Mapping European Habitats to support the design and implementation of a Pan-European Ecological Network

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Mapping European Habitats to support the design and implementation of a Pan-European Ecological Network

The PEENHAB project

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ABSTRACT

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The overall objective of the PEENHAB project to develop a methodology to identify spatially all major habitats in Europe. The Pan-European Ecological Network (PEEN) anticipates in the development of an indicative map of an ecological network for the whole of Europe. The design of such an indicative map requires information about the spatial distribution of habitats and species in Europe, as well as inside as outside protected areas. Therefore, the development of European habitat maps is a prerequisite for the further development of a pan-European ecological network. The habitat classes as given in Annex I of the Habitats Directive, better known as Natura 2000 habitats, are taken as the reference. On the basis of the Annex I habitat definitions knowledge rules were defined in a flexible manner using graphic models within a GIS environment to optimally combine existing spatial databases (such as land cover, soil data, topographic data and species distribution maps) to identify the spatial distribution of the major European habitats. At the same time a bottom-up approach is used in collaboration with the SynBioSys project. Currently, a module has been made to predict the Annex I habitats using the Map of the Natural Vegetation of Europe. Both approaches were integrated within the present PEENHAB project.

Keywords: Habitat mapping, Habitat Directive, PEEN, land cover, species ditribution maps, spatial information, GIS, CORINE, SynBioSys, indicator species.

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Front picture: A "Medio-European limestone beech forests of the Cephalantero-Fagion" (Annex I habitat type 9150) on steep slopes of the Swabian Jura between 430 and 825 m., near Reutlingen/Germany (U. Bohn, May 1993)

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The Pan-European Ecological Network (PEEN) anticipates in the development of an indicative map of an ecological network for the whole of Europe. The design of such an indicative map requires information about the spatial distribution of habitats and species in Europe, as well as inside as outside protected areas. Information about the spatial distribution of species is being collected by many international organisations. However, there are no explicit maps about the spatial distribution of habitats in Europe. Therefore, the development of a European habitat maps is a prerequisite for the further development of a pan-European ecological network.

The overall objective of the present PEENHAB project to develop a methodology to identify spatially all major habitats in Europe in order to produce an indicative map of a Pan-European Ecological Network. The definitions of the habitats as given in Annex I of the Habitats Directive, better known as Natura 2000 habitats, are taken as the reference. On the basis of the Annex I habitat definitions knowledge rules were defined using graphic models within a GIS environment to optimally combine existing spatial databases (such as land cover, soil data, topographic data and species distribution maps) to identify the spatial distribution of the major European habitats. At the same time a bottom-up approach is foreseen in collaboration with the SynBioSys Europe project. The compiled distribution maps of the top-down approach will be confronted with distribution maps of the relevant vegetation types, based on original data (vegetation relevés) representing the vegetation types in question. Currently, a module has been made to predict the Annex I habitats using the Potential Natural Map of Europe and the attached database attribute "diagnostically important species". Both approaches are being combined within the present PEENHAB project.

The methodology has been demonstrated for Annex I habitat type 9150 "Medio-European limestone beach forest of the Cephalanthero-Fagion" resulting in a 250m resolution map with the spatial distribution of the calcareous beech forests in Europe. A validation, as a visual comparison exercise, has been performed using publications of Annex I forest habitat maps of France. This validation suggests a good match between the classification result and the reference data. A more quantitative validation has been performed using the CORINE biotopes database. Of the 44 Biotopes sites with "Beech forests on limestone (41.16)" across Europe 73% of the biotopes sites were identified by our habitat classification. Uncertainties in the habitat mapping approach are especially foreseen in the case of weak Annex I habitat descriptions, uncertainties in the core data, or if spatial distribution maps are not available for the specific indicator species. In 2004 25 major habitat types will be mapped for pan-Europe using the habitat mapping methodology as described in this report.

1 Introduction

1.1 Background

The highly industrialised and expanding society and its associated modern management techniques in agriculture and forestry, have caused dramatic declines in the quality and extent of habitats. These trends are widely recognised and forced national and international bodies to adapt their nature conservation policies with the establishment of ecological networks and the improvement of the environmental and spatial conditions are part of the policies designed to maintain and improve biodiversity. The development of a Pan-European Ecological Network (PEEN) and the development of the Natura 2000 network (the Habitats and Birds Directive) are the most important policy initiations at the European scale. For the sole protection of primary nature conservation areas, the development of the Natura 2000 network (EU Council Directive, 1992) is very significant, but at the same time, it does not guarantee the maintenance of biodiversity in the wider countryside. Biodiversity of the countryside and the environmental conditions that sustain it, are important for a number of reasons (pers. comm. Bunce, de Blust):

Although many species, may have their primary habitat in protected areas, they also often depend on the countryside in various ways (e.g. during migration, dispersion, foraging).

Because spatial relationships are operating on the landscape scale, the environmental pressures influencing biodiversity of the rural areas also affects the habitat quality of the protected areas (e.g. agricultural drainage affects surrounding wetlands).

There is a clear demand by society to have biodiversity within ones reach, in the wider countryside, as well as in designated nature areas, as indicated by local nature trails, walks and interpreter centres.

There is therefore a need to develop additional policy instruments for nature conservation outside protected areas, that are equally appropriate to those applied in the protected areas. One such policy instrument is the development of a Pan-European Ecological Network (PEEN) which can now also anticipate towards restricting potential losses of biodiversity due to climate change (van Opstal, 1999). Ecological networks are important for nature conservation because they are generally recognised by politicians and the public as a valid spatial planning tool to protect threatened species and their habitats. "Since the endorsement of the Pan-European Biological and Landscape Diversity Strategy (PEBLDS) by 54 European countries in 1995, the setting up of a Pan-European Ecological Network (PEEN) has become one of the priorities of European Nature Conservation. PEEN is to be a physical network to conserve a full range of ecosystems, habitats, species and their genetic diversity and landscapes of European importance (van Opstal, 1999). PEEN is to be based on existing initiatives and European directives, its backbone being Natura 2000

(EU Council Directive, 1992) and the Emerald Network" (van Opstal, 1999). The PEEN concept is designed to strengthen the ecological coherence in Europe as a whole with a common set of criteria consisting of core areas, corridors, buffer zones and nature development areas. For the design a spatially coherent ecological network in Europe, it is necessary not only to take the Natura 2000 sites into consideration but also to get a broad overview of the natural and semi-natural habitats in Europe both inside and outside protected areas.

One of the major goals of the PEEN project is to develop an indicative map of the Pan-European Ecological Network for the whole of Europe (van Opstal, 1999). The design of such an indicative map together with an established pan-European ecological network in the end, requires information about the spatial distribution of habitats and species in Europe, as well as inside as outside protected areas. Information about the spatial distribution of species is being collected by many international organisations (e.g. Birdlife International). However, there are no explicit maps about the spatial distribution of habitats in Europe. Therefore, the development of a European habitat map is a prerequisite for the further development of a pan-European ecological network. Furthermore, provision of European figures on the extent of habitats and biodiversity is fundamental for general policy formulation for the maintenance and enhancement of biodiversity across Europe.

1.2 Objective

The overall objective of this project to develop a methodology to identify spatially all major habitats in Europe in order to produce a indicative map of a Pan-European Ecological Network. The definitions of the habitats as given in Annex I of the Habitats Directive (European Commission, 1999) are taken as the reference. On the basis of these habitat definitions ecological knowledge rules will be defined within a GIS environment to optimally combine existing spatial databases (such as land cover, soil data, topographic data and species distribution maps) to identify the spatial distribution of the various habitats. Therefore, a flexible spatial data infrastructure needs to be developed to exploit existing and new spatial information and in which the (ecological) knowledge rules are explicitly defined.

Before maps of European habitats can be produced the following objectives have to be met within the project:

1. Identification, availability and processing of core spatial data sets.
2. Establishment of decision rules for each habitat based on the available spatial data sets and their description in Annex I. Additional knowledge from experts is also needed here.
3. Establishment of a GIS environment in which the decision rules are designed and executed to produce a set of habitat maps.
4. Validation of the developed methodology for a number of selected habitats by experts and potential end users.

This report concentrates on these four objectives.

1.3 Map requirements

- Coverage: pan-Europe, extending from Nova Zembla in the north to Turkey in the south and from Ireland in the west until the Urals in the east.
- Scale: A European habitat map or a set of individual European habitat maps is needed for the design of a Pan-European Ecological Network with a spatial scale of at least 1:5 M. A scale of 1:2,500,000 (1:2.5M) to 1:5,000,000 (1:5M) is aimed at for the final European Habitat Map. At a scale of 1:2.5M it means that 1mm on the map will have a distance of 2.5 kilometres in reality. Therefore a linear feature must have a minimum width of 2.5 kilometres to become mappable and the minimum size of a mapping unit (MMU) will be 100 square kilometres (4mm by 4 mm on a map of 1:2.5M means 10 by 10 km in reality). Such a scale restricts the number of habitats to be delineated (for example habitat 8310 "caves not open to the public").
- Thematicy: Annex I of the Habitats Directive has three hierarchical levels. At the first level there are nine major natural and semi-natural habitat formations. At the second level there are 33 classes. At the third level there are 198 habitat classes of which 65 are priority habitats. Only at the third level the habitat classes (198 habitats) are being described (European Commission, 1999). A choice had to be made at which level of Annex I the habitats should be mapped. It was decided to produce, firstly, a European Map of the habitat formations (nine major formations of level I). Secondly, representative habitat maps will be produced at the third level of Annex I.

1.4 Expected limitations

- Poor definitions and descriptions of habitats with no clearly defined terms.
- Large variations in data sets. A number of data sets have been identified to provide core data to identify the habitat classes. The core datasets are: the CORINE land cover database, the Atlas Florae Europaeae database, the Digital Elevation Model, and the European Soil Database. These datasets differ in: accessibility, extent, scale, accuracy and reliability. As an example, the CORINE land cover database (scale 1:100,000) covers most of Europe, EU15, except for Sweden, and the EU access countries but still misses a large area for a true pan-European coverage. The CORINE land cover database covers 37% of pan-Europe (see paragraph 3.6.3). The same remarks apply to the European Soil database (1:1M).
- The Atlas Florae Europaeae has at this moment 12 volumes published (1972-1999) and covers 3720 plant species of the 12.000 plant species in Europe. The database includes currently 2109 plant species. This limits its use to identify many habitats.
- Difficulties in the translation of the soil database in ecological stand factors.

1.5 Policies in relation to habitat mapping

1.5.1 Pan European Biological and Landscape Diversity Strategy (PEBDLS)

The extent of Europe's semi-natural habitats and their associated biodiversity are in severe decline. Highly valuable and vulnerable ecosystems of international importance, e.g. coastal habitats, marine areas, wetlands, alpine meadows and other semi-natural landscapes, are under severe threat. The Pan-European Biological and Landscape Diversity Strategy presents an innovative and proactive approach to stop and reverse the degradation of biological and landscape diversity in Europe. It addresses all biological and landscape initiatives under one European approach (Council of Europe, 1996).

The strategy seeks to conserve ecosystems, habitats, species with their genetic diversity and landscapes of European importance through the development of the Pan-European Ecological Network within 10 years (Opstal, 1999). The PEBDLS provides a consistent framework to implement the Convention on Biological Diversity (Convention on Biological Diversity, 1996) having the following objectives:

1. To reduce substantially and, if possible, eliminate the current threats to Europe's biological and landscape diversity,
2. To increase the resilience of Europe's biological and landscape diversity,
3. To strengthen the ecological coherence of Europe as a whole.
4. To ensure full public involvement in the conservation and protection of all (semi-) natural ecosystems and species that are endemic in Europe and/or characteristic for Europe.

One way to protect those ecosystems/habitats is the identification and protection of Natura 2000 sites (Habitats and Birds Directives) in Europe and another is to set-up a Pan-European Ecological Network..

1.5.2 Pan-European Ecological Network (PEEN)

The concept of the Pan-European Ecological Network was presented ten years ago. The establishment of a Pan-European Ecological Network (PEEN) has become one of the priorities of European Nature Conservation. The legal framework, the Pan-European Biological and Landscape Diversity and Strategy (PEBLDS), has enforced the setting up of the PEEN project. PEEN can be explained as a physical coherent network in which a range of ecosystems, habitats, species with their genetic diversity and landscapes of European importance are being enforced and conserved (van Opstal, 1999).

EU members and the candidate countries can contribute important building blocks to this network by designating Natura 2000 sites (EU Council Directive, 1992). Natura 2000 sites are special, legally protected zones that are designated under the provisions of the EU Habitats and Birds Directives. Non-EU countries that have signed and ratified the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention) can grant sites a protected status using this convention. Together with Natura 2000, these areas form the Emerald Green Network. Other European countries that are members of the Council of Europe can designate protected areas using the Pan-European Biological and Landscape Diversity Strategy (PEBLDS). The PEBLDS has been accepted as a policy instrument by all European countries and the UN (http://www.biodiversity-chm.nl).

The intended network does not only cover core areas, but also includes corridors, buffer-zones and nature development areas. The core areas are needed to conserve ecosystems, habitats, species and landscapes of European importance. Corridors, or stepping stones, are needed to improve the coherence in the fragmented natural areas. Restoration areas or nature development areas are needed to restore damaged nature elements. Buffer zones are needed to support and protect the network from adverse external influences (Opstal, 1999). The concept of an ecological network relies strongly on the scientific experience that areas which are too fragmented or isolated, do not support viable populations in the long run and therefore a network is needed that can support viable populations again not only by increasing their habitats again but also by improved interchange of the different genetic pools of the same species (Bouwma et al., 2002).

1.5.3 The Habitats Directive

The dramatic decline in the populations of many species is primarily due to the deterioration of their natural habitats which are necessary for their survival. In a few decades, the intensification of many human activities, in e.g. agriculture, forestry, industry, energy, transport and tourism, has led to fragmentation and/or loss of many habitats. Today, half of our mammal species and third of reptile, fish and bird species are endangered!. As for plants, 3000 species are endangered in Europe. Many of their habitats are severely damaged or have largely disappeared. Heathland, steppes and peat bogs have shrunk by 60 to 90%, according to the current Member States. Since the beginning of the century, 75% of the dunes in France, Italy and Spain have disappeared. Moreover, the abandonment of traditional forms of agriculture and pastoralism have led to a general impoverishment of biodiversity and the variety of European landscapes.

To encourage better management of Europe's natural heritage, the Community has gradually started a nature conservation policy within the member states. In 1992 the Maastricht Treaty reaffirmed the obligation to incorporate environmental protection into all European Union policies. Community legislation compromises two Directives: the “Birds” Directive and the “Habitats” Directive, which are concerned with the protection of natural habitats, fauna, flora and the creation of a European network of protected sites (Natura 2000 sites).

The Habitats Directive was adopted in 1992 (European Commission, 1999) the year of the United Nations Conference on Environment and Development in Rio de

Janeiro, and is the main community instrument to safeguarding biodiversity. Each Member State is responsible for identifying and designation of Special Areas of Conservation (SAC) which are important for the protection of the species and habitats in the long-term. The EU has a special responsibility for the conservation of habitats which are in danger of disappearing (e.g. posidonia beds, lagoons and alluvial forests). The Natura 2000 network (EU Council Directive, 1992) will include a sample of all habitats of Community Interest, especially the priority habitats (source: Natura 2000, managing our heritage, CR-99-96-875-EN-C). The Natura 2000 network covers already more than 15% of the Community territorial space.

1.5.4 Emerald Network

The Emerald network is a network of Areas of Special Conservation Interest (ASCIs), which is to be established in the territory of the Contracting parties and Observer States to the Bern Convention, including, among others, Central and Eastern European countries and the EU member States. For EU member States the Emerald network sites are those of the Natura 2000 network. The Emerald network has its legal basis in the Bern Convention, in particular Articles 1, 2, 3, 4, 6 and 9. The idea for the establishment of the Network of Areas of Special Conservation Interest (ASCI), otherwise known as the Emerald Network, was first launched in June 1989 when the Standing Committee of the Bern Convention (Convention of Bern, 1979). This initiative was in response to an increasing need to protect natural habitats, and was made at a meeting exclusively devoted to habitat conservation within the Convention.

1.5.5 Dutch Directive on Nature for People, People for Nature

The Dutch Parliament adopted the Directive "*Natuur voor Mensen, Mensen voor Natuur; nota natuur; bos en landschap in de 21e eeuw*" (Nature for People, People for Nature, policy document on nature, forest and landscape in the 21st century) on 13 July 2000 . This policy document (Ministerie van LNV, 2000) of the Dutch Ministry of Agriculture, Nature Management and Fisheries outlines the new nature policy for the coming decade until 2020. Although it is a strategic document it also contains a programme of goals and measures. One of the goals is that before 2020 the conditions must be in place for the long-term survival of the species and populations that were found in the Netherlands in 1982 (the year the Netherlands ratified the Bern Convention). One of the policy instruments that the Dutch Government is strongly stimulating is the establishment of ecological networks within national and international frameworks.

1.5.6 Dutch Convention Biodiversity International (BBI)

As a signatory to the Convention on Biological Diversity (CBD), the Netherlands has undertaken to implement its resolutions. The results can be seen in its policies for nature, agriculture, environment, fishing, spatial planning, infrastructure, water management, economic activities and development co-operation. The principles of the Convention have been integrated into Dutch policy by the respective ministries in four national policy documents, each of which contains an explicit international component (http://www.biodiversity-chm.nl). In the policy document "Nature for People, People for Nature (2000)" the Netherlands resolves to work towards international co-operation which will lead to a structural reversal of the worldwide loss of biodiversity. The Netherlands focuses its efforts on the protection of ecosystems and landscapes of international value that are of sufficient size and quality, and on the promotion of the sustainable use of biodiversity.

