61	0	0	0	0	21.316	0	2.942
	G3	43	Coniferous woodland		57	1.281	23.998	2.876	2.027	6.436	7.893	1.062	1.748	18.876	62.890	2.293	9.040	50.691	105.385	41.417
	G4	44	Mixed deciduous and coniferous woodland		2	405	11.190	4.052	2.645	6.372	4.832	1.217	3	6.150	23.732	1.349	8.300	14.910	92.552	19.299
	G5	45	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	too small	0	244	26	347	20	575	15	364	26	125	173	65	413	3.548	3.689	1.261
H Inland **unvegetated** or sparsely vegetated habitats	H1	46	Terrestrial underground caves, cave systems, passages and waterbodies*	not applicable	-															
	H2	47	Screes		-	214	0	6	10	9	18	11	50	0	59	80	29	408	3	281
	H3	48	Inland cliffs, rock pavements and outcrops		64	519	2.678	157	0	144	3.897	20	19	1	171	0	0	2.605	44	4.850
	H4	49	Snow or ice-dominated habitats		-	0	363	0	0	0	1.109	0	0	0	0	0	0	3	0	385
	H5	50	Miscellaneous inland habitats with very sparse or no vegetation		-	717	54	408	0	233	47	161	119	0	196	0	8	7.703	177	1.050
	H6	51	Recent volcanic features*	not applicable	-															
I Regularly or recently cultivated	I1	52	Arable land and market gardens		0	4.054	14.047	6.082	8.116	41.621	7.031	28.701	3.351	31.508	130.316	30.528	9.698	150.799	27.003	171.022
	I2	53	Cultivated areas of gardens and parks		-	3	161	4	156	100	49	49	76	170	1.172	608	25	326	180	1.094
J Constructed, industrial and other **artificial** habitats	J1	54	Buildings of cities, towns and villages		0	179	1.606	389	2.497	2.261	1.204	1.422	302	2.871	21.092	1.601	287	6.798	1.329	15.120
	J2	55	Low density buildings		0	562	2.397	589	3.186	3.031	1.424	1.583	431	2.177	9.791	1.169	576	4.806	3.098	14.655
	J3	56	Extractive industrial sites		-	12	81	97	66	339	20	92	25	160	1.214	45	59	733	197	869
	J4	57	Transport networks and other constructed hard-surfaced areas		-	37	345	23	442	172	242	124	76	228	2.619	281	61	2.614	250	2.510
	J5	58	Highly artificial man-made waters and associated structures	no WFD data	-	6	0	0	0	5	0	0	0	4	0	0	0	193	0	128
	J6	59	Waste deposits		-	0	3	8	11	28	0	17	4	95	161	2	37	55	39	74

EUNIS L2	ID	EUNIS_name	constraint	GG	GR	HR	HU	IE	IM	IS	IT	JE	LI	LT	LU	LV	MC	MK	NL	NO	PL	PT
		total		8	132.020	56.633	93.006	70.177	580	102.906	301.426	11	161	64.887	2.596	64.590	2	25.153	37.357	323.441	311.893	89.853
		no-class		8	403	230	57	98	28	280	303	9	0	2	0	12	0	0	22	2.636	7	40
A1	1	Littoral rock and other hard substrata		0	0	0	0	104	1	172	0	0	0	0	0	0	0	0	29	92	0	19
A2	2	Littoral sediment																				
A3	3	Infralittoral rock and other hard substrata																				
A4	4	Circalittoral rock and other hard substrata																				
A5	5	Sublittoral sediment																				
A6	6	Deep-sea bed																				
A7	7	Pelagic water column																				
A8	8	Ice-associated marine habitats																				
X1	9	Estuaries		0	2	0	0	292	0	58	2	0	0	0	0	0	0	0	4	0	0	256
X2_3	10	Coastal lagoons		0	71	0	0	6	0	162	930	0	0	5	0	0	0	0	0	0	3	84
B1	11	Coastal dunes and sandy shores		0	2.467	340	0	249	18	28	731	0	0	0	0	0	0	0	41	0	37	72
B2	12	Coastal shingle		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B3	13	Rock cliffs, ledges and shores, including the supralittoral		0	20	29	0	10	0	148	29	0	0	0	0	0	0	0	0	431	0	3
C1	14	Surface standing waters		0	857	272	1.276	1.164	0	1.222	1.710	0	0	1.031	4	1.023	0	512	2.661	13.020	3.611	519
C2	15	Surface running waters		0	222	226	437	76	0	812	457	0	2	168	2	135	0	8	441	396	704	184
C3	16	Littoral zone of inland surface waterbodies		0	11	0	0	0	0	0	85	0	0	0	0	1	0	0	0	0	1	1
D1	17	Raised and blanket bogs		0	0	0	84	10.805	0	6.493	3	0	0	358	0	1.303	0	0	71	3.297	71	0
D2	18	Valley mires, poor fens and transition mires		0	4	0	2	16	0	0	0	0	0	49	0	145	0	0	44	0	57	2
D3	19	Aapa, palsa and polygon mires		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15.674	0	0
D4	20	Base-rich fens and calcareous spring mires		0	0	0	140	30	0	0	3	0	0	13	0	0	0	0	0	0	93	0
D5	21	Sedge and reedbeds, normally without free-standing water		0	239	90	481	115	0	287	91	0	2	64	0	68	0	5	143	0	459	7
D6	22	Inland saline and brackish marshes and reedbeds		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0
E1	23	Dry grasslands		0	9.366	4.853	1.934	3.685	0	263	9.142	0	0	928	2	2.975	0	3.648	13	4.398	1.591	11.058
E2	24	Mesic grasslands		0	19.112	14.664	10.296	33.306	286	4.564	31.411	0	10	12.291	730	11.526	0	5.585	10.556	2.104	32.157	8.331
E3	25	Seasonally wet and wet grasslands		0	740	1	1.145	6.572	31	707	77	0	0	447	147	1.773	0	56	4.125	6	5.931	379
E4	26	Alpine and subalpine grasslands		0	440	1	0	0	0	0	5.093	0	18	0	0	0	0	395	0	2	25	0
E5	27	Woodland fringes and clearings and tall forb stands*	too small																			
E6	28	Inland salt steppes		0	321	3	0	36	0	23	395	0	0	0	0	0	0	0	84	0	0	173
E7	29	Sparsely wooded grasslands		0	0	0	0	0	0	0	1.637	0	0	0	0	0	0	0	0	0	0	5.945
F1	30	Tundra		0	0	0	0	0	0	9.866	0	0	0	0	0	0	0	0	0	0	0	0
F2	31	Arctic, alpine and subalpine scrub		0	663	0	0	0	0	1.643	3.391	0	5	0	0	0	0	57	0	37.533	19	21
F3	32	Temperate and mediterranean-montane scrub		0	293	36	0	525	77	35.854	278	0	0	17	0	0	0	85	313	33.819	7	2.586
F4	33	Temperate shrub heathland		0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F5	34	Maquis, arborescent matorral and thermo-Mediterranean brushes		0	16.845	1.027	0	0	0	0	5.858	0	0	0	0	0	0	267	0	0	0	1.449
F6	35	Garrigue		0	50	0	0	0	0	0	58	0	0	0	0	0	0	0	0	0	0	170
F7	36	Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)		0	3.861	0	0	0	0	0	479	0	0	0	0	0	0	0	0	0	0	43
F8	37	Thermo-Atlantic xerophytic scrub		0	0	83	101	0	0	100	47	0	0	33	0	0	0	12	110	3	153	1
F9	38	Riverine and fen scrubs		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	21
FA	39	Hedgerows*	too small																			
FB	40	Shrub plantations		0	2.072	367	2.186	0	0	0	8.903	0	0	80	14	28	0	296	65	0	1.285	3.117
G1	41	Broadleaved deciduous woodland		0	12.370	17.391	16.222	297	10	234	57.998	1	6	6.270	726	8.478	0	7.944	1.129	56.560	20.962	11.010
G2	42	Broadleaved evergreen woodland		0	6.111	327	0	0	0	0	14.998	0	0	0	0	0	0	0	0	0	0	3.478
G3	43	Coniferous woodland		0	7.298	1.317	1.094	2.691	50	17	15.740	0	47	7.932	151	10.582	0	581	2.076	65.661	59.392	7.754
G4	44	Mixed deciduous and coniferous woodland		0	4.086	2.697	1.553	296	1	68	10.873	0	22	7.253	176	11.584	0	482	918	4.793	23.072	4.733
G5	45	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	too small	0	2.988	337	246	155	0	0	843	0	0	260	1	761	0	234	1	511	273	957
H1	46	Terrestrial underground caves, cave systems, passages and waterbodies*	not applicable																			
H2	47	Screes		0	282	2	0	85	6	3.071	643	0	0	22	0	31	0	5	116	16	42	102
H3	48	Inland cliffs, rock pavements and outcrops		0	662	222	0	177	0	23.529	4.997	0	1	0	0	0	0	12	0	27.858	22	318
H4	49	Snow or ice-dominated habitats		0	0	0	0	0	0	10.901	404	0	0	0	0	0	0	0	0	2.223	0	0
H5	50	Miscellaneous inland habitats with very sparse or no vegetation		0	1.001	466	23	162	1	1.913	1.018	0	0	7	0	8	0	54	0	39.841	84	1.152
H6	51	Recent volcanic features*	not applicable																			
I1	52	Arable land and market gardens		0	36.140	9.118	49.313	6.989	41	53	103.799	0	26	24.850	358	12.844	0	4.363	8.292	10.295	146.022	20.549
I2	53	Cultivated areas of gardens and parks		0	88	62	361	217	5	149	331	0	0	64	5	30	0	8	494	344	516	123
J1	54	Buildings of cities, towns and villages		0	1.240	1.134	3.488	790	2	80	8.378	0	11	997	145	473	1	212	3.192	608	7.169	2.110
J2	55	Low density buildings		0	1.001	1.047	2.132	934	18	161	8.283	0	10	1.536	98	736	0	250	1.745	1.137	7.159	2.356
J3	56	Extractive industrial sites		0	271	48	81	87	1	14	510	0	0	56	2	33	0	28	35	59	340	132
J4	57	Transport networks and other constructed hard-surfaced areas		0	388	235	299	181	3	34	1.386	0	0	143	28	40	0	43	619	121	512	524
J5	58	Highly artificial man-made waters and associated structures	no WFD data	0	29	4	0	0	0	0	89	0	0	1	0	0	0	0	0	0	1	66
J6	59	Waste deposits		0	5	4	55	6	0	1	20	0	0	9	4	1	0	11	17	4	105	9