The International Biodiversity Policy Programme (BBI) now brings the Dutch environmental policy plans together and provides a broad overview of what the Netherlands has resolved to carry out in this respect. The BBI is therefore the logical successor to the international nature management programme (PIN), which ran from 1996 to 2000. In principle the BBI will run from 2002 to 2006. Many of the policy objectives are long-term and will not be realised, for example, until 2020; they will therefore remain on the Dutch policy agenda after 2006. For the purpose of subsidy schemes for nature projects in central and eastern Europe, the Government has issued a separate Central and Eastern European Action Plan, which should become part of the BBI.

On the European level, the Dutch government is working towards establishing a Pan-European Ecological Network (PEEN) by 2020. The PEEN will afford adequate protection to all European hot spots. The goal is to interconnect and sufficiently protect these hot spots. Those components of the Dutch National Ecological Network with international significance are obviously a part of the PEEN.

1.6 Related projects

1.6.1 SynBioSys Europe

SynBioSys Europe is an initiative of the European Vegetation Survey. It is an information system for the evaluation and management of biodiversity among plant species, vegetation types and landscapes. The project is co-ordinated by Alterra and will function as a network of distributed databases related through a webserver. GIS webmapping tools will be used for the visualisation of layers of information on plant species, vegetation and landscape data (http://www.synbiosys.alterra.nl/eu/). Hence, SynBioSys concentrates it work on three levels: species, vegetation and landscape, being explained in more detail below.

Species
SynBioSys is developing a standard species list for the European vascular and cryptogam flora. The list will be compiled by bringing together and analysing national floras. Computerised links between the SynBioSys checklist, national floras and

vegetation tables will enable standard query routines to highlight environmental conditions for sustaining plant communities.

Vegetation
On the vegetation level, SynBioSys Europe uses the newly completed report on European vegetation (Rodwell et al., 2002) on the basis of phytosociological alliances. This hierarchic classification comprises 15 formations, 80 vegetation classes, 233 orders and 925 alliances. For each vegetation unit the following items will be described: general description, species composition, structure and dynamics, ecology, geographic distribution, nature conservation and bibliography. A link to the EUNIS Habitat Classification is designed to help implementing the Natura 2000 and Emerald networks.

Landscape
For the landscape typology the recently published Map of Natural Vegetation of Europe by the Bundesamt für Naturschutz, Bonn, German (Bohn et al., 2003) will be used as a basis. Within SynBioSys Europe it is assumed that each mapping unit of PNV map represents a specific landscape because the potential natural vegetation is effectively predicted from relationships between soil and climate.

1.6.2 BioHab

BioHab is a recently started EU project (Concerted Action 2002-2005) will build upon a European network to set-up a framework for the co-ordination of information on biodiversity and habitats. The project is being co-ordinated by Alterra. The background of the project is that there is a gap between the coarse level of remotely sensed land cover categories and the detailed information on habitats. Knowledge about the intermediate level of information is essential to link with biodiversity and assess the impact of land use changes. BioHab is based on a series of workshops addressing individual topics. One of the first workshops has summarised existing European habitat classifications and will exploit the experience of the consortium to define a series of European General Habitats designed for field mapping. The main concept behind BioHab is to develop more complete, specific and user-friendly tools in support of implementing the Habitats Directive (EU Council Directive, 1992), including Natura 2000, as well as other policy initiatives, e.g. Emerald. It is specifically designed to assist field practitioners as well as stakeholders in their work, because a good understanding in the field will ultimately ensure that the habitats are well defined and have policy relevance. The development of the original CORINE biotope classification and its replacement, EUNIS, is a clear recognition of the need for a consistent approach to habitats. The EUNIS Habitat classification has been developed to facilitate harmonised description and collection of data across Europe through the use of criteria for habitat identification. It is a comprehensive pan-European system, covering all types of habitats from natural to artificial, from terrestrial to freshwater and marine habitat types. However, it is a theoretical classification, which has not been tested in the field, but because it presents a unique coverage of habitats in Europe, and it is the best unified approach for habitat description and will form the basis of BioHab habitat description.

1.6.3 BioPress

BioPress is a recently started EU project (Shared Cost Action 2002-2005) within the 5th framework and falls under the GMES (Global Monitoring of the Environment and Security) programme of the European Commission and the European Space Agency (ESA). One of the main targets of the GMES programme is to have an independent European regional monitoring system in support of the European Community. The subtitle of BioPress is: "linking pan-European land cover change to pressures on biodiversity". The GMES project is carried out by a consortium of 8 with amongst others Alterra and is co-ordinated by the Centre for Ecology and Hydrology (CEH at Monks Wood). The focus of BIOPRESS is to develop a standardised product that will link measures of historical (1950 – 2000) land cover changes in and around Natura 2000 sites to pressures on biodiversity. The characterisation of land cover changes in and around representative Natura 2000 sites will be based on visual interpretations of aerial photographs in relation to the CORINE land cover database (1950-1990). The project will also develop a pan-European land cover change monitoring concept based on the integration of CORINE Land Cover, Earth Observation and field data and will focus on the habitats in and around the Natura 2000 sites. The idea is to develop a spatially referenced product showing the main pressures on biodiversity in relation to Natura 2000 sites (intensification, abandonment, afforestation, urbanisation) from the integration of data on land cover changes (1950-1990/2000) and other biological, environmental and socio-economic data. A state-of-the-art semi- quantitative pressure state-model called MIRABEL (Petit et al., 2001) will convert the quantified pressures into assessments of biodiversity of specific habitats.

1.6.4 Planta Europa – Important Plant Areas in Europe

A central question of Planta Europa is: where are the best sites for plant conservation in Europe? Are current conservation efforts (e.g. the Habitats Directive) adequate for European wild plants and their habitats? At present there is no comprehensive information on the most important plant sites across Europe, or what is being done to maintain their conservation value. The Important Plant Areas (IPA's) will make a significant contribution to the Pan-European Ecological Network (PEEN). Identifying the most significant areas for wild plant conservation across Europe ultimately depends on the availability of sound information. Thus, whatever the motivation for applying the criteria, the net result will be a list of sites across Europe identified using consistent principles that relate to objective, scientific data, and the most up to date botanical knowledge available in each country. A site qualifies as an IPA under criterion C (criterion A relates to significant population of one or more specific plant species and criterion B relates to the exceptionally rich flora in a specific biogeographical zone) if the site is an outstanding example of a habitat type of global or European plant conservation and botanical importance. No list of habitat types of global conservation and botanical importance has yet been suggested. Habitat types of European conservation and botanical importance are defined as: all botanically based habitats listed in Annex I of the EU Habitats (European Commission, 1999) and Species Directive and all botanically based habitats listed in the Council of Europe's Bern Convention list of endangered natural habitats requiring priority action – the Emerald Network list. (Source: leaflet Planta Europa: guidelines for the selection of important sites and website: www.plantaeuropa.org.uk).

2 Habitat classifications and concepts

2.1 Concepts and definitions

Before discussing the various habitat classifications in a European context, it is necessary to have a closer look at the definition of the term habitat and other related terms. Within the European Community the term habitat has a deviating definition.

In the European Nature Information System (EUNIS) a ***habitat*** *is defined as follows:*

Plant and animal communities as the characterising elements of the biotic environment, together with abiotic factors (soil, climate, water availability and quality, and others), operating together at a particular scale.

While in the Dutch context a habitat is specified from the species requirements (as the living environment of a species) the authors prefer the ecotope approach in European habitat mapping. In landscape ecology the terms ecotopes and physiotopes are often being used and are closely related to each other.

By RIZA (Dutch Institute for Inland Water Management and Waste Water Treatment) an ecotope is defined as follows:

A physically limited ecological unit, whose composition and development are determined by abiotic, biotic and anthropogenic aspects together.

In other words, ecotopes are more or less homogeneous units on the scale of the landscape, identifiable by their similarities and differences in geomorphological and hydrological characteristics, vegetative structure and land use. The concept of the physiotope is used, in relation to the ecotope, for the unit that is homogeneous in respect of the abiotic conditions that are important to biotic aspects. In other words, if management and stage of development are the same, then the physiotope and ecotope are the same physical unit (source: RIZA, www.minvenw.nl/rws/riza/).

So, in short, the physiotope describes the abiotic environment (e.g. soil an water) and the ecotope is described by the physiotope and the vegetation structure. The vegetation structure can be derived to some degree from land cover maps and the physiotopes to some degree from amongst others soil databases and digital elevation models.

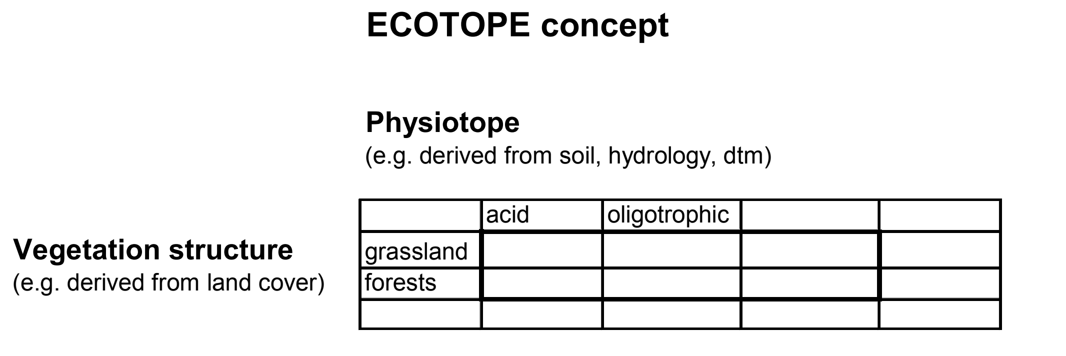

Figure 2.1 The ecotope concept

The physiotope can be described by: location, topography, geology, geomorphology, site characteristics such as acidity, humidity, organic content etc., soil type, trophic level and hydrology. In table 2.1 an example is given how an ecotope can be described in general terms.

Table 2.1 The ecotope can be described in general characteristics (Runhaar en van 't Zelfde, 1996)

Characteristics	**Classes**
Medium	Terrestrial, aquatic
Vegetation structure	Pioneer vegetation, grasslands, shrubs, forests, water vegetation etc.
Salinity	Salt, brackish, fresh (oligohalien, mesohalien, euhalien)
Substrate	Stony, etc.
Humidity	Open water, wet, humid, dry
Trophic level	Eutrophic, mesotrophic, oligotrophic
Acidity	Acid, alkaline
Dynamics	Blown,

Concluding, this project is designed to identify and map the major ecotopes in Europe. However, in relation to the Habitats Directive and EUNIS and to avoid confusion the term habitat will be used subsequently.

2.2 Existing classifications

Within the PEENHAB project the habitat types as defined in (European Commission, 1999) of the Habitats Directive will be used since the backbone of PEEN consists of Natura 2000 sites which were selected according to the Habitats Directive. Furthermore, Annex I habitats are described in more detail than for example the EUNIS habitat types. However, before making a final decision on the targeted habitats one has to be aware that many other European habitat classifications exist and to acknowledge their value. There are also many regional and national habitat classifications which will not be considered within this project. Knowledge of these other European habitat classifications is an advantage in the process of European habitat mapping. Unfortunately, these classifications differ in nomenclature, criteria and approach which makes it not always easy to relate and compare them. In Figure 2.2 an overview is given of the most important European habitat classifications (classification in terms of typology and nomenclature). The

EUNIS habitat classification has been developed under the guidance of the European Environmental Agency (EEA) and will probably become the new standard, however this classification is still in progress. The EUNIS habitat classification is based upon experience from amongst others the Palaearctic habitat classification (Devilliers & Devilliers-Terschuren, 1996) and the CORINE biotopes classification (CEC, 1991). CORINE biotopes and the Palaearctic classification are strongly related. The EUNIS habitat classifications has made formal links to the other classifications and made them available at the website (http://mrw.wallonie.be/dgrne/sibw/EUNIS). Unfortunately, the EUNIS habitat classification has not yet full descriptions for each habitat type.

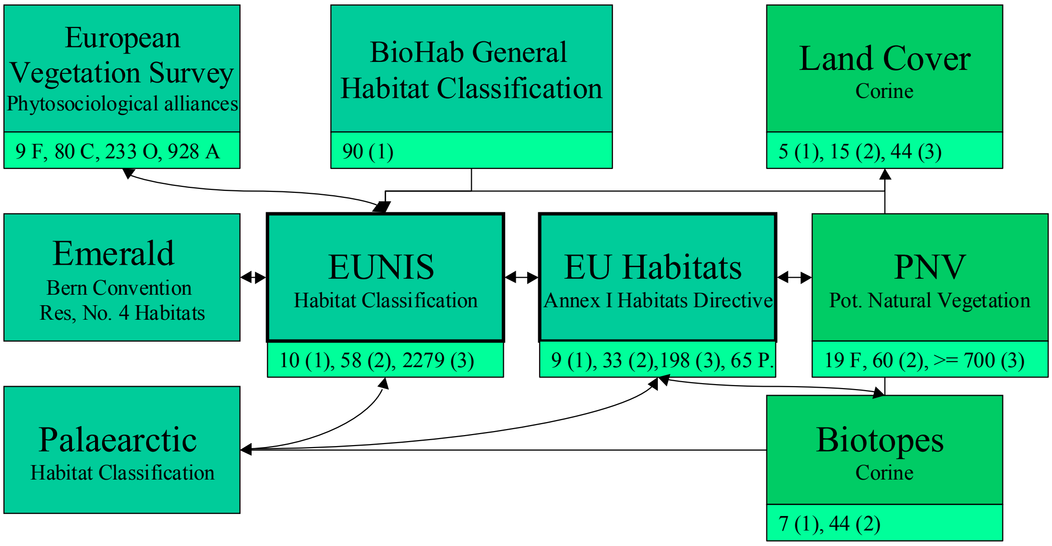

Figure 2.2 Relationships between various existing habitat classifications and related databases

The major European habitat classifications will be discussed in more detail in the following paragraphs, concerning the following classifications: Annex I habitats of the EU Habitats Directive, the EUNIS habitat classification and the phytosociological alliances as well as the nomenclatures of the following databases: CORINE Biotopes, CORINE land cover and the PNV map. All these classifications are theoretical and have not been tested in the field. Experience has shown that training and standardised field recording procedures are essential to produce reliable figures and clear definitions.

2.2.1 The Habitats Directive

The European Commission has published an Interpretation Manual of EU habitats in 1999 for the delineation of Natura 2000 sites (European Commission, 1999) . It states: "*The EU Habitats Directive is a Community legislative instrument in the field of nature conservation that establishes a common framework for the conservation of wild animal and plant species and natural habitats of Community importance; it provides for the creation of a network of special areas of conservation, called Natura 2000, to maintain and restore, at favourable* *conservation status, natural habitats and species of wild fauna and flora of Community interest".* Animal and plant species names are clearly presented in the Directive and, despite minor misspellings or use of synonyms. In contrast, the development of a common agreed definition is essential for the different habitat types of Annex I. See table 2.4 for an overview of the Annexes in the Habitats Directive. Annex I lists today 198 European natural habitat types (European Commission, 1999), including 65 priority (i.e. habitat types in danger of disappearance and whose natural range mainly falls within the territory of the European Union). Annex I is based on the hierarchical classification of European habitats developed by the CORINE Biotopes project (CEC, 1991) since that was the only existing classification at European level.

Table 2.2 Annexes of the Habitats Directive

ANNEX I: Natural habitat types of community interest whose conservation requires the designation of special areas of conservation.
ANNEX II: Animal and plant species of community interest whose conservation requires the designation of special areas of conservation.
ANNEX III: Criteria for selecting sites eligible for identification as sites of community importance and designation as special areas of conservation
ANNEX IV: Animal and plant species of community interest in need of strict protection.
ANNEX V: Animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures.
ANNEX VI: Prohibited methods and means of capture and killing and modes of transport.

Annex I of the EU habitat classification has nine major habitat classes on the first hierarchical level, on the second level there are 31 habitat groups (see Annex I) and on the third level there are 198 classes of which 65 are priority habitats (European Commission, 1999).

The 1991 Habitat classification (EU13) was extended in 1993 with the accession of Austria, Finland and Sweden which resulted in the inclusion of a new biogeographical region (the Boreal region). In total there are now six biogeographical regions distinguished: Boreal, Atlantic, Continental, Alpine, Mediterranean and Macaronesian. With the extension of the European Community to Central and Eastern Europe (EU28) in 2004 the Pannonian biogeographical region has to be added and some 20 new habitat types have been defined and will be added to Annex I habitat list. Within the framework of the present project it is important to observe that the level of detail of the descriptions differs largely between the 198 habitat types of Annex I. The Fennoscandinavian habitats especially have a very limited or very broad descriptions of the habitats which hampers their spatial identification. Moreover, habitat classes for the Iberian Peninsula are very well presented while habitats classes from e.g. Greece are underrepresented suggesting a poor balance in national experts that were involved in the establishment of the Annex I habitat list.

The description of Annex I habitats was provided by national experts. Each habitat is described in terms of:

1. Natura 2000 code: a four digit code
2. Explicit name of the habitat
3. Definition. This is a general description in terms in terms of vegetation, syntaxa, abiotic features and origin.
4. Characteristic species. Listing of animal and plant key species including details of their occurrence on Annexes II and IV
5. Geographic distribution
6. Correspondence with other classification systems
7. Bibliographic references.

Within the present (PEENHAB) project Annex I habitat list and their definition will be used. A major reason for this is that the habitats are adequately described making it possible to define knowledge rules for the spatial identification of important habitats. Furthermore that the Natura 2000 sites are identified according to Annex I habitat list and they these Natura 2000 sites will probably form the backbone of a Pan-European Ecological Network (PEEN).

2.2.2 CORINE Biotopes classification

The Biotopes project, as part of the CEC work programme, was concerned with "gathering, co-ordinating and ensuring the consistency of information on the state of the environment and natural resources in the Community". A first task was to establish a network of sources of information and expertise on all aspects of nature conservation. Within this network, agreed procedures were then developed and implemented. These procedures (in particular, the selection criteria and the various standard nomenclatures developed in the biotopes project) are now accepted as a standard by many international, national and regional agencies responsible for nature protection. The CORINE Biotopes database (CEC, 1991) was developed by DG XI during 1985-1990, and maintained by EEA from 1990-1993. The database now contains details of 7741 sites of European importance for nature conservation in 13 EU Member States, and is in active preparation in 10 non-EU countries and represents now the most comprehensive European source of such information. However, there are problems with consistencies, for example dry calcareous grasslands in north-west Scotland and parts of Italy are not identical due to inconsistent definition of the word "dry".

A habitat typology is needed to describe the recognisable communities formed by the interactions between flora, fauna and the abiotic environment. The typology must cover the complete geographical and environmental range of the European Union. To obtain easily recognisable and understandable units led to the use of the phytosociological classification of vegetation (Rodwell et al., 2002) as the main reference. However, EUNIS has subsequently extended to new habitats that uses criteria which are outside the phytosociological domain.

Due to amongst other the emphasis on human-influenced habitat systems and reference to physical features the typology deviated from the phytosociological hierarchy. Within the Biotopes project of site selection only the natural, near-natural and semi-natural habitats have been considered.

The CORINE Biotopes classification has seven major habitat groups on the first level and 45 classes on the second level (see Appendix 3). In total the CORINE Biotopes classification has six levels with an enormous amount of habitat classes at the lowest levels (CEC, 1991).

2.2.3 Palaearctic Habitat classification

The Palaearctic habitat classification (Devilliers & Deviliers-Terschuren, 1996) can be considered as a follow up of the CORINE Biotopes project to complete the description of existing European habitats, amongst others due to the extension of the European Community towards Eastern and Northern Europe. The setting-up of the Palaearctic classification has been sponsored by the Commission to increase the knowledge of the variability of habitats in Europe. The Palaearctic classification has been developed over the years in several stages corresponding to successive extensions of range and increase in precision (www.kbinirsnb.be/cb/databases/cb_db_physispal_eng.htm). The higher level habitats (see amongst others Table 2.2) are directly derived from those proposed in the CORINE Biotopes project (Devilliers & Deviliers-Terschuren, 1996).

Table 2.3 Palaearctic major habitats (first level)

1	Coastal and halophytic communities
2	Non-marine waters
3	Scrub and grassland
4	Forests
5	Bogs and marshes
6	Inland rocks, screes and sands
7	Deserts
8	Agricultural land and artificial landscapes
9	Wooded grassland and scrubs

2.2.4 The EUNIS Habitat classification

The EUNIS habitat classification is strongly related to the Palaearctic habitat classification but a novel feature of the hierarchical classification is the development of clear criteria in order to make a key for the identification of habitats analogous to keys for identification of species. These criteria are however not appropriate for field mapping because many terms used e.g. fry and montane do not have definitions that can be used in the field. The classification is based on general vegetation science with additions of abiotic features. The EUNIS habitat classification gives a more comprehensive overview of European habitats (more than 2600 terrestrial classes have been identified already) than the 198 Annex I habitats of the Habitats Directive and has a more scientific approach.

On their website it is stated (mrw.wallonie.be/dgrne/sibw/EUNIS/) that: "the EUNIS Habitat classification has been developed to facilitate harmonised description and collection of data across Europe through the use of criteria for habitat identification. It is a comprehensive pan-European system, covering all types of habitats from natural to artificial, from terrestrial to freshwater and marine habitats types. It is built to link to and correspond with other major habitat systems in Europe". It cross-references to all EU Habitats Directive habitat types used for EU Member States.

With the advent of remote-sensing based land cover mapping, the possibilities in database development and to consolidate the work, the EEA has taken the responsibility to build on the Palaearctic habitat work (Devilliers & Deviliers-Terschuren, 1996) and to include new habitats that are not covered by the Palaearctic classification, such as those in the marine and urban environment. It cross-references to the Corine Land Cover classification, to some regional and national classifications, and to other systems such as the phytosociological alliances in Europe (Rodwell et al., 2002).

The EUNIS classification has four formal levels. Units at level 5, 6 and 7 have been added only to complete the linkage to the marine classification or to Annex I of the Habitats Directive.

Table 2.4 EUNIS major habitats (first level)

A	Marine habitat
B	Coastal habitats
C	Inland surface water habitats
D	Mire, bog and fen habitats
E	Grassland and tall forb habitats
F	Heathland, scrub and tundra habitats
G	Woodland and forest habitats and other wooded land
H	Inland unvegetated or sparsely vegetated habitats
I	Regularly or recently cultivated agricultural, horticultural and domestic habitats
J	Constructed, industrial and other artificial habitats

On the first level the EUNIS habitat classification has ten major habitats. On the second level there are 54 habitats, on the third level there are 162 habitats and on the lowest level there are already more than 2400 habitats for the terrestrial environment.

The EUNIS habitat classification is being promoted by the EEA and is currently being promoted for description purposes within the European Community.

Major limitation of the EUNIS classification at present is that there is no description behind the habitat types at this hampers its application within the present project.

2.2.5 Phytosociological plant communities in Europe

An overview of the European phytosociological plant communities at the level of alliances is given in Rodwell et al., 2002. In an attempt to develop a more coherent picture of the vegetation across the whole of Europe, the European Vegetation Survey (EVS), a working group of the international association of vegetation science was established in 1992. Besides providing formal support for national programmes of vegetation survey, the EVS has devoted particular meetings to the understanding of the syntaxonomy and ecology of the major vegetation groups across Europe as defined by Rodwell et al, 2002.

On the first level there are 15 formations (see Appendix 2), on the second level there are 80 classes, on the third level there are 233 orders and on the fourth level there are 928 alliances. A link with the EUNIS habitat classification has been described for most phytosociological alliances. However, most alliances have several EUNIS classes (and vice versa) indicating that the links are not straightforward in many cases.

A link needs to be established also with Annex I habitat types. A linkage with the phytosociological communities in Europe of the most important habitat classifications will significantly improve the description of those habitat types, not only in terms of their species composition but also in terms of their abiotic requirements.

2.2.6 The Map of Natural Vegetation of Europe

The PNV map was produced in Germany by the Institute für Bundesamt für Naturschutz - BfN (Bohn et al., 2003). More than 100 geobotanists from 31 European countries co-operated on this map, its legend and the explanatory text. The database itself will be discussed in more detail in Chapter 3 (section 3.7). On the first level there are 19 vegetation formations and formation complexes based on physiognomic-ecological features, of which 14 (A to O) represent the main macroclimatic zones and belts in a sequence from north to south/southeast, or altitudinal sequence (See also Appendix 5). The last five formations (P to U) represent azonal vegetation types, which are characterised by dominant site factors, such as salinity or water logging (Bohn et al., 2003).

2.2.7 CORINE land cover classification

The CORINE (Co-ordination of Information on the Environment) programme was initiated by the EU in 1985. A number of databases have been created with the aim to provide information on the status and changes of the environment. One of these databases is the CORINE land cover database (CEC, 1994) next to the CORINE Biotopes database (CEC, 1991). The databases themselves are described in more detail in the Chapter 3. The CORINE land cover nomenclature has 5 major categories at the first level, 15 land cover categories and the second level and 44 categories at the third level (See Appendix 4) In section 3.5.1 the CORINE land cover database will be discussed in more details . In Box 1 the most important CORINE land cover classes in relation to the natural and semi-natural habitats are shortly described. In Bossard et al., 2000 a much more extensive description is given for each CORINE land cover class, including detailed descriptions with particularities, inclusions and exclusions, photo's, and visual interpretation characteristics.

Box 1. Description of the most important CORINE land cover classes. (Source: Bossard, M., J. Feranec, and J. Otahel, 2000).

2.3.1 Pastures
Dense grass cover, of floral composition, dominated by graminacea, not under a rotation system. Mainly for grazing, but the fodder may be harvested mechanically. Includes areas with hedges (bocage).

Extension: Grazing used by cattle. Pastures can be described as extensively used grasslands with presence of farm structure such as: fences, shelters, enclosures, watering places, drinking trough, or regular agricultural works: mowing, drainage, hay making, agricultural practices, manuring.

2.4.3. Land principally occupied by agriculture with significant natural vegetation
Areas principally occupied by agriculture, interspersed with significant natural areas (including wetlands and water bodies, out crops).

2.4.4. Agro-forestry areas
Annual crops or grazing land under the wooded cover of forestry species.

3.1.1. Broad-leaved forest
Vegetation formation composed principally of trees, including shrub and bush understoreys, where broad-leaved species predominate.

Extension: this class includes areas with a crown cover of more than 30 % or a 500 subjects/ha density for plantation structure, broad-leaved trees represent more than 75 % of the planting pattern. In case of young plants or seedlings the proportion of broad-leaved plants to be considered is at least 75 % of the total amount of plants.

3.1.2 Coniferous forest
Vegetation formation composed principaly of trees, including shrub and bush understoreys, where coniferous species predominate.

Extension: Coniferous trees represent more than 75 % of the formation. In case of young plants or seedlings, the proportion of coniferous plants to be considered is at least 75 % of the total amount of plants and their texture is very similar to a surrounding coniferous forest texture.

3.1.3 Mixed forest
Vegetation formation composed principally of trees, including shrub and bush understoreys, where neither broad-leaved nor coniferous species predominate.

Extension: Mixed forests with a crown cover of more than 30 % or a 500 subjects/ha density for plantation structure. The share of coniferous or broad-leaved species does not exceed 25 % in the canopy closure.

3.2.1 Natural grasslands
Low productivity grassland. Often situated in areas of rough, uneven ground. Frequently includes rocky areas, briars and heathland.

Extension: Natural grasslands are areas with herbaceous vegetation (maximum height is 150 cm and gramineous species are prevailing) which cover at least 75 % of the surface covered by vegetation which developed under a minimum human interference (not mowed, fertilized or stimulated by chemicals which might influence production of biomass); here belong for instance grass formations of protected areas, karstic areas, military training fields, etc. (even though the human interference cannot be altogether discarded in quoted areas, it does not suppress the natural development or species composition of the meadows), areas of shrub formations of scattered trees.

3.2.2 Moors and heath lands
Vegetation with low and closed cover, dominated by bushes, shrubs and herbaceous plants (heather, briars, broom, gorse, laburnum, etc.).

Extension: This class includes temperate shrubby area vegetation (climax stage of development): includes dwarf forest trees with a 3 m maximum height in climax stage.

3.2.3 Sclerophyllous vegetation
Bushy sclerophyllous vegetation, includes maquis and garrigue. In case of shrub vegetation areas composed of sclerophyllous species such as Juniperus oxycedrus and heathland species such as Buxus spp. or Ostrya carpinifolia with no visible dominance (each species occupy about 50% of the area), priority will be given to sclerophyllous vegetation and the whole area will be assigned class 323.

Extension: This class includes evergreen sclerophyllous bushes and scrubs which compose maquis, garrigue, mattoral and phrygana.

3.2.4 Transitional woodland-scrub
Bushy or herbaceous vegetation with scattered trees. Can represent either woodland degradation or forest regeneration/recolonisation.

Extension: Areas of natural developmental forest formations (young broad–leaved and coniferous wood species with herbaceous vegetation and dispersed solitary trees) for instance; in abandoned meadows and pastures or after calamities of various origin, part of this class may be also various degenerative stages of forest caused by industrial pollution, etc.

3.3.1 Beaches, sand, dunes
Beaches, dunes and expanses of sand or pebbles in coastal or continental locations, including beds of stream channels with torrential regime.

Extension: This class includes supra-littoral beaches and dunes developed at the back of the beach from high water mark towards land.

3.3.2 Bare rocks
Scree, cliffs, rock outcrops, including active erosion, rocks and reef flats situated above the high-water mark.

3.3.3 Sparsely vegetated areas
Includes steppes, tundra and badlands. Scattered high-altitude vegetation.

Extension: Scattered vegetation is composed of gramineous and/or ligneous and semi-ligneous species for determining the ground cover percentage, excluding cryptograms.

3.3.4 Burnt areas
Areas affected by recent fires, still mainly black.

3.3.5 Glaciers and perpetual snow.
Land covered by glaciers or permanent snowfields.

4.1.1 Inland marshes.
Low-lying land usually flooded in winter, and more or less saturated by water all year round.

Extension: This class includes non-forested areas of low-lying land flooded or liable to flooding by fresh, stagnant or circulating water. Covered by specific low ligneous, semi-ligneous or herbaceous vegetation.

4.1.2 Peat bogs
Peatland consisting mainly of decomposed moss and vegetable matter. May or may not be

exploited.

4.2.1 Salt marshes
Vegetated low-lying areas, above the high-tide line, susceptible to flooding by sea water. Often in the process of filling in, gradually being colonized by halophilic plants.

4.2.2 Salines
Salt-pans, active or in process of abandonment. Sections of salt marsh exploited for the production of salt by evaporation. They are clearly distinguishable from the rest of the marsh by their parcellation and embankment systems.

4.2.3 Intertidal flats
Generally unvegetated expanses of mud, sand or rock lying between high and low water marks. 0 m contour on maps.

5.1.1 Water courses
Natural or artificial water-courses serving as water drainage channels. Includes canals. Minimum width for inclusion: 100 m.

5.1.2 Water bodies
Natural or artificial stretches of water.

5.2.1 Coastal lagoons
Stretches of salt or brackish water in coastal areas which are separated from the sea by a tongue of land or other similar topography. These water bodies can be connected to the sea at limited points, either permanently or for parts of the year only

5.2.2 Estuaries
The mouth of a river within which the tide ebbs and flows.

5.2.3 Sea and ocean
Zone seaward of the lowest tide limit.

(Source: Bossard, M., J. Feranec, and J. Otahel, 2000.)

2.3 Links between CORINE land cover and various habitat classifications

The CORINE land cover database (CEC, 1994) is a key data source to map the habitats in Europe. Therefore the relations between CORINE land cover and existing habitat classification will be discussed here in more detail. Although the relationships have been described in tables, they are of limited value for analytical purposes due to the fact that many one-to-many relationships exist between the various classifications.

2.3.1 Relationship EUNIS Habitat classification and Habitats Directive

Recently Moss and Davies (2002b) have also produced a document that contains cross-references between the EUNIS habitat classification and the habitats included in Annex I of the EC Habitats Directive. An example is given below (Moss and Davies, 2002b).

Table 2.5 Example of the formalised relationship between the EUNIS habitat classification and the Habitats Directive (Moss and Davies, 2002b)

EUNIS code	EUNIS code + linked classification code	EUNIS Scientific name	Relation of Annex I habitat to EUNIS type (<, >, =, # or ?)	Annex I Natura2000 code	Palaearctic Class Code	Annex I name
G2	G2	Broadleaved evergreen woodland				
G2.1	G2.1	Mediterranean evergreen [Quercus] woodland	<	9330	45.2	Quercus suber forests
G2.1	G2.1	Mediterranean evergreen [Quercus] woodland	<	9340	45.3	Quercus ilex and Quercus rotundifolia forests
G2.11	G2.1/P-45.2	[Quercus suber] woodland	<	9330	45.2	Quercus suber forests
G2.111	G2.1/P-45.21	Tyrrhenian [Quercus suber] forests	>	9330	45.2	Quercus suber forests
G2.112	G2.1/P-45.22	Southwestern Iberian [Quercus suber] forests	>	9330	45.2	Quercus suber forests
G2.113	G2.1/P-45.23	Northwestern Iberian [Quercus suber] woodland	>	9330	45.2	Quercus suber forests
G2.114	G2.1/P-45.24	Aquitanian [Quercus suber] woodland	>	9330	45.2	Quercus suber forests
G2.12	G2.1/P-45.3	[Quercus ilex] woodland	<	9340	45.3	Quercus ilex and Quercus rotundifolia forests
G2.121	G2.1/P-45.31	Meso-Mediterranean [Quercus ilex] forests	>	9340	45.3	Quercus ilex and Quercus rotundifolia forests
G2.122	G2.1/P-45.32	Supra-Mediterranean [Quercus ilex] forests	>	9340	45.3	Quercus ilex and Quercus rotundifolia forests
G2.123	G2.1/P-45.33	Aquitanian [Quercus ilex] woodland	>	9340	45.3	Quercus ilex and Quercus rotundifolia forests
G2.124	G2.1/P-45.34	[Quercus rotundifolia] woodland	>	9340	45.3	Quercus ilex and Quercus rotundifolia forests
G2.3	G2.3	Macaronesian [Laurus] woodland	=	*9360	*45.61 -> 45	Macaronesian laurel forests (Laurus, Ocotea)
G2.31	G2.3/P-45.61	Azorean laurisilvas	>	*9360	*45.61 -> 45	Macaronesian laurel forests (Laurus, Ocotea)
G2.32	G2.3/P-45.62	Madeiran laurisilvas	>	*9360	*45.61 -> 45	Macaronesian laurel forests (Laurus, Ocotea)
G2.33	G2.3/P-45.63	Canarian laurisilvas	>	*9360	*45.61 -> 45	Macaronesian laurel forests (Laurus, Ocotea)
G2.4	G2.4	[Olea europaea] - [Ceratonia siliqua] woodland	<	9320	45.1	Olea and Ceratonia forests
G2.41	G2.4/P-45.11	Wild [Olea europaea] woodland	>	9320	45.1	Olea and Ceratonia forests
G2.42	G2.4/P-45.12	[Ceratonia siliqua] woodland	>	9320	45.1	Olea and Ceratonia forests
G2.43	G2.4/P-45.13	Canarian [Olea europaea] woodland	>	9320	45.1	Olea and Ceratonia forests
G2.5	G2.5	[Phoenix] groves	<	*9370	*45.7	Palm groves of Phoenix
G2.51	G2.5/P-45.71	Cretan [Phoenix theophrasti] groves	>	*9370	*45.7	Palm groves of Phoenix
G2.52	G2.5/P-45.72	Canarian [Phoenix canariensis] groves	>	*9370	*45.7	Palm groves of Phoenix
G2.6	G2.6	[Ilex aquifolium] woods	=	9380	45.8	Forests of Ilex aquifolium

In addition, the relationship between the EUNIS and Palaearctic Habitat classification has also been established (but will not be discussed here).
Because the relationship between the EUNIS habitat classification and the Habitats Directive is not one to one relationship, the relationships are expressed with: >: wider, <: narrower, =: same, #: overlap, ?: not determined. For each of the 2490 EUNIS habitat classes the relationship with Annex I is given.