Level 1 types	EUNIS L2	ID	EUNIS_name	constraint	RO	SE	SI	SK	SM	TR	UK	VA	ME	KS
			total		237.922	449.444	20.275	49.026	62	779.779	244.713	1	14.148	10.991
			no-class		22	527	1	0	0	445	527	0	92	0
A **Marine** habitats	A1	1	Littoral rock and other hard substrata		0	0	0	0	0	0	388	0	0	0
	A2	2	Littoral sediment											
	A3	3	Infralittoral rock and other hard substrata											
	A4	4	Circalittoral rock and other hard substrata											
	A5	5	Sublittoral sediment											
	A6	6	Deep-sea bed											
	A7	7	Pelagic water column											
	A8	8	Ice-associated marine habitats											
	X1	9	Estuaries		0	25	0	0	0	2	45	0	0	0
	X2_3	10	Coastal lagoons		541	23	0	0	0	78	4	0	0	0
B **Coastal** habitats	B1	11	Coastal dunes and sandy shores		2	51	0	0	0	561	357	0	39	0
	B2	12	Coastal shingle		0	0	0	0	0	0	0	0	0	0
	B3	13	Rock cliffs, ledges and shores, including the supralittoral		0	42	0	0	0	7	40	0	2	0
C Inland surface **waters**	C1	14	Surface standing waters		1.635	35.223	25	208	0	11.478	2.117	0	260	15
	C2	15	Surface running waters		1.984	1.066	44	94	0	957	38	0	7	8
	C3	16	Littoral zone of inland surface waterbodies		8	0	0	0	0	0	0	0	0	0
D **Mires**, bogs and fens	D1	17	Raised and blanket bogs		8	1.585	0	2	0	0	11.022	0	0	0
	D2	18	Valley mires, poor fens and transition mires		0	466	15	1	0	0	20	0	0	0
	D3	19	Aapa, palsa and polygon mires		0	24.802	0	0	0	0	0	0	0	0
	D4	20	Base-rich fens and calcareous spring mires		6	10	4	1	0	0	9	0	0	0
	D5	21	Sedge and reedbeds, normally without free-standing water		906	40	3	17	0	1.390	92	0	10	0
	D6	22	Inland saline and brackish marshes and reedbeds		0	0	0	2	0	0	0	0	0	0
E **Grasslands** and land dominated by forbs, mosses or lichens	E1	23	Dry grasslands		4.005	38.813	240	986	4	75.826	2.343	0	2.206	769
	E2	24	Mesic grasslands		37.309	3.727	3.655	4.554	12	117.518	65.696	0	1.534	2.410
	E3	25	Seasonally wet and wet grasslands		2.580	213	38	1	0	7.227	19.057	0	8	76
	E4	26	Alpine and subalpine grasslands		1.310	1.015	27	116	0	29.367	2.668	0	160	212
	E5	27	Woodland fringes and clearings and tall forb stands*	too small										
	E6	28	Inland salt steppes		31	11	1	0	0	195	277	0	1	0
	E7	29	Sparsely wooded grasslands		0	0	0	0	0	0	0	0	0	0
F Heathland, scrub and tundra	F1	30	Tundra		0	0	0	0	0	0	0	0	0	0
	F2	31	Arctic, alpine and subalpine scrub		393	9.239	182	67	0	36.626	9.220	0	191	24
	F3	32	Temperate and mediterranean-montane scrub		169	19.910	69	52	0	0	15.346	0	0	10
	F4	33	Temperate shrub heathland		0	0	0	0	0	0	599	0	0	0
	F5	34	Maquis, arborescent matorral and thermo-Mediterranean brushes		0	118	0	0	0	7.774	0	0	33	3
	F6	35	Garrigue		0	0	0	0	0	0	0	0	0	0
	F7	36	Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)		0	0	0	0	0	0	0	0	0	0
	F8	37	Thermo-Atlantic xerophytic scrub		2.331	30	1	3	0	928	10	0	100	0
	F9	38	Riverine and fen scrubs		0	51	0	0	0	0	8	0	0	0
	FA	39	Hedgerows*	too small										
	FB	40	Shrub plantations		7.118	14	187	331	0	6.406	14	0	29	59
G Woodland, **forest** and other wooded land	G1	41	Broadleaved deciduous woodland		50.947	25.715	4.939	11.749	5	56.159	9.156	0	4.340	4.240
	G2	42	Broadleaved evergreen woodland		0	0	0	0	0	3.578	0	0	22	0
	G3	43	Coniferous woodland		11.871	219.820	2.800	5.653	0	59.029	14.733	0	1.310	236
	G4	44	Mixed deciduous and coniferous woodland		11.268	16.581	4.466	3.958	1	35.625	1.427	0	1.045	106
	G5	45	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	too small	434	3.539	47	187	0	4.731	203	0	309	63
H Inland **unvegetated** or sparsely vegetated habitats	H1	46	Terrestrial underground caves, cave systems, passages and waterbodies*	not applicable										
	H2	47	Screes		128	36	6	0	0	1.266	367	0	17	2
	H3	48	Inland cliffs, rock pavements and outcrops		51	4.134	200	70	0	28.295	696	0	264	22
	H4	49	Snow or ice-dominated habitats		0	210	0	0	0	6	0	0	0	0
	H5	50	Miscellaneous inland habitats with very sparse or no vegetation		34	3.047	3	8	0	58.037	1.471	0	269	123
	H6	51	Recent volcanic features*	not applicable										
I Regularly or recently cultivated **agricultural**, horticultural and domestic	I1	52	Arable land and market gardens		87.254	33.462	2.529	17.984	28	220.495	65.443	0	1.676	2.249
	I2	53	Cultivated areas of gardens and parks		98	641	15	71	0	465	3.094	0	10	1
J Constructed, industrial and other **artificial** habitats	J1	54	Buildings of cities, towns and villages		4.517	1.259	311	1.392	5	6.082	9.934	0	89	126
	J2	55	Low density buildings		10.466	3.340	351	1.365	6	7.702	6.316	0	95	205
	J3	56	Extractive industrial sites		242	112	12	29	0	733	688	0	10	19
	J4	57	Transport networks and other constructed hard-surfaced areas		184	470	97	111	0	684	1.199	0	4	9
	J5	58	Highly artificial man-made waters and associated structures	no WFD data	0	0	4	0	0	83	1	0	11	0
	J6	59	Waste deposits		69	80	3	13	0	23	88	0	5	4