2.3.2 Relationship CORINE biotopes and CORINE land cover

Within the CORINE Biotopes project the relationship between CORINE land cover and biotopes has already been carried out. It is stated that "although remote sensing is not capable in distinguishing the degree of detail recorded in the biotopes database, some categories are directly comparable (see table 2.5). The CORINE biotopes sites (CEC, 1991) with their specific habitats have been overlaid with the CORINE land cover database which (CEC, 1994) resulted in the matrixes below.

Table 2.6 Relationship between CORINE land cover and CORINE Biotopes (Source:: CEC, 1991)

	311 Broad-leaved forest	312 Coniferous forest	313 Mixed forest	321 Natural grassland (3)	322 Moors and heathland	323 Sclerophyllous vegetation	324 Transitional woodland/shrub	331 Beaches, dunes, sands	332 Bare rock	333 Sparsely vegetated areas	334 Burnt areas	335 Glaciers and perpetual snow	411 Inland marshes	412 Peatbog	421 Salt marshes	422 Salines	423 Intertidal flats	511 Water courses	512 Water bodies	521 Coastal lagoons	522 Estuaries	523 Sea and ocean
11 Open sea																						X
12 Sea inlets																						X
13 Tidal rivers and estuaries																					X	
14 Mud flats and sand flats																	X					
15 Salt marshes, salt pastures, salt steppes															X	X						
16 Coastal sand dunes and sand beaches								X														
17 Shingle or stony beaches								X														
18 Sea cliffs									X													
19 Islets and rock stacks									X													
1A Machair (1)																						
21 Lagoons																				X		
22 Standing waters (fresh)																			X			
23 Standing water (brakish)																			X			
24 Running water																		X				
31 Heath and scrub					X																	
32 Sclerophyllous scrub, garrigue and maquis						X																
33 Phrygana						X																
34 Dry calcareous grasslands and pseudosteps				X																		
35 Dry siliceous grasslands				X																		
36 Alpine and boreal grasslands				X																		
37 Humid grasslands and tall herb communities				X																		
38 Mesophile grasslands				X																		
41 Broadleaved decidous forests	X																					
42 Native coniferous forests		X																				
43 Mixed woodland			X																			
44 Alluvial and very wet forest	X	X	X																			
45 Broadleaved evergreen woodland	X																					
51 Raised bogs														X								
52 Blanket bogs														X								
53 Water-fringe vegetation													X									
54 Other bogs and mires													X									
61 Scree									X													
62 Exposed bedrock, inland cliffs									X													
63 Permanent ice and snow												X										
64 Inland sand dunes								X														
65 Caves (1)																						

2.3.3 Relationship EUNIS Habitat classification and CORINE land cover

Recently Moss and Davies (2002a). have produced cross-references between the EUNIS habitat classification and the CORINE land cover database (CEC, 1994). In this document for each CORINE land cover class a long list of related habitats is given. For example, for the CORINE class "natural grassland" there are 155 related EUNIS habitats.

A specific example is given for the CORINE land cover class "Glaciers and perpetual snow" including the following EUNIS habitats (Moss and Davies, 2002a):

H4	Snow or ice dominated habitats
H4.1	Snow packs
H4.2	True glaciers
H4.2/P-63.31	Ice sheets and ice gaps
H4.2/P-63.32	Cirque and valley glaciers
H4.2/P-63.23	Glaciers
H4.3	Rock glaciers and unvegetated ice-dominated moraines
H4.3/P-63.21	Rock glaciers
H4.3/P-63.22	Ice-core moraines
H4.33	Unvegetated glacial moraines in the process of formation

2.3.4 Relationship Habitats Directive and CORINE land cover

Through the EUNIS Habitat Classification there is an indirect relationship between the Habitats Directive and CORINE land cover. The habitat classifications have more details than CORINE land cover. Therefore, an exercise has been done to try to relate the 9 major (level 1) habitat classes of the Habitats Directive to CORINE land cover. In this case 21 CORINE land cover classes have been related to one of the major habitat classes (see Table 2.7). The urban and agricultural classes of CORINE have not been related to the Habitats Directive because these classes are not a target of the Habitats Directive. Each major habitat class is represented by one or more CORINE land cover classes.

Table 2.7 Relationship between the Habitats Directive (level 1) and CORINE land cover

Corine Land Cover (Natural and semi-natural)		Annex I Habitats, Level 1		Coastal and Halophytic	Coastal sand dunes and inland dune	Fresh Water	Temperate heath and scrub	Sclerophyllous vegetation	Natural and semi-natural grassland	Raised bogs and mires and fens	Rocky Habitats and caves	Forests
Level I	*Level II*	*Level III*		1	2	3	4	5	6	7	8	9
3 forests and semi-natural areas												
	3.1 forest	311	Broad-leaved forest									x
		312	Coniferous forest									x
		313	Mixed forest									x
	3.2 Shrub and herbaceous vegetation associations	321	Natural grassland						x			
		322	Moors and heathland				x					
		323	Sclerophyllous vegetation					x				
		324	Transitional woodland/shrub				x					
	3.3 Open spaces with little or no vegetation	331	Beaches, dunes, sands		x							
		332	Bare rock								x	
		333	Sparsely vegetated areas						x			
		334	Burnt areas									
		335	Glaciers and perpetual snow									
4 wetlands												
	4.1 inland waters	411	Inland marshes							x		
		412	Peatbog							x		
	4.2 coastal wetlands	421	Salt marshes	x								
		422	Salines	x								
		423	Intertidal flats	x								
5 Water bodies												
	5.1 inland water courses	511	Water courses			x						
		512	Water bodies			x						
	5.2 Marine waters	521	Coastal lagoons	x								
		522	Estuaries	x								
		523	Sea and ocean									

On basis of this matrix maps have been produced for all nine major habitats (Habitats Directive Annex I level 1) based on the information in the CORINE land cover database. These maps are discussed in paragraph 3.6.

3 Data sources

The major spatial data sources that are available for pan-Europe or at least for a large part of Europe are discussed below. Most data sources differ in extent, scale, spatial accuracy, thematic accuracy, acquisition date, and in the number of thematic classes. These need therefore be discussed because these characteristics determine also their usefulness. Data sets that can be used for validation such as the CORINE Biotopes database are discussed also in this chapter. Some classifications have already been discussed in the Chapter 2, however, this was strictly related to their legend or typology. In this chapter the spatial data sets will be discussed in terms of their technical features. In Chapter 4 the methodology will be discussed of how these data sets can be used to identify the major European habitats. The following data sets are being discussed in this chapter: administrative, biogeographic, altitude, soils, land cover, Flora Europapaeae, Potential Natural Vegetation Map and the CORINE biotopes database. In this chapter there is special attention for the soil and land cover databases because the various sources needed to be integrated to give these databases a pan-European coverage with optimal spatial and thematic detail.

3.1 Administrative and topographical data

Within the description of Annex I habitats the geographic distribution is often being described, e.g.: along the coast of the Algarve in South-Portugal. Also in the Flora Europapaeae the geographic distribution is described for most species in this way, while in the Atlas Florae Europapaeae, concerning a more limited amount of species, the spatial distribution is given on a 50 km by 50 km grid. Therefore administrative data and topographical data can be important in pinpointing the habitats spatially.

For administrative and topographical GIS data over Europe there is a range of sources, such as: the Digital Chart of the World (DCW), the ESRI Data & Maps and Bartholomew Euromaps. These data sources have a scale of approximately 1:1M. The former mentioned has a low spatial accuracy and the latter one a higher spatial accuracy. In terms of thematic accuracy, no individual data set is ideal. Bartholomew Euromaps distinguishes most thematic classes (Mücher et. al., 2000). For example, to identify all major and medium sized rivers, use has to be made of all three sources because all sources separately do lack some major rivers. In most cases the ESRI spatial data sets are sufficient for displaying e.g. administrative boundaries, national borders, cities, major rivers, major urbanised areas and roads. However, a topographical data set with a spatial scale of 1:250,000 (and a high accuracy and reliability) would be preferred but is lacking for pan-Europe as far as the authors know.

3.2 Biogeographic data

3.2.1 BRME

The Biogeographical Regions Map of Europe (BRME) contains the official delineations (see Figure 3.1) used in the Habitats Directive (92/43/EEC) and for the Emerald Network. The map of the Biogeographic Regions (EEA, 2002) was developed as a tool for assessment of the Natura 2000 network (EU Council Directive 92/43/EEC). To the originally five regions (Alpine, Atlantic, Continental, Macaronesian and Mediterranean) the Boreal region was added when Finland and Sweden joined the European Union. The BRME is based on the PNV map (Bohn, 2003), taking climate types into account and eliminating edaphic vegetation zones and isolated islands. The current BRME is an extension of the EU15 map made by the Council of Europe (Secretariat of the Bern Convention) used for setting up of the Emerald Network. The non-EU part of the map is based on an aggregation of the units of the Pan-European Map of Natural Vegetation (Bohn, 2003), see also section 3.7. Five regions were added to the EU15 map (Anatolian, Arctic, Pannonian, Black Sea and Steppic), resulting in a total number of eleven biogeographic regions. The same interpretation principles were used as for the EU15 map. It has an equivalent objective of site assessment and reporting on a pan-European scale. EEA uses BRME for reporting on the state of Europe's environment. BRME (version 4) was delivered by ETC/NC in May 1998 to the EEA (EEA, 2002). There have been no quality checks or improvements on the data (i.e. some polygons have no label).

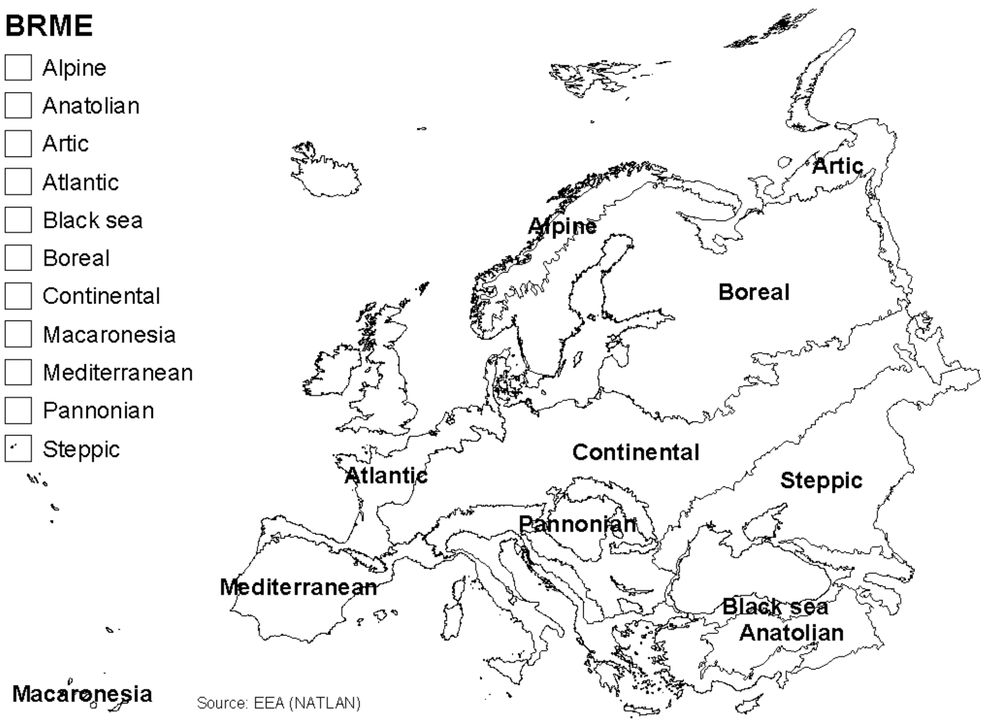

Figure 3.1 The Biogeographical Regions Map of Europe (BRME). Source: EEA (NATLAN)

3.2.2 DMEER

The Digital Map of European Ecological Regions (DMEER) is a biogeographic map that illustrates the distribution of ecological regions and sub-regions, on the basis of a unified concept and updated knowledge of climatic, topographic, geobotanical European data. It incorporates information from several European sources but has currently not been published. This map was based on a hierarchical classification, using two major sources: the Potential Natural Vegetation Map of Europe and a European classification of climate and topology delivered by CEH. The hierarchical classification represented 6 aggregation levels from a dendrogram, reaching from 46 to 183 ecological regions (see Appendix 6 for detailed information on the legend), covering all Europe. A final draft of DMEER was composed according to the expert opinions. DMEER was meant to be a useful and efficient step toward setting land management priorities (DMEER, 1997), but has been largely replaced by the increased spatial detail of the data source discussed in the next section.

3.2.3 The Environmental Classification of Europe (EnC)

Stratification into relatively homogeneous regions is an essential basis for strategic sampling of ecological variables and consistent modelling exercises. Within a given stratum, changes or effects can be analysed within a relatively homogeneous environment, which then enables variation to be partitioned. Such a process is imperative to produce statistically robust results, which require data to be representative from a defined population. For example, when examining a single class to determine the influence of causal factors of change on species abundance, statistical procedures can ensure that the observed effects are indeed caused by that change and not by inherently different environments. A first statistical approach, carried out by Jones and Bunce (1985), was followed by a grid based European Land Classification by the Institute for Terrestrial Ecology (ITE) – now Centre for Ecology and Hydrology (CEH) – in 1992 (Bunce et al, 1996a, b and c). The grid size of 0.5° degrees is too coarse for adequate definition at the local level.

When more detailed climate data sets became (Mücher et al, 2003) available, a new version has been produced resulting in an eighty-four class Environmental Classification of Europe (EnC), as shown in Figure 3.2. The EnC has been constructed by Principal Component Analysis (PCA) and statistical clustering of climatic and topographic variables. The EnC is appropriate for strategic random sampling for resource assessment, measurement of change, and modelling. Three levels of aggregation are described to further facilitate analysis within thirteen Environmental Zones that are considered appropriate for summary purposes. The Department of Plant Production of Wageningen University and Alterra were involved in the production of the environmental database (Mücher et al, 2003; Metzger et al., 2004).

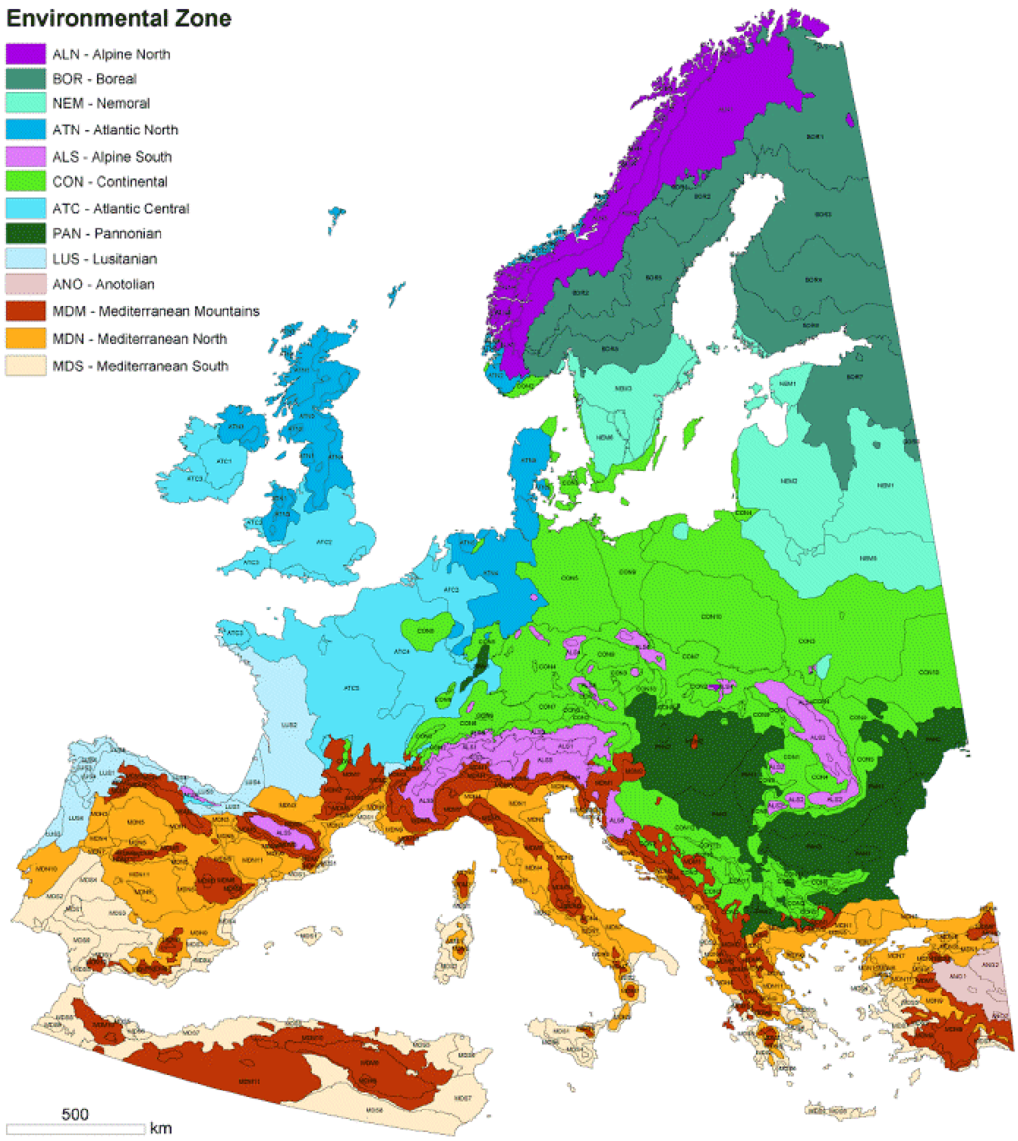

Figure 3.2 The Environmental Classification of Europe in eighty-four classes. Where the size of the class permits, the individual classes are labelled within the main Environmental Zones. The classification extends from 11° west to 32° east and from 34° north to 72° north. It is projected in a Lambert Azimuthal equal area projection. Because certain classes do not necessarily fit traditional experience, in this classification strict statistical rules have been maintained, recognising these apparent inconsistencies, e.g. PAN1 in the Vosges and Schwartzwald and CON2 in southern Norway

The EnC is considered as the most robust and scientifically constructed bio-geographical database available and is independent of individual judgement. The only limitation is that the database does not cover pan-Europe entirely.

3.3 Digital Elevation Models

GTOPO30 is a global digital elevation model (DEM) resulting from a collaborative effort led by the staff at the U.S. Geological Survey's EROS Data Center in Sioux Falls, South Dakota. Elevations in GTOPO30 are regularly spaced at 30-arc seconds (approximately 1 kilometre). GTOPO30 was developed to meet the needs of the geospatial data user community for regional and continental scale topographic data. The completion of global coverage of 30-arc second elevation data finished in 1993. The DEM is based on data from 8 different sources of elevation information, including vector and raster data sets. The data of the European continent originates almost completely from the Digital Chart of the World. Figure 3.3 shows a detail of the global elevation model USGS GTOPO30 for pan-Europe and is displayed as a relief map. GTOPO30 is a global data set covering the full extent of latitude from 90 degrees south to 90 degrees north, and the full extent of longitude from 180 degrees west to 180 degrees east. The horizontal coordinate system is decimal degrees of latitude and longitude referenced to WGS84. The vertical units represent elevation in meters above mean sea level. The elevation values range from -407 to 8,752 meters. In the DEM, ocean areas have been masked as "no data" and have been assigned a value of -9999. Lowland coastal areas have an elevation of at least 1 metre, so in the event that a user reassigns the ocean value from -9999 to 0 the land boundary portrayal will be maintained. Due to the nature of the raster structure of the DEM, small islands in the ocean less than approximately 1 square kilometre will not be represented. From the Digital Elevation model other parameters can be derived such as slope, aspect and relief. (see also edcdaac.usgs.gov/gtopo30/gtopo30.html).

Figure 3.3 Detail of the global USGS GTOPO30 Digital Elevation Model for Europe

3.4 Soils

For pan-Europe there are two major soil databases. The first one is the European Soil Database (CEC, 1985). The second one is the FAO-Unesco Soil Map of the World (FAO, 1991). The former is more detailed than the latter one, but unfortunately, the ESDB (CEC, 1985) does not cover the whole of pan-Europe. Therefore, it is necessary to integrate both databases for the characterisation of the abiotic conditions of European habitats.

3.4.1 European Soil Database 1:1M

The Soil Geographical Data Base of Europe at scale 1:1,000,000 (CEC, 1985) is part of the European Soil Data Base. It is the resulting product of a collaborative project involving all the European Union and neighbouring countries. It is a simplified representation of the diversity and spatial variability of soil profiles. The methodology used to differentiate and name the main soil types is based on the terminology of the FAO legend for the Soil Map of the World at scale 1:5,000,000. This terminology has been refined and adapted to take account of the characteristics of the European landscapes. It is based on the distinction of the main pedogenetic processes leading to soil differentiation: brunification, lessivage, podzolisation and hydromorphy (CEC, 1985). The database contains a list of Soil Typological Units (STU). Besides the soil names they represent, these units are described by variables (attributes) specifying the nature and properties of the soils: for example the texture, the water regime, the stoniness, etc. The geographical representation was chosen at a scale corresponding to the 1:1,000,000. At this scale, it is not feasible to delineate the STU's. Therefore they are grouped into Soil Mapping Units (SMU) to form soil associations and to illustrate the functioning of pedological systems within the landscapes (CEC, 1985).

Harmonisation of the soil data from the member countries is based on a dictionary giving the definition for each occurrence of the variables. Considering the scale, the precision of the variables is weak. Furthermore, these variables were assessed over large areas by expert judgement rather than actual soil pit measurements. This expertise results from synthesis and generalisation tasks of national or regional maps published at more detailed scales, for example 1:50,000 or 1:25,000 scales. Delineation of the Soil Mapping Units is also the result of expertise and experience. Heterogeneity is high in many European regions, for example cambisols in the mountains can range from fertile soils to peat bogs. The spatial variability of soils is very important and is difficult to express at global levels of precision. Quality indices of the information (purity and confidence level) are included with the data in order to guide usage. Notice that in Figure 3.4, showing the attribute parent material, there is a lot of difference in spatial detail, for example for the Scandinavian regions there is almost no detailed information.

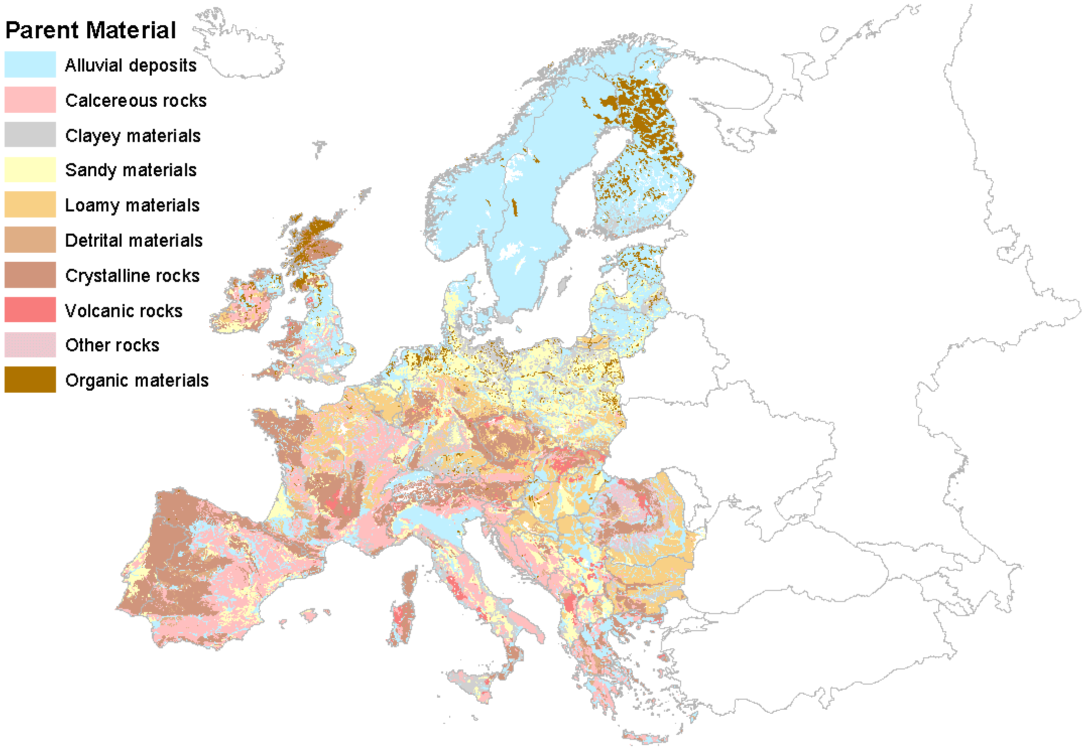

Figure 3.4 The European Soil Database 1:1M (source: European Soil Bureau, EC)

3.4.2 FAO-UNESCO soil map of the world

The FAO-UNESCO Soil Map of the world was published between 1974 and 1978 at 1 : 5,000,000 scale (FAO, 1991). The legend comprises an estimated 1650 different map units, which consist of soil units or associations of soil units. The soil units (106 from Af to Zt) are grouped in 26 major soil groupings. Additionally, soil texture is recognised and digitised with several characteristic classes of relative clay, silt and sand proportions. The dataset is available in the Arc/Info vector format. A template layer containing topographic information (coastlines, islands, lakes, glaciers, double lined rivers and outer sheet boundaries) was prepared and digitised for each map sheet. The legend of the soil map of the World (FAO, 1988) comprises an estimated 1650 different map units, which consist of soil units or associations of soil units. When a map unit is not homogeneous, it is composed of a dominant soil and component soils. The latter are: associated soils, covering at least 20 % of the area; and inclusions, important soils which cover less than 20 % of the area. The list of components for each mapping unit is found on the back of the maps. The relative distribution of dominant and component soils is given by the Composition Rules in the following page (Table 1, 'No.' stands for number of soil units) (FAO, 1988). The term "mapping unit" should not be confused with the ARC/INFO parameter "MAP UNIT" which refers to the unit of length on the digitised maps: meters, inches or degree decimals. The legend of the soil map of the world (FAO, 1991) comprises 106 soil units (from Af to Zt), grouped in 26 major soil groupings. An alphabetical list of soil unit symbols and their names is given in Appendix 7.

3.4.3 Integration of both soil databases

Integration of the two soil databases was necessary to cover pan-Europe entirely with the aim to maintain as much as spatial detail as possible. Maps of abiotic soil conditions indicating specific ecological site factors have been produced for four simple themes: calcareous soils (Figure 3.5), wet soils (Figure 3.6), organic soils (Figure 3.7) and salt areas (Figure 3.8). Concerning the ESDB (CEC, 1985) the calcareous soils have been derived from the parent material attribute table, the wet soils from the water regime attribute table, and the salt and organic soils by their soil type. A difficult part of the integration of the ESDB with the FAO soil database (FAO, 1991) was the fact that the attributes of the ESDB were not consistently available. Some attributes were available for some countries while other attributes were available for other countries. This meant that the integration of the two databases had to be implemented on a single attribute basis. From the FAO soil database a selection of soil types was made for each theme (calcareous, wet, organic, salt) separately (see Appendix 8).

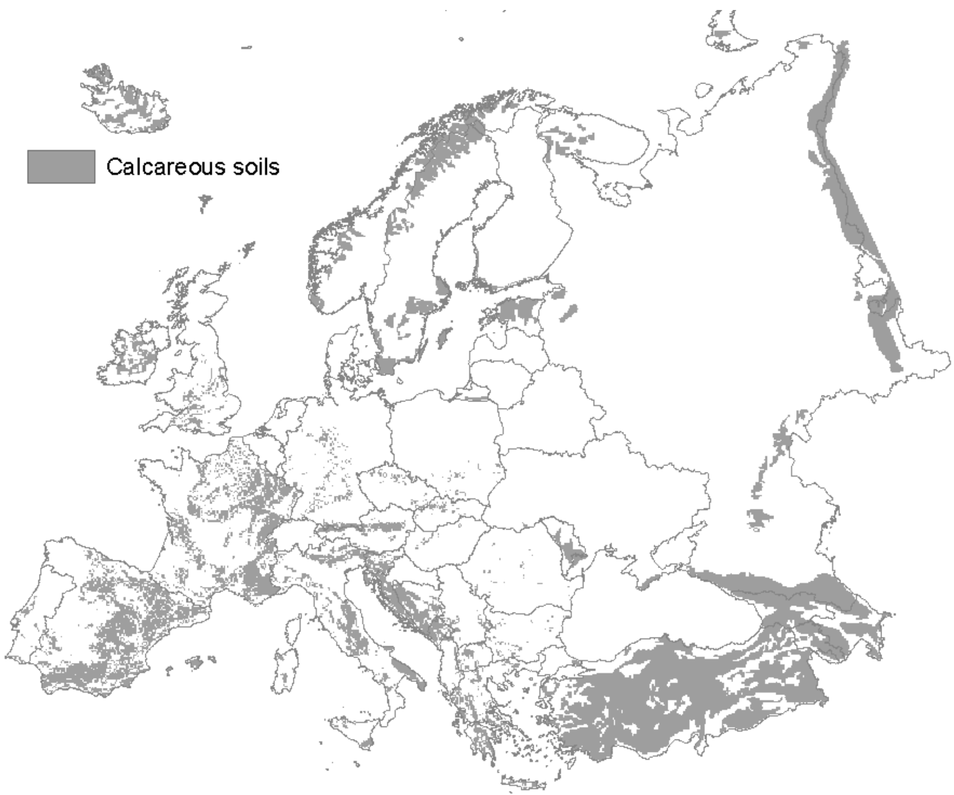

Figure 3.5 Calcareous soils

Figure 3.6 Wet soils

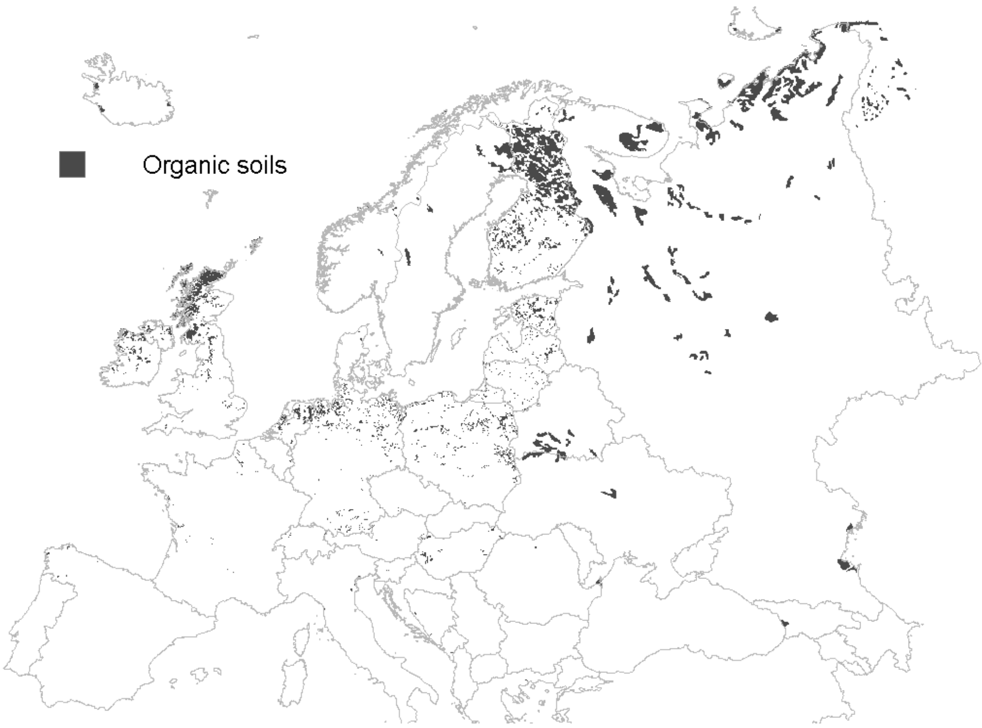

Figure 3.7 Organic soils

Figure 3.8 Soils with salt

3.5 Land cover

In this section three land cover databases will be discussed that were integrated into a new pan-European land cover database with the objective of maintaining as much as possible spatial and thematic detail. This meant that the land cover database with the highest spatial and thematic accuracy, in this case the CORINE land cover database (CEC, 1994), formed the base data set. The two other land cover databases that were used in the integration process were the PELCOM (Mücher et al., 2001) and GLC2000 land cover databases (Fritz et al., 2003). The latter is a newly established global land cover database based on the interpretation of SPOT-VEGETATION data of the year 2000.

3.5.1 CORINE

The CORINE (Co-ordination of Information on the Environment) programme was initiated by the EU in 1985. A number of databases were created within this framework with the aim to give information on the status and changes of the environment. One of these databases is the CORINE land cover database (Figure 3.9). The land cover information (CEC, 1994) is derived from high-resolution satellite data by computer assisted visual interpretation, in combination with ancillary information. The final CORINE land cover database consists of a geographical database describing vegetation and land use in 44 classes, grouped in a three level nomenclature (see Appendix 4) in order to cover the entire land cover spectrum of Europe (CEC, 1994). The minimum mapping unit is 25 hectares. For line elements the minimum width is 100 metres (Thunnissen and Middelaar, 1995). The scale of the land cover database is 1 : 100,000.