14.2 CLC-EUNIS CROSSWALK

Adapted and enhanced from crosswalk developed by ETC-BD

CLC_Code	CLC_Name	EUNIS code L2	EUNIS name L2	Remark
1.1.1.	Continuous urban fabric	J1	Buildings of cities, towns and villages	
1.1.2.	Discontinuous urban fabric	J1	Buildings of cities, towns and villages	
1.2.1.	Industrial or commercial units	J2	Low density buildings	
1.2.1.	Industrial or commercial units	J5	Highly artificial man-made waters and associated structures	new
1.2.2.	Road and rail networks and associated land	J4	Transport networks and other constructed hard-surfaced areas	
1.2.3.	Port areas	J4	Transport networks and other constructed hard-surfaced areas	
1.2.4.	Airports	J4	Transport networks and other constructed hard-surfaced areas	
1.3.1.	Mineral extraction sites	H3	Inland cliffs, rock pavements and outcrops	new
1.3.1.	Mineral extraction sites	J2	Low density buildings	
1.3.1.	Mineral extraction sites	J3	Extractive industrial sites	
1.3.2.	Dump sites	J6	Waste deposits	
1.3.3.	Construction sites	J2	Low density buildings	
1.4.1.	Green urban areas	E2	Mesic grasslands	
1.4.1.	Green urban areas	I2	Cultivated areas of gardens and parks	
1.4.2.	Sport and leisure facilities	E2	Mesic grasslands	
1.4.2.	Sport and leisure facilities	I2	Cultivated areas of gardens and parks	
2.1.1.	Non-irrigated arable land	I1	Arable land and market gardens	
2.1.2.	Permanently irrigated land	I1	Arable land and market gardens	
2.1.3.	Rice fields	I1	Arable land and market gardens	
2.2.1.	Vineyards	FB	Shrub plantations	
2.2.2.	Fruit trees and berry	FB	Shrub plantations	

	plantations			
2.2.2.	Fruit trees and berry plantations	G1	Broadleaved deciduous woodland	
2.2.2.	Fruit trees and berry plantations	G2	Broadleaved evergreen woodland	
2.2.3.	Olive groves	G2	Broadleaved evergreen woodland	
2.3.1.	Pastures	B1	Coastal dunes and sandy shores	
2.3.1.	Pastures	E2	Mesic grasslands	?
2.3.1.	Pastures	E7	Sparsely wooded grasslands	
2.3.1.	Pastures	FA	Hedgerows	
2.4.1.	Annual crops associated with permanent crops	I1	Arable land and market gardens	new
2.4.2.	Complex cultivation patterns	I1	Arable land and market gardens	
2.4.2.	Complex cultivation patterns	I2	Cultivated areas of gardens and parks	
2.4.3.	Land principally occupied by agriculture, with significant areas of natural vegetation	I1	Arable land and market gardens	
2.4.4.	Agro-forestry areas	E7	Sparsely wooded grasslands	
3.1.1.	Broad-leaved forest	B1	Coastal dunes and sandy shores	
3.1.1.	Broad-leaved forest	G1	Broadleaved deciduous woodland	
3.1.1.	Broad-leaved forest	G2	Broadleaved evergreen woodland	new
3.1.2.	Coniferous forest	B1	Coastal dunes and sandy shores	new
3.1.2.	Coniferous forest	G3	Coniferous woodland	
3.1.3.	Mixed forest	G4	Mixed deciduous and coniferous woodland	
3.2.1.	Natural grassland	E1	Dry grasslands	
3.2.1.	Natural grassland	E2	Mesic grasslands	
3.2.1.	Natural grassland	E3	Seasonally wet and wet grasslands	
3.2.1.	Natural grassland	E4	Alpine and subalpine grasslands	
3.2.1.	Natural grassland	E5	Woodland fringes and clearings and tall forb stands	

3.2.1.	Natural grassland	E6	Inland salt steppes	
3.2.2.	Moors and heathland	E5	Woodland fringes and clearings and tall forb stands	
3.2.2.	Moors and heathland	F2	Arctic, alpine and subalpine scrub	
3.2.2.	Moors and heathland	F3	Temperate and mediterranean-montane scrub	
3.2.2.	Moors and heathland	F4	Temperate shrub heathland	
3.2.2.	Moors and heathland	F9	Riverine and fen scrubs	
3.2.2.	Moors and heathland	G5	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	
3.2.3.	Sclerophyllous vegetation	B1	Coastal dunes and sandy shores	
3.2.3.	Sclerophyllous vegetation	E5	Woodland fringes and clearings and tall forb stands	?
3.2.3.	Sclerophyllous vegetation	F5	Maquis, arborescent matorral and thermo-Mediterranean brushes	
3.2.3.	Sclerophyllous vegetation	F6	Garrigue	
3.2.3.	Sclerophyllous vegetation	F7	Spiny Mediterranean heaths (phrygana, hedgehog-heaths and related coastal cliff vegetation)	
3.2.3.	Sclerophyllous vegetation	F8	Thermo-Atlantic xerophytic scrub	
3.2.4.	Transitional woodland shrub	E1	Dry grasslands	
3.2.4.	Transitional woodland shrub	E5	Woodland fringes and clearings and tall forb stands	
3.2.4.	Transitional woodland shrub	G5	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	?
3.3.1.	Beaches, dunes, and sand plains	B1	Coastal dunes and sandy shores	
3.3.1.	Beaches, dunes, and sand plains	B2	Coastal shingle	
3.3.1.	Beaches, dunes, and sand plains	C3	Littoral zone of inland surface waterbodies	
3.3.1.	Beaches, dunes, and sand	E1	Dry grasslands	

	plains			
3.3.1.	Beaches, dunes, and sand plains	F3	Temperate and mediterranean-montane scrub	
3.3.1.	Beaches, dunes, and sand plains	F4	Temperate shrub heathland	
3.3.1.	Beaches, dunes, and sand plains	H5	Miscellaneous inland habitats with very sparse or no vegetation	
3.3.2.	Bare rock	A1	Littoral rock and other hard substrata	
3.3.2.	Bare rock	B3	Rock cliffs, ledges and shores, including the supralittoral	
3.3.2.	Bare rock	H2	Screes	
3.3.2.	Bare rock	H3	Inland cliffs, rock pavements and outcrops	
3.3.3.	Sparsely vegetated areas	E4	Alpine and subalpine grasslands	
3.3.3.	Sparsely vegetated areas	F1	Tundra	
3.3.3.	Sparsely vegetated areas	F2	Arctic, alpine and subalpine scrub	
3.3.3.	Sparsely vegetated areas	H3	Inland cliffs, rock pavements and outcrops	
3.3.3.	Sparsely vegetated areas	H5	Miscellaneous inland habitats with very sparse or no vegetation	
3.3.3.	Sparsely vegetated areas	H6	Recent volcanic features	
3.3.4.	Burnt areas	H5	Miscellaneous inland habitats with very sparse or no vegetation	
3.3.5.	Glaciers and perpetual snow	H4	Snow or ice-dominated habitats	new
4.1.1.	Inland marshes	C2	Surface running waters	
4.1.1.	Inland marshes	C3	Littoral zone of inland surface waterbodies	?
4.1.1.	Inland marshes	D2	Valley mires, poor fens and transition mires	
4.1.1.	Inland marshes	D4	Base-rich fens and calcareous spring mires	
4.1.1.	Inland marshes	D5	Sedge and reedbeds, normally without free-standing water	?
4.1.1.	Inland marshes	D6	Inland saline and brackish marshes and	new