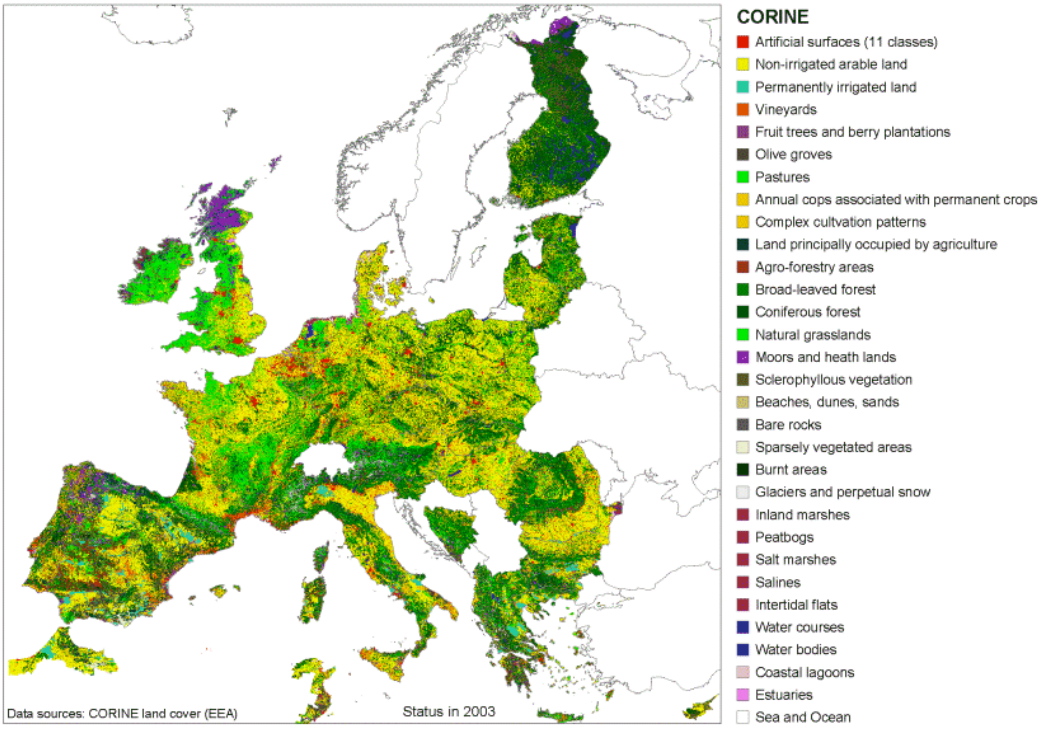

Figure 3.9 Extent of the CORINE land cover database in 2003 (source EEA)

3.5.2 PELCOM

The 1km-resolution pan-European land cover database, called PELCOM (Mücher et al., 2001), contains 16 thematic classes and is based on the interpretation of NOAA-AVHRR satellite data of 1997. Only the land cover classes urban areas, wetlands and water bodies have been derived from ancillary data sources. For validation of the PELCOM land cover database high-resolution satellite images have been used. Ideas have been followed from the IGBP-DIS global land cover database validation (Loveland & Belward, 1997). Due to the amount of work the validation has been limited to confidence site mapping. IGBP-DIS provided 30 Landsat-TM images for Europe. In addition, ten high resolution satellite images were provided by PELCOM partners. This resulted in 40 high-resolution satellite images distributed over pan-Europe that were interpreted. Visual interpretations of the high-resolution satellite images were done independently of the PELCOM land cover database, but use of ancillary data was allowed (topographic maps, national land cover databases). This resulted in a total area of (interpreted) confidence sites of 7,700 km^2. The total average accuracy was 69.2%, which can be considered as a good result considering the mixed pixel and geo-referencing problems of AVHRR data (Mücher et al., 2001).

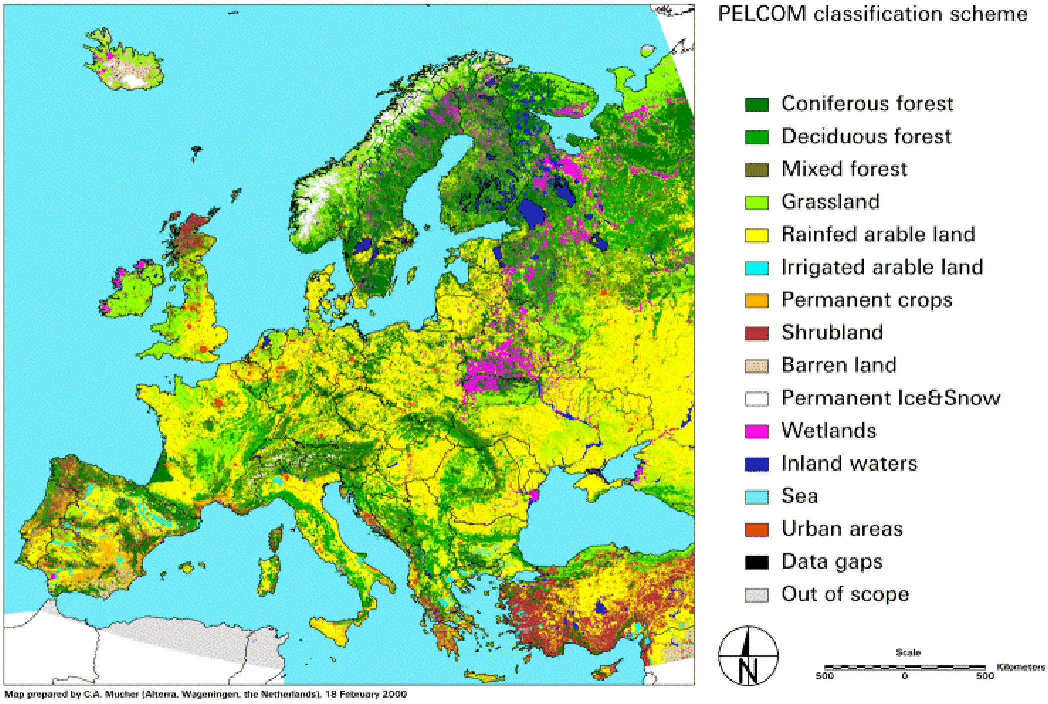

Figure 3.10 The PELCOM database: a 1km pan-European land cover database

3.5.3 GLC2000

The co-ordination of the Global Land Cover 2000 project has been carried out under the Fifth Framework Programme 1999-2002 for Research of the European Commission (Fritz et al., 2003). It is part of the project of the European Commission called Global Environment Information System (GEIS). The GLC2000 project was carried out to provide information to the International Conventions on Climate Change, the Convention to Combat Desertification, the Ramsar Convention and the Kyoto Protocol. Furthermore the GLC2000 land cover database has been chosen as a core dataset for the Millennium Ecosystems Assessment. This means in particular that the GLC2000 dataset will be a main input dataset to define the boundaries of the different ecosystems such as forest, urban, grassland, and cultivated systems (Fritz et al, 2003). The global land cover database has 23 classes (see Figure 3.11 and Appendix 9).

In contrast to former global mapping initiatives the GLC2000 project is a bottom up approach to global mapping (Bartholomé et al., 2003). In this project more than 30 research teams have been involved, contributing to 19 regional windows. There were two conditions to be fulfilled by the regional experts to guarantee a certain degree of consistency. The data had to be based on SPOT-4 VEGETATION VEGA2000 dataset, which was made freely available by CNES (Centre National d'Études Spatiales). Secondly the partners agreed to use the Land Cover Classification System which was provided by FAO (Di Gregorio and Jansen, 2000). The fact that the mapping was carried out by regional experts had a number of benefits. Firstly, since each regional expert has a high level of understanding of their particular region, a certain level of quality can be guaranteed. Secondly, each partner has the freedom to apply their own methods of mapping and define their own regional legend. This allows the partners to apply the classification techniques they find most appropriate for land cover in their respective region. Thirdly the regional mapping approach ensures that access could be gained to reference material (Fritz et al, 2003). For more information on the production of the glc2000 database the website (http://www.gvm.jrc.it/glc2000) should be consulted.

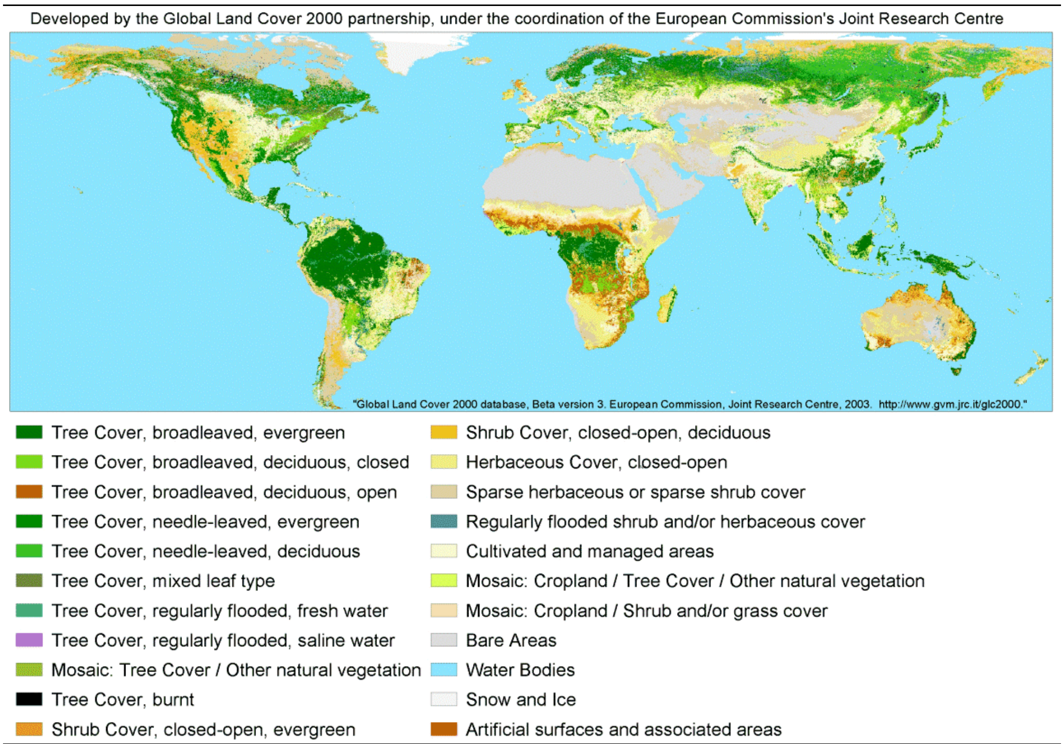

Figure 3.11 GLC2000 global land cover database (Source: JRC)

3.5.4 Compilation European Land Cover Database

The CORINE land cover database is the most detailed land cover database covering a large part of Europe. Unfortunately, the CORINE land cover database covers only 37% of the terrestrial area of pan-Europe, also shown in Figure 3.12. Therefore the CORINE land cover database has to be integrated with other data sources. A compilation was therefore carried out on a country basis according to the figure below, in which 37% is from CORINE, 10% is from PELCOM and 53% is from GLC2000 land cover database . In total pan-Europe covers a terrestrial area of approximately 11M km^2.

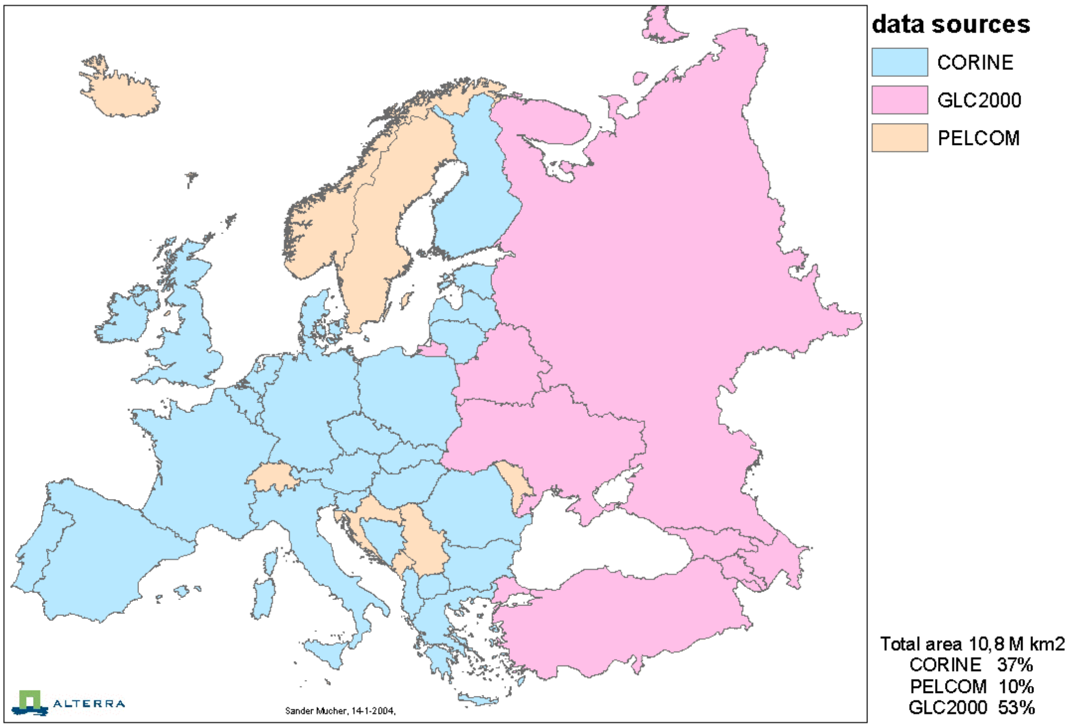

Figure 3.12 Overview of the extent of coverage of the various land cover data sources over Europe

Before the three land cover databases could be integrated it was necessary to harmonise the legends as far as possible. Harmonisation of the legends was based on the CORINE legend. The PELCOM (Mücher et al., 2001) and GLC2000 (Fritz et al., 2003) legends had therefore to be transformed according to the CORINE nomenclature. Before this was done the CORINE nomenclature was revised. This lead to the following actions classes 1-11 "artificial surfaces" were recoded to 1 class called "urban", the class "rice fields" (2.1.3) was added to class "permanently irrigated land" (2.1.2), the class "mixed forest" (3.1.3) was added to the class "broadleaf forest" (3.1.1), and the class "transitional woodland-scrub" (3.2.4) to class "sclerophyllous vegetation" (3.2.3). The last two classes were merged because there was too much confusion between these two land cover classes within CORINE.

The recoding of PELCOM and GLC2000 into the CORINE nomenclature was implemented on the basis of expert knowledge and visual comparisons of the databases. In Appendix 9 the recoding schemes are given for the two land cover databases. The result of the recoding and the compilation according to figure 3.12 resulted in a new Pan-European land cover database with a spatial resolution of 250m and a revised legend according to the CORINE land cover nomenclature, as shown in Figure 3.13.

In Table 3.1 an overview is given of the classes present in the final pan-European land cover database (last column) according to the CORINE land cover nomenclature and from which data sources these classes could be derived. It is very important to note that different data sources have been used in the compilation process and that this has consequences for the thematic and spatial quality. For example the spatial resolution of the CORINE land cover database is much higher than for PELCOM and GLC2000 land cover database. Compilation into one pan-European land cover database with a 250m resolution, as shown in Figure 3.13, is still justified according to the authors due to the fact that in central and especially in western-Europe the landscape is much more fragmented than in eastern-Europe, justifying the aggregation of the CORINE land cover to a 250m resolution and disaggregation of PELCOM and GCL2000 to a 250 m resolution in the eastern and northern parts of Europe. Concerning the thematic quality the land cover compilation has a much higher impact; CORINE land cover contains much more thematic classes than the other two databases. Still the authors tried to keep as much as possible CORINE land cover classes so that no information would get lost and the knowledge that aggregation in fewer classes stays always a possibility in a later stage. The consequence of this is that a specific classes e.g. moors and heathland is only present where Europe is covered by the CORINE database. Given the fact that most moors and heathland are situated in the Atlantic region this does not hamper the given approach. Nevertheless, if heathland is occurring outside the region covered by CORINE (see Figure 3.12), than it is most likely situated in the class sclerophyllous scrubs or transitional woodland scrub which is covered by PELCOM and GLC2000 (see Table 3.1).

Without a doubt it is possible to aggregate the land cover classes in a limited amount of classes and resample to entire land cover database to a 1km spatial resolution. However, this would hamper the spatial identification of many habitats which are related to specific Corine land cover classes and are often small in size and highly fragmented.