			reedbeds	
4.1.2.	Peatbogs	D1	Raised and blanket bogs	missing
4.1.2.	Peatbogs	D3	Aapa, palsa and polygon mires	
4.2.1.	Salt marshes	A2	Littoral sediment	new
4.2.2.	Salines	J5	Highly artificial man-made waters and associated structures	new
4.2.3.	Intertidal flats	A1	Littoral rock and other hard substrata	
4.2.3.	Intertidal flats	A2	Littoral sediment	
5.1.1.	Water courses	C2	Surface running waters	
5.1.1.	Water courses	J5	Highly artificial man-made waters and associated structures	
5.1.2.	Water bodies	C1	Surface standing waters	
5.1.2.	Water bodies	J5	Highly artificial man-made waters and associated structures	
5.2.1.	Coastal Lagoons	X2_3	Sublittoral sediment	new
5.2.2.	Estuaries	X1	Surface running waters	new
5.2.3.	Sea and ocean	A3	Infralittoral rock and other hard substrata	new
5.2.3.	Sea and ocean	A4	Circalittoral rock and other hard substrata	
5.2.3.	Sea and ocean	A5	Sublittoral sediment	
5.2.3.	Sea and ocean	A6	Deep-sea bed	
5.2.3.	Sea and ocean	A7	Pelagic water column	
5.2.3.	Sea and ocean	A8	Ice-associated marine habitats	

14.3 HABITATS (ANNEX I) USED FOR MAPPING EUNIS CLASSES

The distribution maps according to Art. 17 of the habitat directive were used to define areas, with a high likelihood that the specific habitat type and therefore the corresponding EUNIPS type occurs. For most countries the data is available in 10*10 km grid cells (except Finnland and France).

group	Annex_I	ES_L2	remark
B - coastal	1210	B2	
B - coastal	1220	B2	
B - coastal	1230	B3	
B - coastal	1240	B3	
B - coastal	1250	B3	
B - coastal	1610	B1/B2	
B - coastal	1620	B3	
B - coastal	1640	B1	
B - coastal	2110	B1	
B - coastal	2120	B1	
B - coastal	2130	B1	
B - coastal	2140	B1	
B - coastal	2150	B1	
B - coastal	2160	B1	
B - coastal	2170	B1	
B - coastal	2180	B1	
B - coastal	2190	B1	2nd. Option: C1.1 Permanent oligotrophic lakes, ponds and pools
B - coastal	21A0	B1	
B - coastal	2210	B1	
B - coastal	2220	B1	
B - coastal	2230	B1	
B - coastal	2240	B1	
B - coastal	2250	B1	
B - coastal	2260	B1	
B - coastal	2270	no	mainly G3, minor part in B1
D - bogs_mires	7110	D1	

D - bogs_mires	7120	D1	
D - bogs_mires	7130	D1	
D - bogs_mires	7140	D2	
D - bogs_mires	7210	D4	BAN: not in ETC-BD list
D - bogs_mires	7220	D4	BAN: not in ETC-BD list
D - bogs_mires	7230	D4	
D - bogs_mires	7310	D3	
D - bogs_mires	7320	D3	
D - bogs_mires	7210	D5	
D - bogs_mires	1340	D6	
D - bogs_mires	1410	D5	mainly also A2
F - shrubs	4090	F7	
F - shrubs	5410	F7	
F - shrubs	5420	F7	
F - shrubs	5430	F7	
F - shrubs	5140	F5	
F - shrubs	5210	F5	
F - shrubs	5220	F5	
F - shrubs	5230	F5	
F - shrubs	5310	F5	
F - shrubs	5320	F5	
F - shrubs	5330	F5	
F - shrubs	6310	F5	
F - shrubs	1430	F6	
F - shrubs	1520	F6	
F - shrubs	5110	F3	
F - shrubs	5120	F3	
F - shrubs	5130	F3	
F - shrubs	10A0	F3	
F - shrubs	40C0	F3	
F - shrubs	2310	F4	
F - shrubs	2320	F4	
F - shrubs	4010	F4	

F - shrubs	4020	F4	
F - shrubs	4030	F4	
F - shrubs	4040	F4	
F - shrubs	4050	F4	

14.4 AGGREGATION OF POTENTIAL NATURAL VEGETATION CLASSES

ID_PotNatVeg	Name_PotNat_Veg	agg_Codes
1	Vegetation of coastal sand dunes, sea shores and Halophytic vegetation	P1,P2.1
2	Ombrotrophic mires (bogs)	S1
3	Minerotrophic mires (fens)	S3.2,S3.3
4	Polygonal mires, Palsa mires and Boreal aapa mire complexes	S2.1,S2.2,S3.1
5	Tall sedge fens	S3.4
6	Inland halophytic vegetation	P2.2
7	Subnival-nival vegetation of high mountains in the boreal and nemoral zone	A2
8	Alpine vegetation (Alpine grasslands, low creeping shrub, dwarf shrub and shrub vegetation, rock and scree vegetation) in the boreal, nemoral and Mediterranean zone	B2
9	Forest steppes (meadow steppes alternating with deciduous broad-leaved forests) and dry grasslands alternating with xerophytic scrub	L
10	Mediterranean sclerophyllous forests and scrub	J
11	Oroxerophytic vegetation (thorn-cushion communities, tomillares, mountain steppes, partly scrub)	N
12	Arctic polar deserts, Northern arctic tundras, Middle arctic tundras, Southern arctic tundras, Mountain tundras and sparse mountain vegetation (Island, Kola penisula and Ural)	A1,B1.1,B1.2,B1.3,B1.5
13	Arctic shrub tundras	B1.4
14	Atlantic dwarf shrub heaths	E

14.5 DEFINITION OF GEOLOGICAL SUBSTRATE IN ESDB

The classification of the dominant parent material was used to derive the differentiation between calcareous and siliceous soils.

Database field: PAR-MAT-DOM2

calcareous…1 Sediment…2 siliceous….3	ID_DOM1	ID_DOM2	name_Group_DOM2
0		0	No information
2	1	10	consolidated-clastic-sedimentary rocks
2		11	psephite or rudite
2		12	psammite or arenite
3		13	pelite, lutite or argilite
3		14	facies bound rock
2	2	20	sedimentary rocks (chemically precipitated, evaporated, or organogenic or biogenic in origin)
1		21	calcareous rocks
0		22	evaporites
3		23	siliceous rocks
3	3	30	igneous rocks
3		31	acid to intermediate plutonic rocks
3		32	basic plutonic rocks
3		33	ultrabasic plutonic rocks
3		34	acid to intermediate volcanic rocks
3		35	basic to ultrabasic volcanic rocks
3		36	dike rocks
3		37	pyroclastic rocks (tephra)
3	4	40	metamorphic rocks
3		41	weakly metamorphic rocks
3		42	acid regional metamorphic rocks
3		43	basic regional metamorphic rocks
3		44	ultrabasic regional metamorphic rocks
1		45	calcareous regional metamorphic rocks
3		46	rocks formed by contact metamorphism

3		47	tectogenetic metamorphism rocks or cataclasmic metamorphism
0	5	50	unconsolidated deposits (alluvium, weathering residuum and slope deposits)
2		51	marine and estuarine sands
3		52	marine and estuarine clays and silts
2		53	fluvial sands and gravels
3		54	fluvial clays, silts and loams
3		55	lake deposits
3		56	residual and redeposited loams from silicate rocks
1		57	residual and redeposited clays from calcareous rocks
2		58	slope deposits
2	6	60	unconsolidated glacial deposits/glacial drift
2		61	morainic deposits
2		62	glaciofluvial deposits
2		63	glaciolacustrine deposits
3	7	70	eolian deposits
3		71	loess
3		72	eolian sands
0	8	80	organic materials
0		81	peat (mires)
0		82	slime and ooze deposits
1		83	carbonaceaous rocks (caustobiolite)
2	9	90	anthropogenic deposits
2		91	redeposited natural materials
2		92	dump deposits
2		93	anthropogenic organic materials

14.6 SUBALPINE ZONE

Main approach:

Deriving subalpine zone by analysis of highest distribution of broadleaved forest.

1. Defining potential subalpine zone as mask for analysis
   1.1. Preparation of two data sources:
      a) Selection of all polygons, that represent subalpine (or higher zones) from Potential Natural Vegetation (EurVegMap) in scale of 1:25 Mil.
      b) Calculation of all areas > 1.700 m from DEM 100x100 m and conversion to polygon. Exclusion of very small areas.

   1.2. Merging of the two potential subalpine zone layers and creation of a 25 km Buffer representing the analysis mask

2. Preparation of forest data
   2.1. Resampling of JRC Forest TYPE MAP (25x25m) to 100x100m
      => Deriving forest type "coniferous" and "broadleaved"
      => Deriving water mask (distinguishing freshwater and seawater)

3. Intersection of forest data, potential subalpine zone and DTM
   3.1. Selection of pixels "broadleaved" and clipping to analysis mask
   3.2. Intersection of clipped broadleaved forest pixels with DTM 100x100m
   3.3. Filtering of outliers (single pixels in area of 1 km², pixels > 2.200 m altitude, CLC-glaciers, CLC-bare rocks)

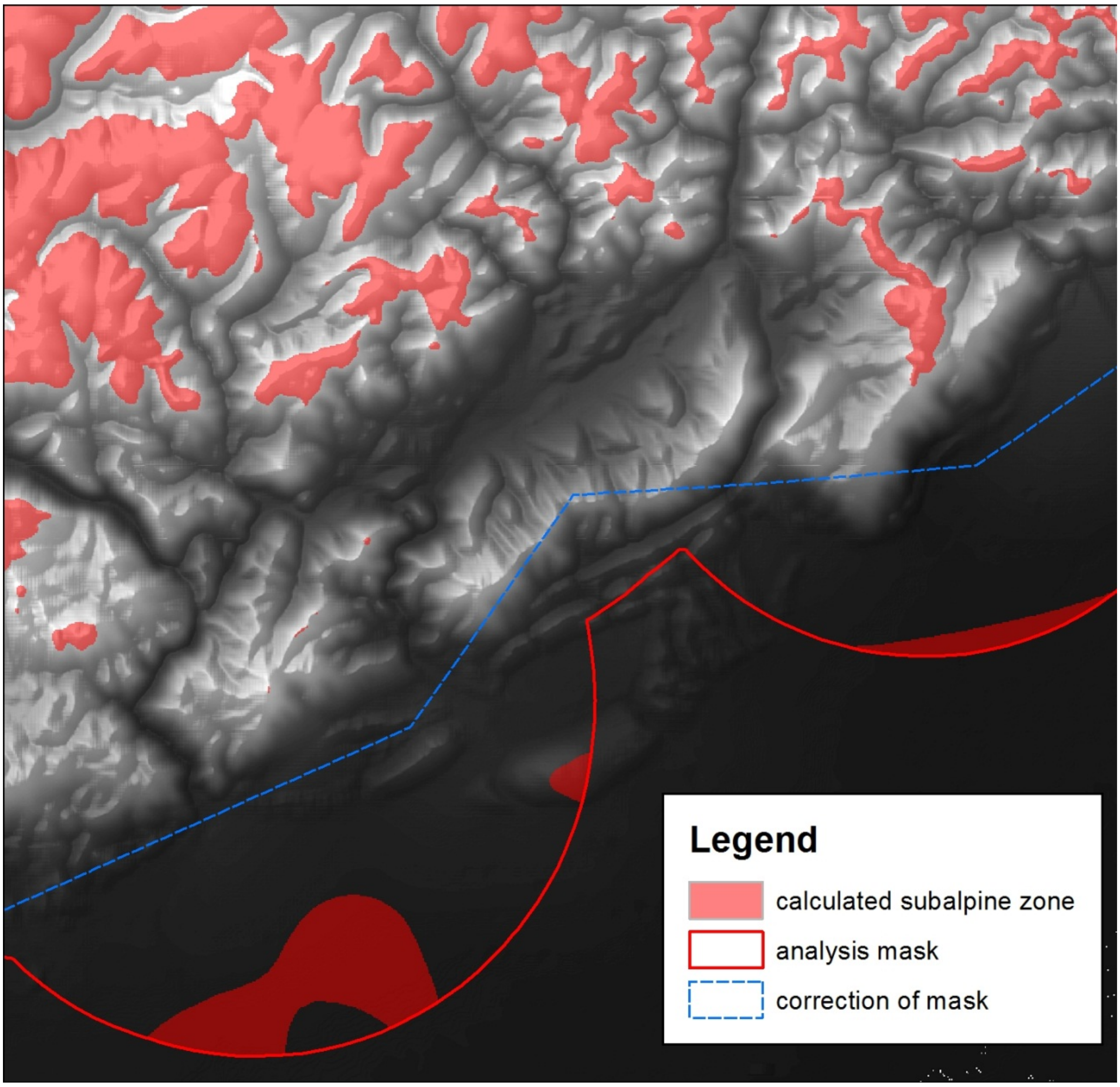
4. Calculation of subalpine zone
   4.1. Calculation of Focal Statistics (MAXIMUM altitude, 100x100m) in area of 5 km² around every pixel of broadleaved forest (with option "Ignore NoData").

   4.2. Aggregation to 10x10km by Maximum and conversion to points as basis for interpolation (this operation is executed to decrease number of interpolation points and by this accelerate the interpolation process).

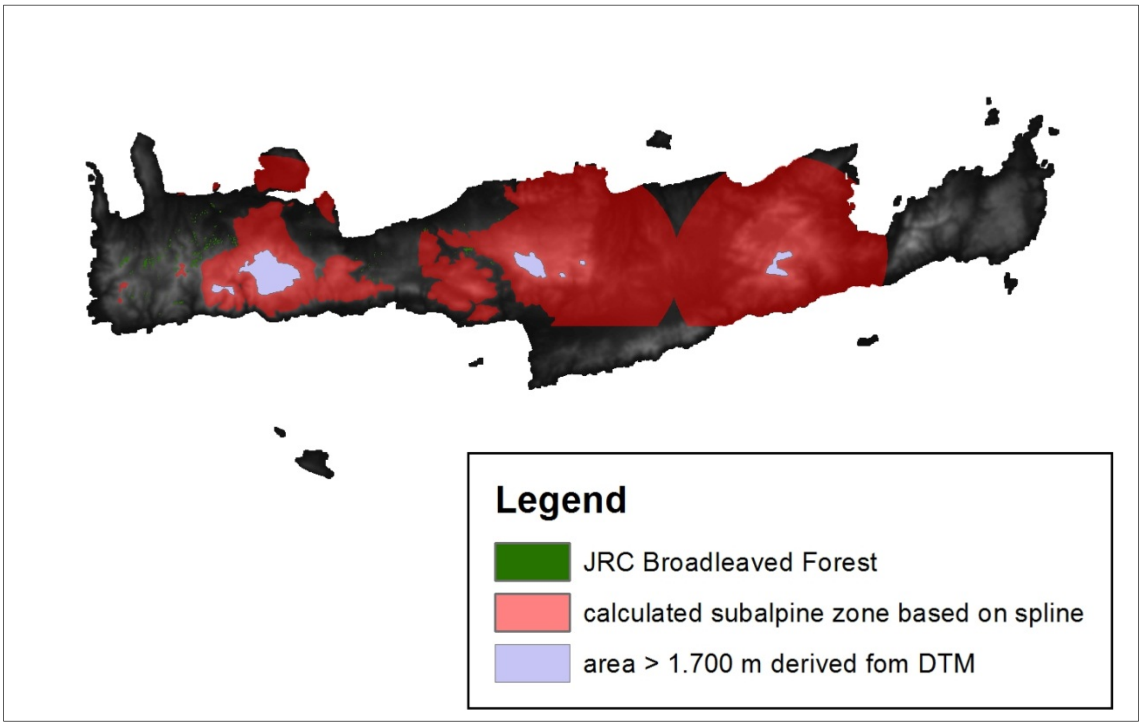
   4.3. Interpolation of potential boundary of *high montane/subalpine* zone by executing Spline 100x100m.

   4.4. Comparison of SPLINE with DTM: pixels of the DTM that are higher than the spline represent subalpine/alpine zone.

5. Correction of the results
   5.1. In fringe areas the result based on the interpolated spline shows errors and hast to be corrected.