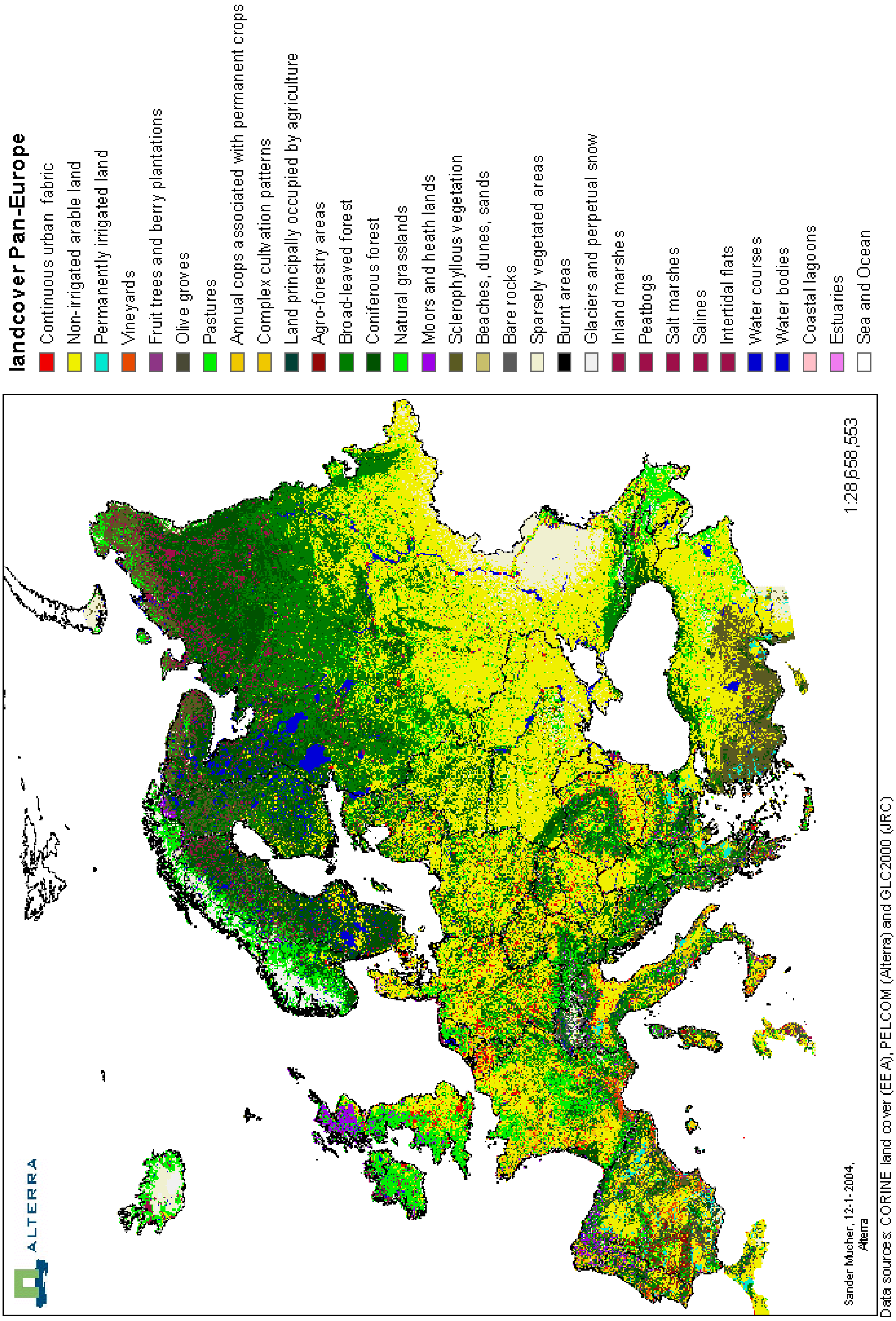

Figure 3.13 Pan-European land cover database with a spatial resolution of 250m based on CORINE and PELCOM data sources (source: Alterra)

Table 3.1 The classes present in the final pan-European land cover datase (last column) according to the CORINE land cover nomenclature and from which data sources these classes could be derived

CORINE		Data sources			Final
		Corine	Pelcom	Glc2000	Present
continuous urban fabric	1	X	X	X	P
discontinuous urban fabric	2	X			
industrial and commercial units	3	X			
road and rail networks and associated land	4	X			
port areas	5	X			
airports	6	X			
mineral extraction sites	7	X			
dump sites	8	X			
construction sites	9	X			
green urban areas	10	X			
port and leisure facilities	11	X			
non-irrigated arable land	12	X	X	X	P
permanently irrigated land	13	X	X		P
rice fields	14	X			
vineyards	15	X	X		P
fruit trees and berry plantation	16	X			P
olive groves	17	X			P
pastures	18	X			P
annual cops associated with permanent crops	19	X			P
complex cultivation patterns	20	X			P
land principally occupied by agriculture with significant natural vegetation	21	X			P
agro-forestry areas	22	X			P
broadleaf forests	23	X	X	X	P
coniferous forest	24	X	X	X	P
mixed forest	25	X	X	X	
natural grasslands	26	X	X	X	P
moors and heath lands	27	X			P
sclerophyllous vegetation	28	X	X		P
transitional woodland-scrub	29	X		X	
beaches, sand, dunes	30	X			P
bare rocks	31	X			P
sparsely vegetated areas	32	X	X	X	P
burnt areas	33	X		X	P
glaciers and perpetual snow	34	X	X	X	P
inland marshes	35	X	X	X	P
peat bogs	36	X			P
salt marshes	37	X			P
salines	38	X			P
intertidal flats	39	X			P
water courses	40	X			P
water bodies	41	X	X	X	P
coastal lagoons	42	X			P
estuaries	43	X			P
sea and ocean	44	X	X		P

On basis of this 250 m resolution pan-European land cover database, as shown in 3.1.3 and it's relationship with Annex I of the Habitats Directive as described in paragraph 2.3.4, it is possible produce a map of the Annex I habitats at level 1. This result is shown in Figure 3.14. The statistics of this 250m resolution European habitat map are shown in Table 3.2. An important remark about this habitat map is that for the moment the pastures (land cover class 2.3.1) have been included within the major habitat "Natural and semi-natural grasslands (6)". The major habitats "Forests (9)" and "Natural and semi-natural grasslands (6)" do have the largest acreage, with respectively 54% and 24%. So these two major habitats cover almost 80% of all natural and semi-natural habitats. The habitats "Coastal and halophytic habitats (1)" and "Coastal sand dunes and inland dunes (2)" are the smallest and do cover only 0.5% of all habitats.

Table 3.2 Statistics of the European habitat map as displayed in Figure 3.14

Annex I habitat (Natura2000), level 1	km2	Perc (%)
1. Coastal and halophytic habitats	23845	0.4
2. Coastal sand dunes and inland dunes	4051	0.1
3. Freshwater habitats	269979	4.1
4. Temperate heath and scrub	340089	5.2
5. Sclerophyllous scrub (matorral)	506875	7.8
6. Natural and semi-natural grasslands	1540657	23.7
7. Raised bogs, mires and fens	275055	4.2
8. Rocky habitats and caves	33100	0.5
9. Forests	3517707	54.0
Total	6511359	100.0

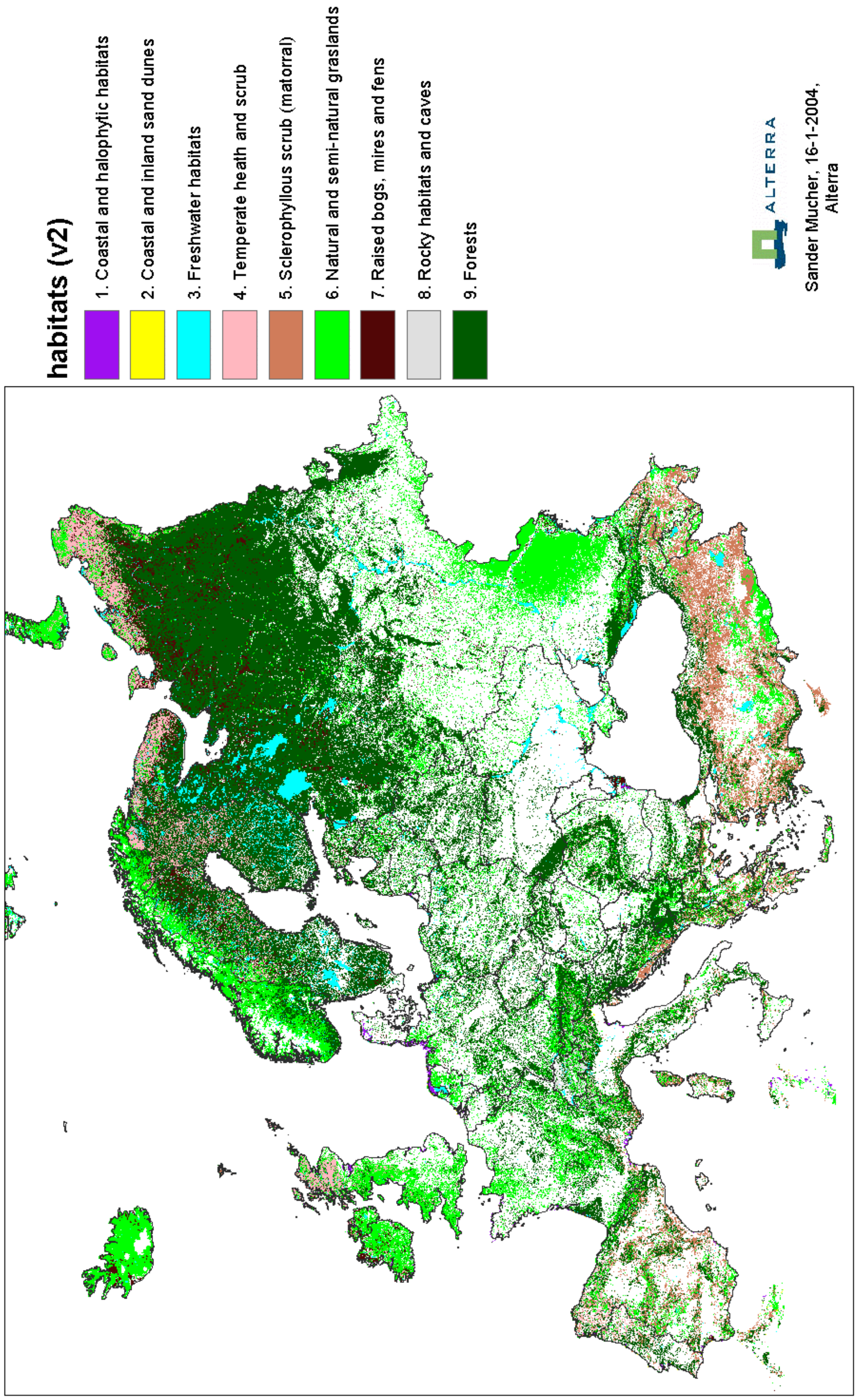

Figure 3.14 Map of the level 1 (Natura2000) habitats of Annex I at a 250m spatial resolution

3.6 Atlas Florae Europaeae (AFE)

Atlas Florae Europaeae (AFE) is designed to map the distribution of vascular plants in Europe (Jalas & Suominen, 1976). The project was launched in 1965 as a collaborative effort of European botanists and, since then, the secretariat has functioned at the Botanical department of the Finnish Museum of Natural History, Helsinki (www.fmnh.helsinki.fi/map/afe). The principal aim of the AFE is to produce complementary maps with taxonomic notes of species and subspecies based on the taxonomy of the Flora Europaeae. The chorological data are gathered by national collaborators in each European country. Between 1972 - 1999 the Committee and Societas Biologica Fennica Vanamo have published 12 volumes of the Atlas, including 2039 pages and 3270 maps.

Table 3.3 Overview of published AFE maps and related families

Volumes of the Atlas Florae Europaeae:		Maps	Year
1. Pteridophyta	(Psilotaceae - Azollaceae)	1-150	1972
2. Gymnospermae	(Pinaceae – Ephedraceae)	151-200	1973
3. Salicaceae to Balanophoracea		201-383	1976
4. Polygonaceae		384-478	1979
5. Chenopodiaceae to Basellaceae		479-668	1980
6. Caryophyllaceae	(Alsinoideae,Paronychioideae)	669-1011	1983
7. Caryophyllaceae	(Silenoideae)	1012-1508	1986
8. Nymphaeaceae to Rununculaceae		1509-1953	1989
9. Paeoniaceae to Capparaceae		1954-2109	1991
10. Cruciferae	(Sisymbrium to Aubrieta)	2110-2433	1994
11. Cruciferae	(Ricotia to Raphanus)	2434-2927	1996
12. Resedaceae to Plantanaceae		2928-3270	1999

Currently the maps cover the families which include more than 20% of the vascular plants of European flora. All the distribution maps published in AFE Volumes 1 to 12 were made manually (Jalas & Suominen, 1976). Later the maps were scanned into a digital database. The AFE database can be used by means of a free Windows program, which is available from the AFE Database home page (www.fmnh.helsinki.fi/map/afe).

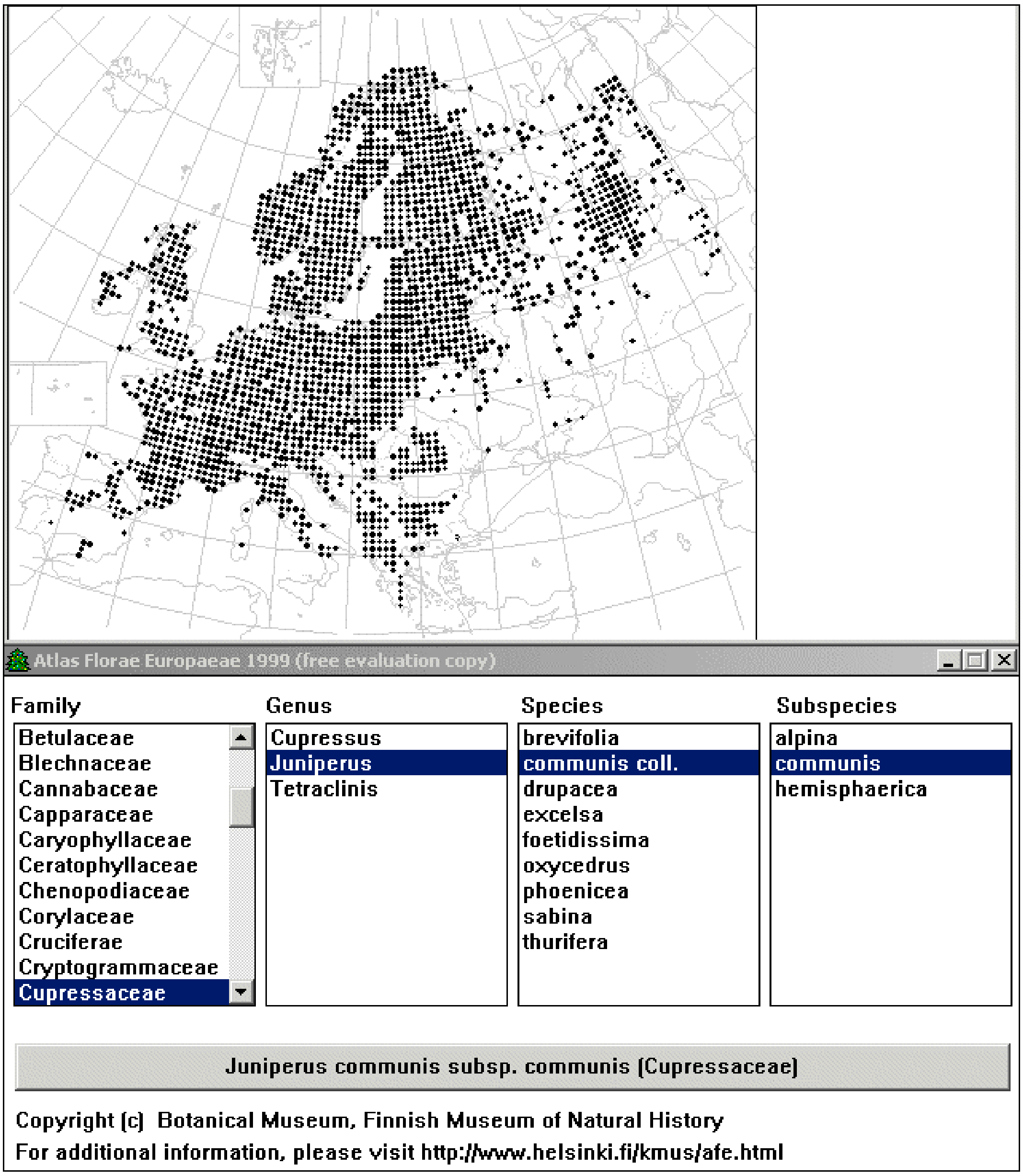

Figure 3.15 Example of Atlas Florae Europaeae for Juniperus communis

An important region within pan-Europe that is not covered by the AFE is a part of south-eastern Europe, including; Turkey, Azerbaijan, Armenia, Georgia and the southern part of Russia close to the border of Georgia, as shown in Figure 3.15.

3.7 The Map of the Natural Vegetation of Europe

The Map of the Natural Vegetation of Europe, further referred to as PNV map (Potential Natural Vegetation map), as shown in Figure 3.16, was produced in Germany by the Institute für Bundesamt für Naturschutz - BfN (Bohn, 2003). More than 100 geobotanists from 31 European countries co-operated to produce the map, its legend and the explanatory text. The vector map defines the distribution of plant communities and their complexes, which are adapted to existing climatic and edaphic conditions, excluding, as far as possible, human impact. This map consists of 699 mapping units organised into a hierarchical classification. The main groups of the system are 19 physiognomic-structurally and ecologically characterised formations or formation complexes, of which 14 (denoted with the capital letters A to O) represent the macroclimatic zones in the progression from northern to southern and south-eastern Europe and their corresponding altitudinal belts in the mountains. The differentiation and spatial progression of these zones is determined primarily by the temperature gradient. The last five formations (P to U) represent azonal vegetation types marked by dominant edaphic site factors such as saline or wet soils and are modified only secondarily by macroclimatic factors. The formations are subdivided into sub-groups according to their species composition, finer climatic gradations and large scale habitat factors. These are in turn subdivided according to their nutrient regime, altitudinal belt, moisture regime and geographic location. The 699 mapping units form the basic units of the vegetation map. As a rule, these consist of spatially extensive zonal and azonal natural plant communities in a given area; in special cases they may consist of a combination of equally well-represented vegetation units.