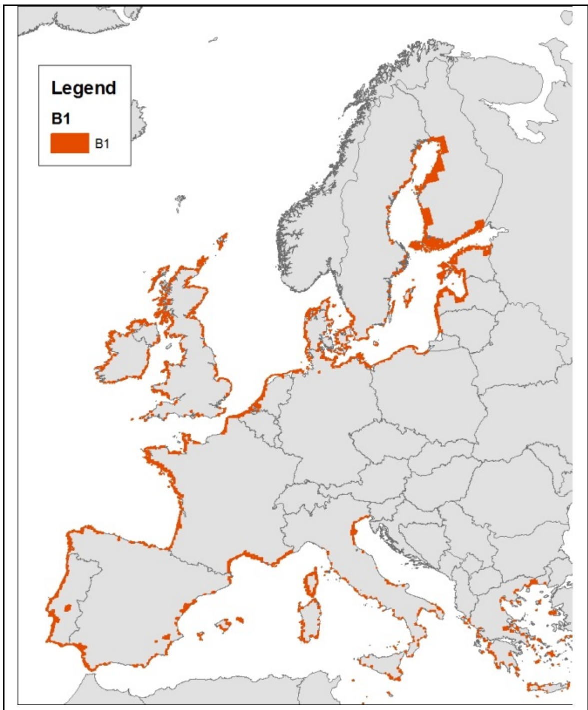


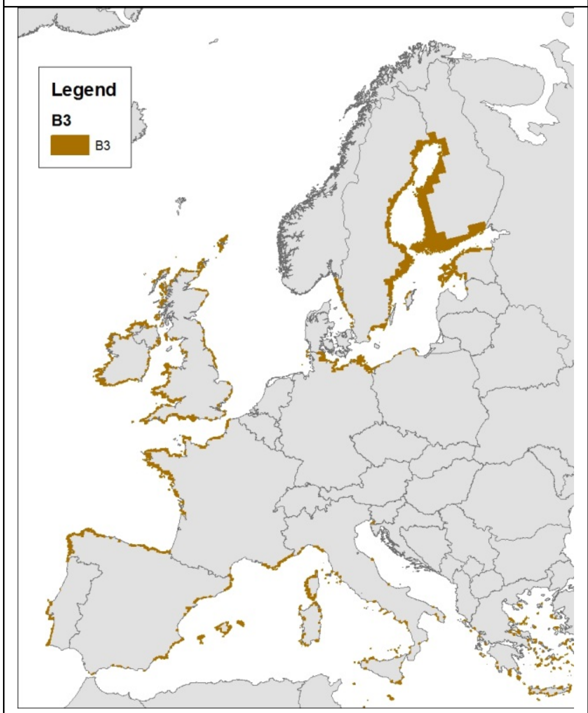
5.2. The method based on the distribution of broadleaved forests shows weaknesses in some mediterranean areas (e.g. high planes in turkey) and especially islands (e.g. Crete, Sicily, Cypres etc.). In areas with questionable results polygons derived by DTM (> 1.700) are taken and integrated.



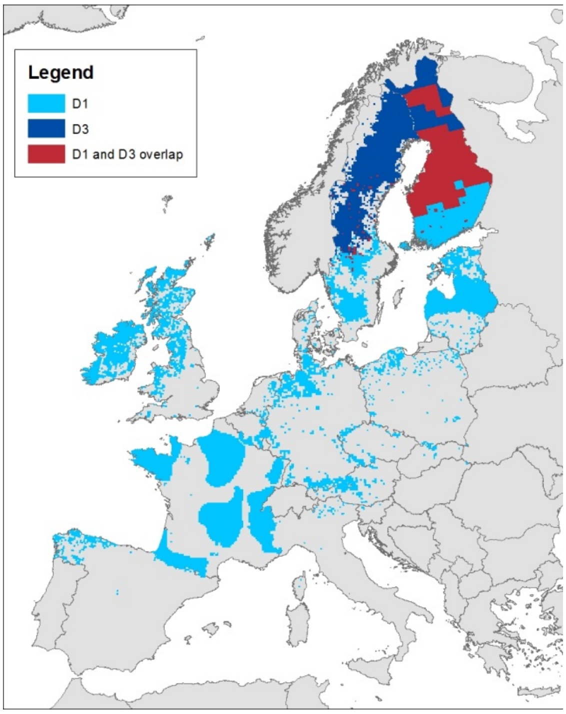
14.7 ART. 17 DISTRIBUTION MAPS

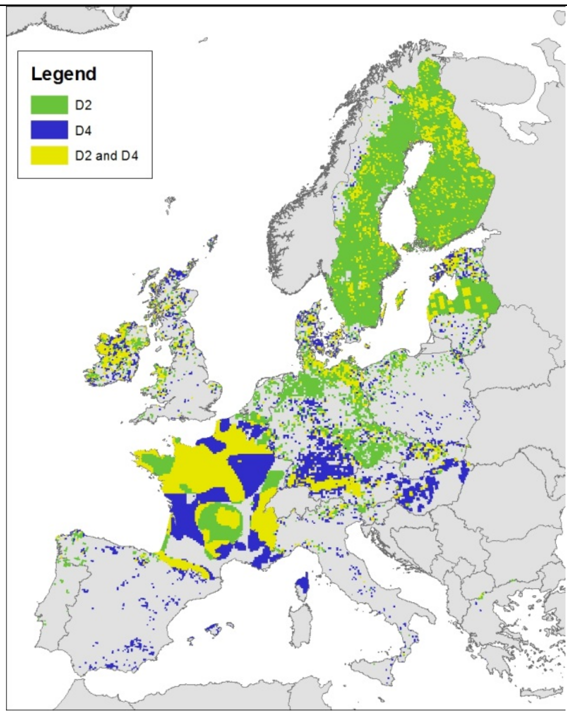
14.7.1 B Coastal habitats

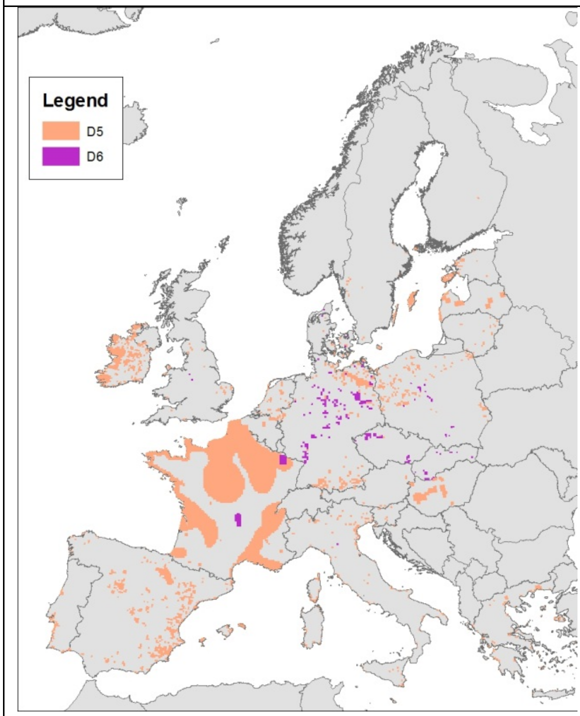




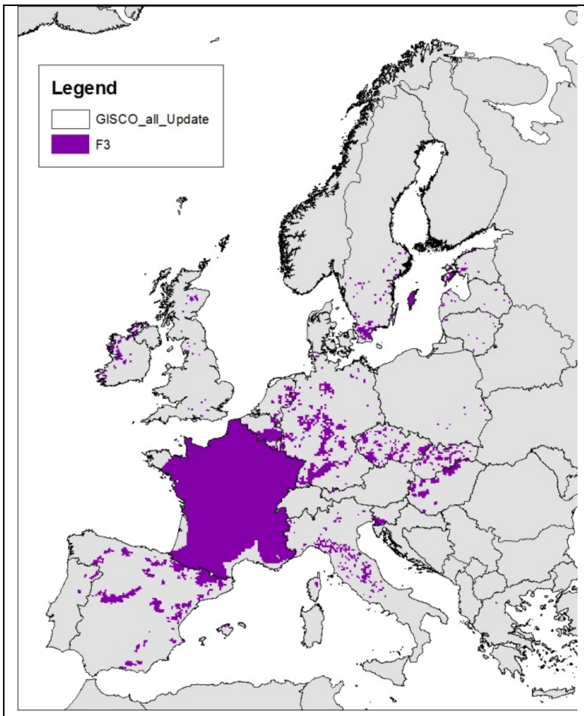
14.7.2 D bogs and mires

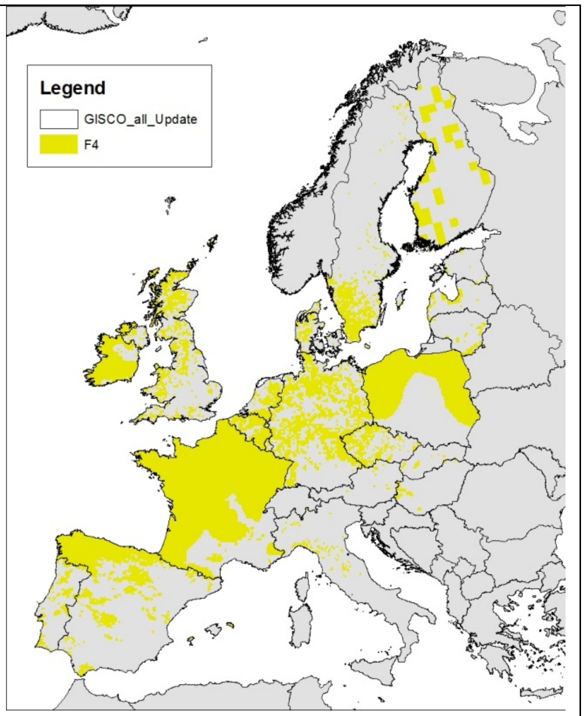


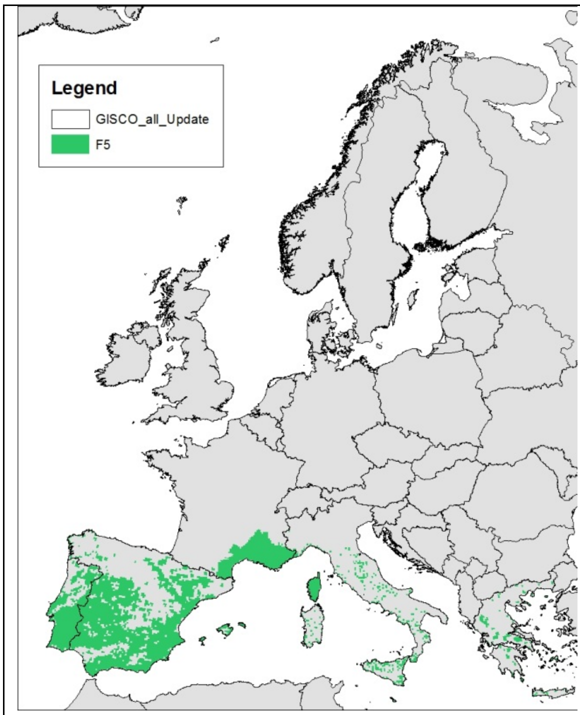


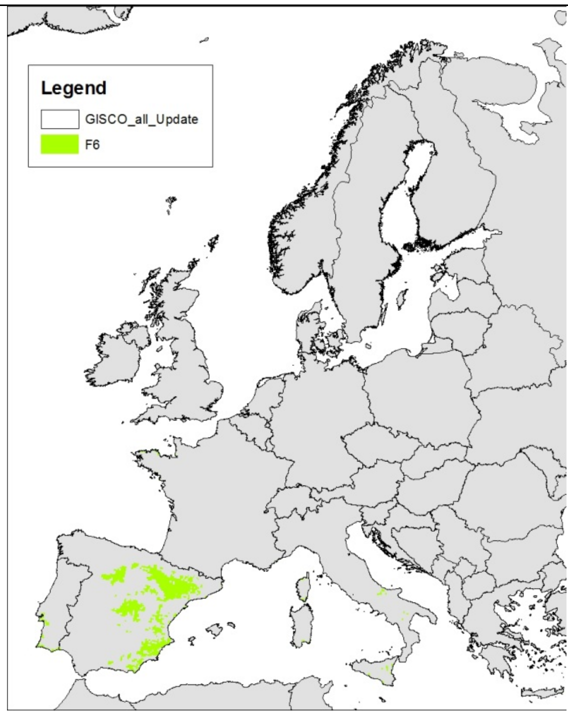


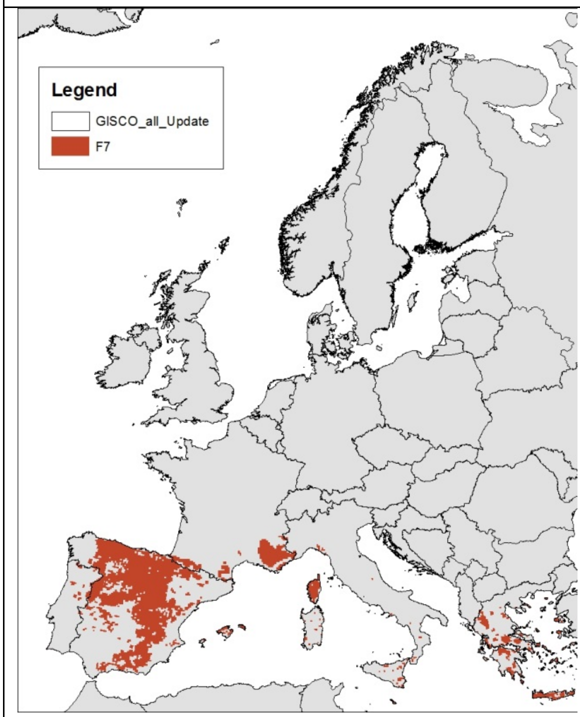
14.7.3 F heathlands






Legend
GISCO_all_Update
F5


Legend
GISCO_all_Update
F6


Legend
GISCO_all_Update
F7

15.1 HABITAT MODELING – DESCRIPTION OF ANNEX I (EXAMPLE)

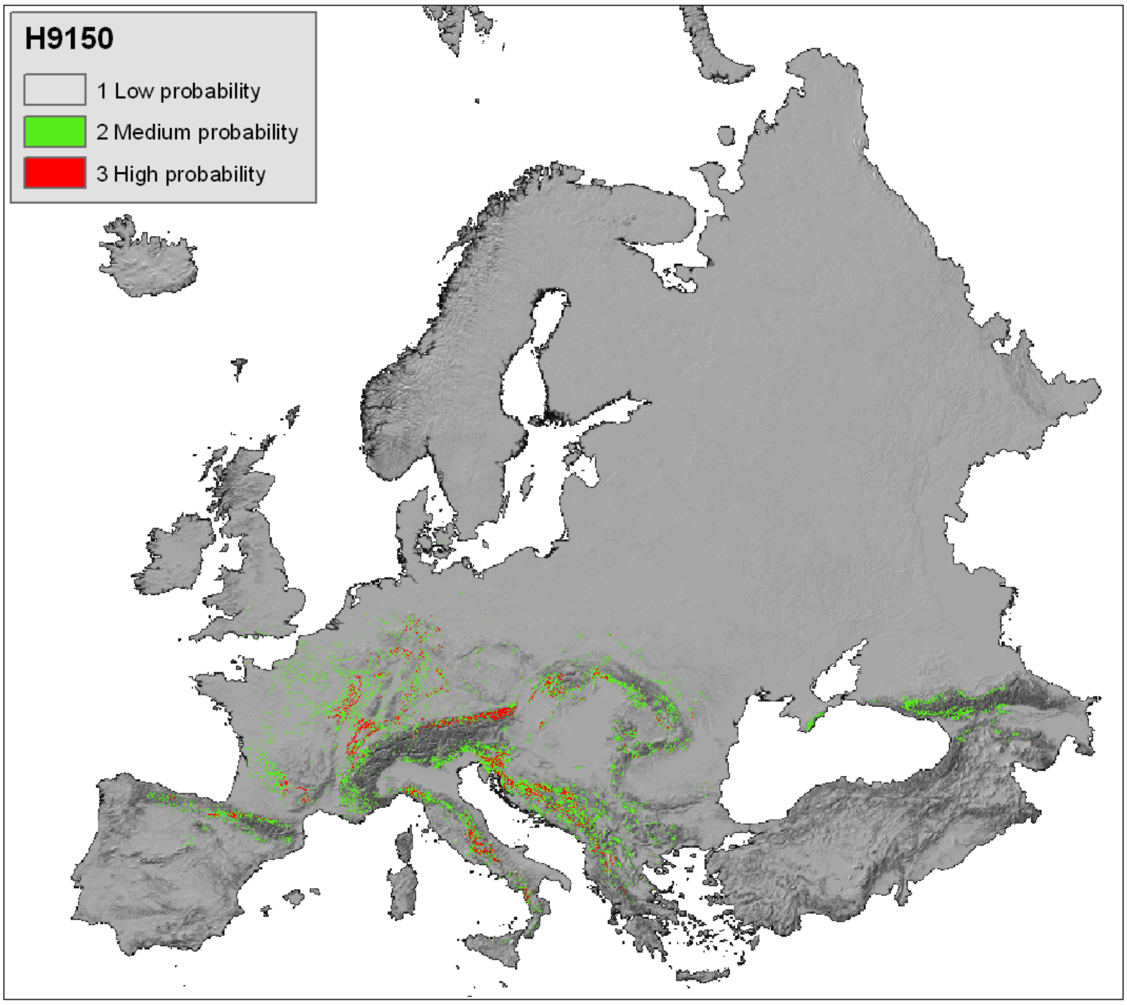
Medio-European limestone beech forests of the Cephalanthero-Fagion
Natura 2000 habitat type code **9150**
EUNIS class G1.66: Medio-European limestone [Fagus] forests
Palearctic habitat code (and Corine Biotopes) **41.16**
Priority Habitat: No
Parent: Foreststs of Temperate Europe (9100)
Description
Xero-thermophile *Fagus sylvatica* forests developed on calcareous, often superficial, soils, usually of steep slopes, of the medio-European and Atlantic domaines of Western Europe and of central and northern Central Europe, with a generally abundant herb and shrub undergrowth, characterized by sedges (*Carex digitata*, *Carex flacca*, *Carex montana*, *Carex alba*), grasses (*Sesleria albicans*, *Brachypodium pinnatum*), orchids (*Cephalanthera* spp., *Neottia nidus-avis*, *Epipactis leptochila*, *Epipactis microphylla*) and thermophile species, transgressive of the *Quercetalia pubescentipetraeae*. The bush-layer includes several calcicolous species (*Ligustrum vulgare*, *Berberis vulgaris*) and *Buxus sempervirens* can dominate. Sub-types : • 41.161 - Middle European dry-slope limestone beech forests Middle European sedge and orchid beech woods of slopes with reduced water availability. • 41.162 - North-western Iberian xerophile beech woods *Fagus sylvatica* forests of relatively low precipitation zones of the southern ranges of the Pais Vasco and of superficially dry calcareous soils of the Cordillera Cantabrica, with *Brachypodiumpinnatum* ssp. *rupestre*, *Sesleria argentea* ssp. *hispanica*, *Carex brevicollis*, *Carex ornithopoda*, Interpretation Manual - EUR25 Page 98 *Carex sempervirens*, *Carex caudata*, *Cephalanthera damasonium*, *C. longifolia*, *Epipactis* *helleborine*, *Epipactis microphylla*, *Neottia nidus-avis*.
Plants
Fagus sylvatica, Carex digitata, *C. flacca*, *C. montana*, *C. alba, Sesleria albicans*, *Brachypodium pinnatum, Cephalanthera* spp., *Neottia nidus-avis*, *Epipactis leptochila*, *Epipactis microphylla, Buxus sempervirens*.
Geographic distribution
EU27 (minus the Netherlands and Portugal)
http://eunis.eea.europa.eu/habitats-factsheet.jsp?idHabitat=10189

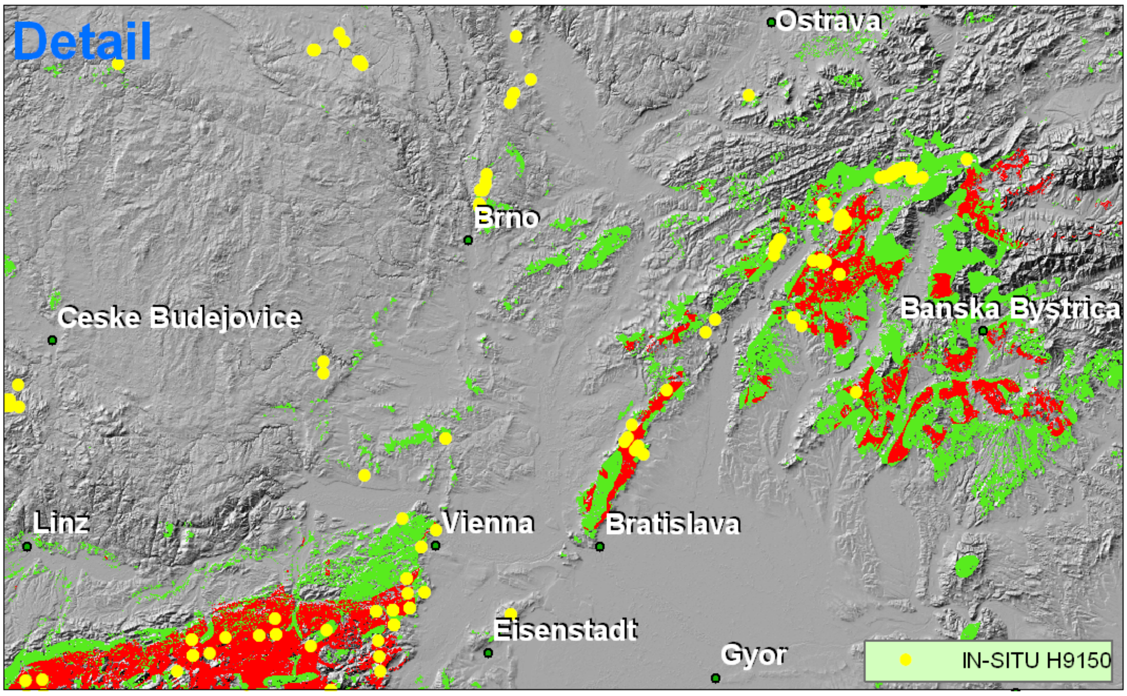
15.1.1 Knowledge rules

CLC:	**311** - Broad-leaved forest											
Annex I:	**9150** - Medio-European limestone beech forests of the Cephalanthero-Fagion											
Mapping rules:	Atlant. Central all Alpine South / Continental 400-1200 + Calcareous soils + Fagus.											
Indicator species:	Fagus sylvatica, Carex digita, Cephalantera spp., Neotttia nidus-avis.											
GHC (BioHab):	Forest phanerophytes / Winter deciduous + Fagus over 70% + shallow dry calcareous soils + steep slopes + ground flora species.											
Field identification:	A well defined category but grades into 9130.											
Occurrence:	Widespread in large patches but often replaced by Picea abies in the Alps.											
Direct threats:	Felling withy deeper soils conversion to conifer.											
Climate change:	Thermophilic species will be favoured.											
Succession:	Climax.											
Distribution (sites):	*aln*	*bor*	*nem*	**ATN**	**ALS**	**CON**	**ATC**	**PAN**	**LUS**	**MDM**	**MDN**	*mds*
Distribution (Bunce):	*aln*	*bor*	*nem*	*atn*	**ALS**	*con*	**ATC**	**PAN**	*lus*	*mdm*	*mdn*	*mds*

Photo 1 Medio-European limestone beech forest on a slope above the Ticha orlice river, Ceskomoravska-mezihori hills, Eastern Bohemia, Czech Republic (photo Pavel Kovar).

RESULT H9150 MEDIO-EUROPEAN LIMESTONE BEECH FORESTS





Yellow dots indicate the in-situ vegetation relevés for the selected habitat type H9150, and shows that the probability map is quite good for the specific area. Nevertheless, this is not the fact for all habitats, since the quality of the probability maps depends on the straightforwardness of the knowledge rules and the availability of qood quality envirionmental data layers on which the modeling is based. If there is a lack of information on the quality of the various freshwater water bodies, it will become difficult to model these fresh water habitats.