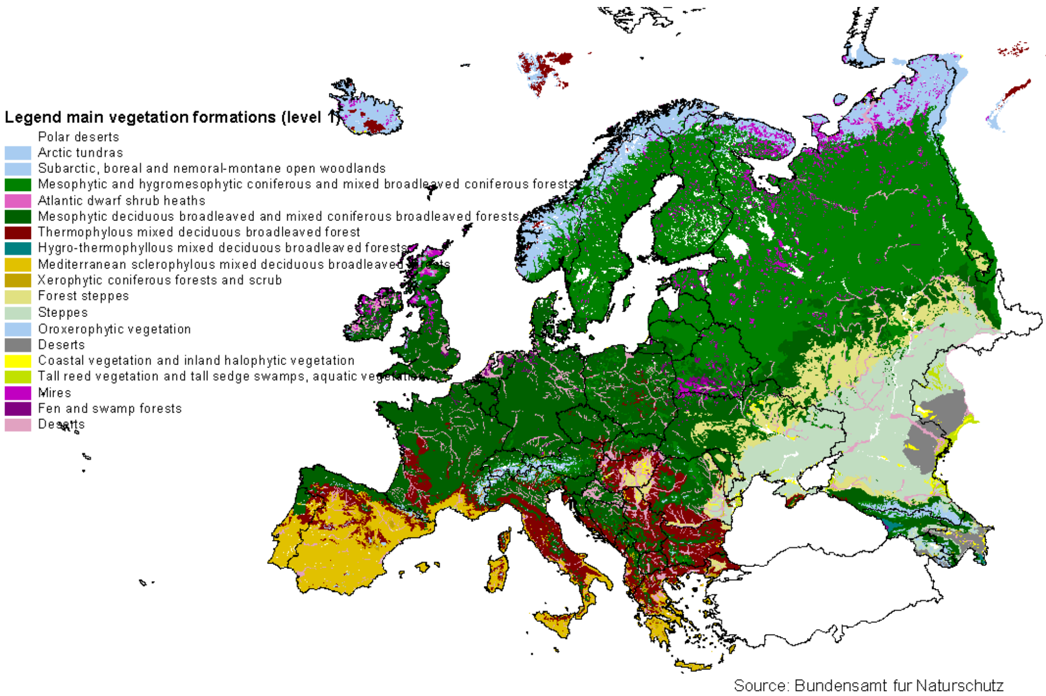

Figure 3.16 Potential Natural Vegetation Map (Source: Bundesamt für Naturschutz, Bonn)

The map is designed for defining potential natural vegetation and does not necessarily describe the actual vegetation at a given location. For example, for the northern part of France the potential natural vegetation may be a beech forest but actually the land may be used to cultivate maize. However, there is also a comprehensive text description for each mapping unit. This comprehensive text description can be used very well within the present PEENHAB project. An overview of all the attributes and their explanation can be found in the Appendix. 14. Among the many items in the text descriptions there are some that can be used to connect mapping units to Nature2000 habitat types. These attributes are for example: 'Dominant and most frequent species in different layers', 'Diagnostically important species', and 'Site conditions of the mapping unit' (including geology), see also Appendix 14. How the database is used within the present project in its methodological approach is explained in more detail in Chapter 4.

3.8 CORINE biotopes site database

The CORINE Biotopes database (CEC, 1991) is part of the EC CORINE Programme, developed by DG XI during the period 1985-1990, and was maintained by the EEA (Moss et al., 1995). The database now contains details of 7741 sites of European importance for nature conservation in 13 EU Member States, and is in active preparation in ten non-EU countries. The CORINE Biotopes project comprised a number of linked activities: notably, i) the compilation of a database of sites of major importance for nature conservation and ii) the development of a classification of European habitats, which has been discussed in the chapter 2.

The aim of CORINE was to meet the need for better knowledge of the environment. For nature protection the main components of this policy are implemented by:

1. the Directive on the conservation of wild birds (1979)
2. the adoption of the Bern Convention on the Conservation of European Wildlife and Natural Habitats (1981)
3. the adoption of the Bonn Convention on the Conservation of Migratory Species of Wild Animals (1982)
4. the adoption of the Convention on Trade in Endangered Species (CITES) (1984)
5. the Directive on the conservation of fauna, flora and habitats (the Habitats Directive) (1992).

The Biotopes site database was designed to assemble reliable and consistent information about the location and status of ecosystems, habitats and species in need of protection and to make this information accessible to policy-makers. The main methodological approaches were the development of: i) objective criteria which provided a common basis on which to judge the 'importance' of a locality for nature conservation in Europe; ii) a common format for the data, so as to establish an acceptable compromise between the requirement for extensive information about each site and the difficulty of acquiring information at the necessary level of detail in every Member State of the EC; iii) nomenclatures to describe habitats, species taxonomy and other important site characteristics (CEC, 1991). A limited amount of errors in the databases is due to: general data errors, inadequate site information, inadequate habitat description, and inadequate precise coordinates of the sites.

The site selection criteria, independently of the current protection status, are concerned with; i) the presence of threatened species of plants or animals or of sensitive habitat types; ii) the richness of a site for a taxonomic group of species or a collection of habitat types. The first type of criteria were defined precisely, used systematically in site selection, and recorded explicitly in the database. One of the three following criteria should apply:

1. One of the 100 most important sites in the Community or one of the five most important sites in a region for a threatened species.
2. One of the 100 most important or representative sites in the Community or one of the five most important or representative sites in a region for a sensitive habitat type.
3. The site supports at least 1% of the Community population of a threatened species.

The database has specific tables for: amphibians, birds, fishes, mammals, plants and invertebrates. Some important descriptive tables for the biotopes sites are cited in Table 3.4, Table 3.5 and Table 3.6.

Table 3.4 Character fields within the table HABEUR of the CORINE biotopes database

Field	Field Name	Type	Width	Definition	Remark
1	HABCODE	Character	9	Hierarchical habitat code	Palaearctic Habitat Classification codes
2	LEVEL	Character	1	Level in hierarchy of code	
3	DESCRIPT	Character	73	Brief text description of habitat class	
4	COM	Memo	10	Phytosociological communities	
5	TXT	Memo	10	Text description of habitat class	
6	REF	Memo	10	Published documentation for habitat description	

Table 3.5 Character fields within the Table HUMANACT of the CORINE biotopes database

Field	Field Name	Type	Width	Definition
1	ACT_CODE	Character	2	Code for human activity affecting site
2	DESCRIPT	Character	45	Text description of human activity

Table 3.6 Character fields within the Table MOTIVATN of the CORINE biotopes database

Field	Field Name	Type	Width	Definition
1	MOTICODE	Character	2	Code for motivation for inclusion of site in inventory
2	DESCRIPT	Character	45	Text description of motivation

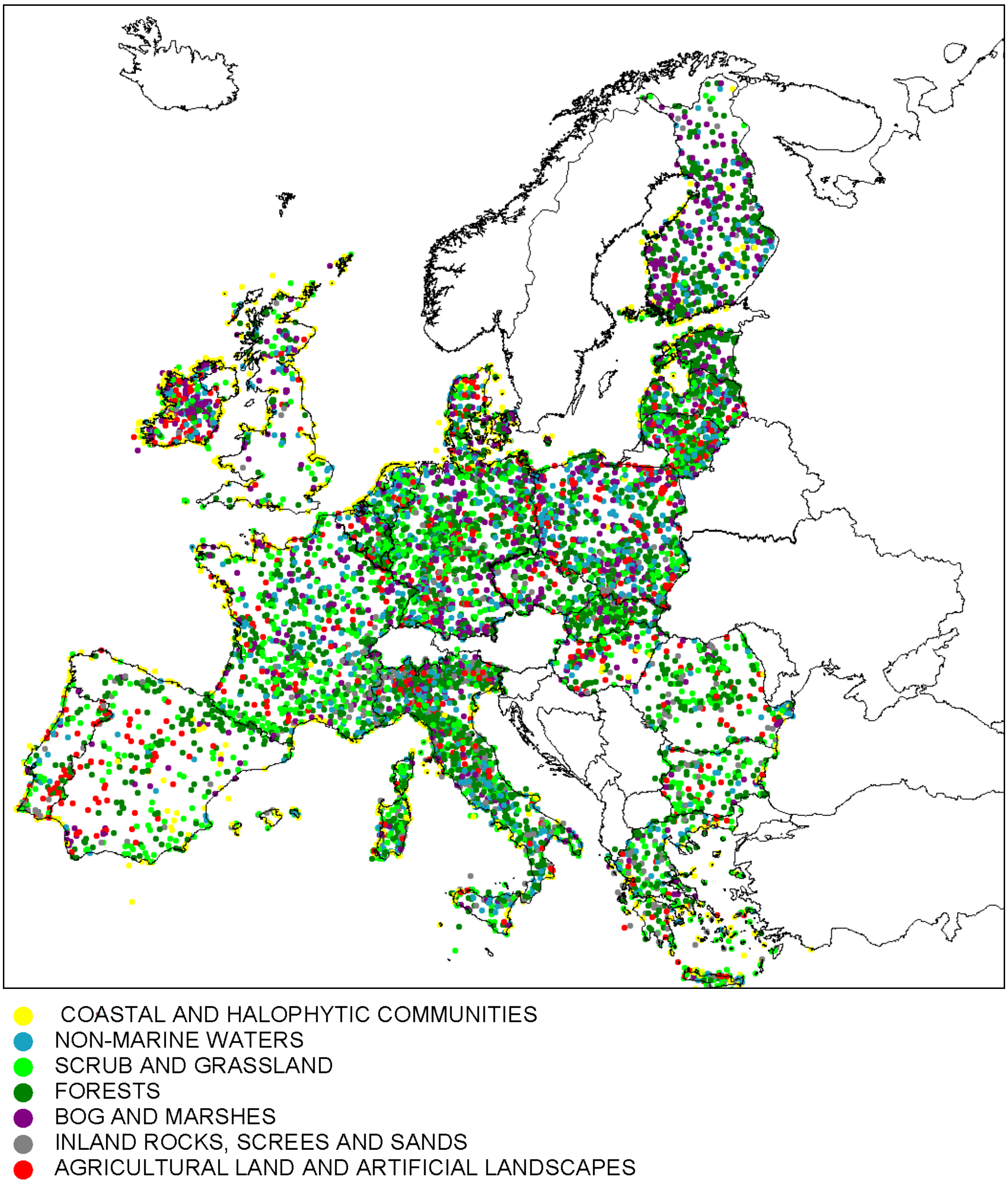

Figure 3.17 CORINE biotopes database displaying major biotopes types

4 Methodology

4.1 Introduction

The objective of this project is to map European habitats as defined in Annex I (European Commission, 1999) of the Habitats Directive by using a multi-source integrated methodology that explores the use of European spatial data sets. An example is provided by Earth Observation derived land cover data together with other existing spatial information on the biotic and abiotic conditions, and the use of expert knowledge rules. The Natura 2000 sites, delineated according to guidelines of the Habitats Directive, will have a high reliability but a relatively low accuracy, meaning that only the most precious parts of the exiting habitats are being delineated and protected. As an example, part of Annex I habitat 4010 "Northern Atlantic wet heaths with Erica tetralix" will be situated in designated Natura 2000 sites. However, a large part of this habitat type will also be located outside designated areas. However, the Natura 2000 sites can be used in the validation process. As shown in Figure 4.1 most countries have a much larger area of semi-natural and natural habitats than is being designated by Natura 2000 sites, the only exception is Denmark.

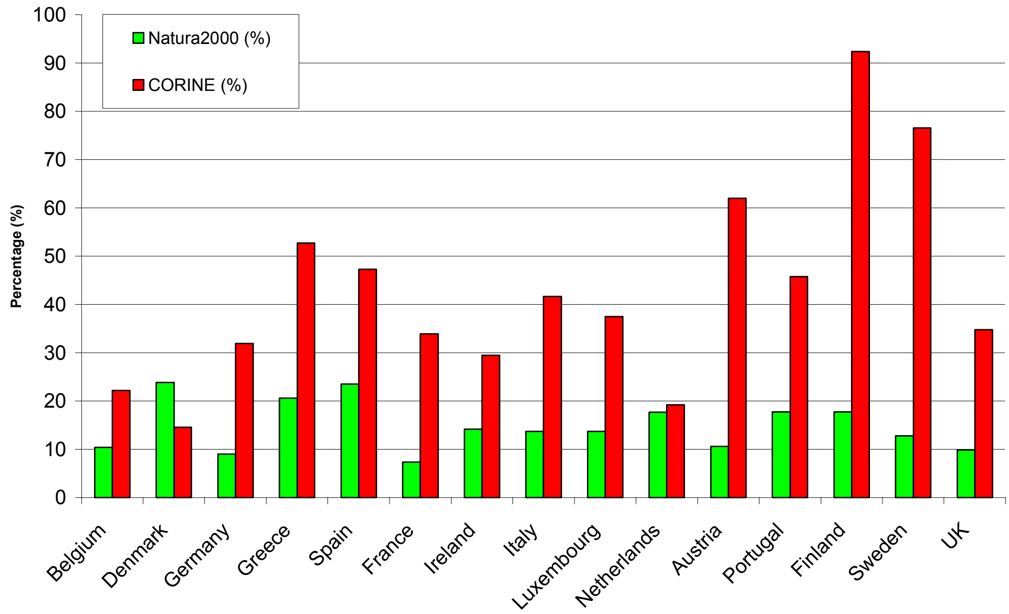

Figure 4.1 Comparison of national figures on natural and semi-natural areas derived from CORINE land cover with the area protected by Natura 2000 sites

As mentioned before, the design of a pan-European ecological network requires a synoptic overview of European habitats since many species are not only depending on designated sites but are rather present in the wider countryside. So far, there is no complete overview of the actual distribution of European habitats. Next to actual land cover maps, the best available map is the Potential Natural Vegetation (PNV) map that indicates the potential habitats.

4.2 Methodological aspects

A methodology has to be developed that enables the spatial identification of individual European habitats on basis of:

- their description in Annex I of the Habitats Directive, in conjunction with
- a set of core spatial data sets such as the CORINE land cover database, topographical data, biogeographical regions, digital elevation models, distribution maps of individual plant species, and the European Soil database.

Each data set is contributing to an improved spatial identification of the actual habitats in what is called a top-down approach, as shown in Figure 4.2.

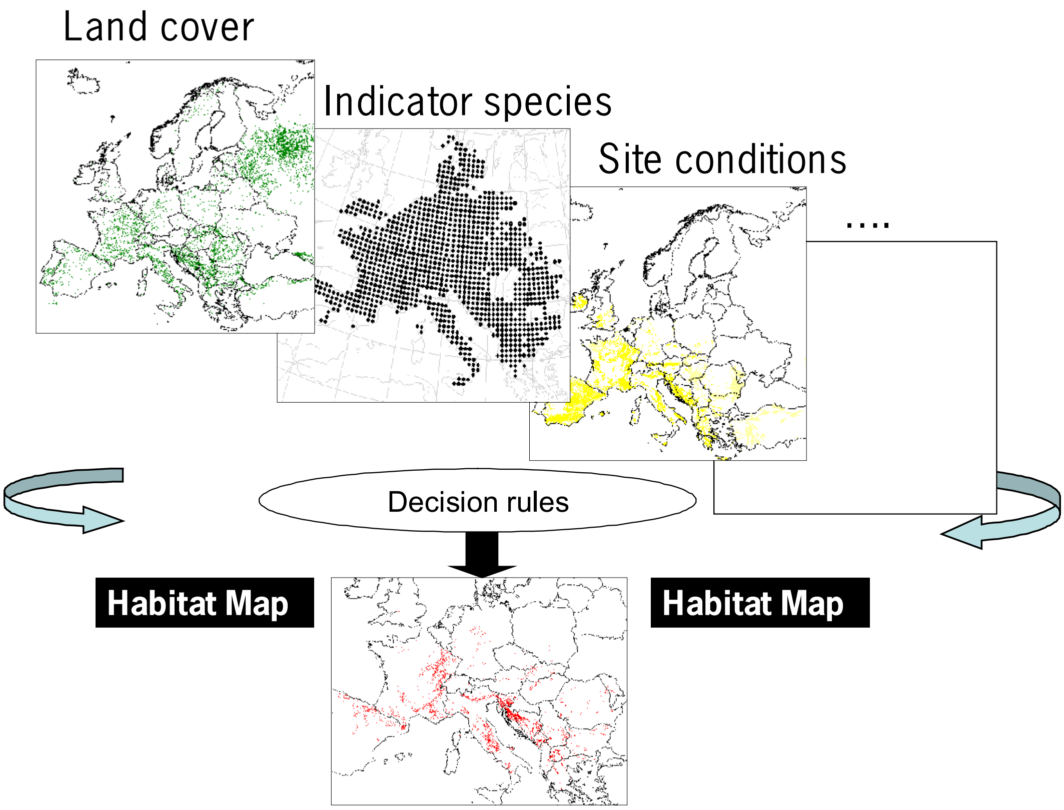

Figure 4.2 Flowchart of the methodological approach to identify European habitats

The decision rules will consist of a combination of a number of filters on the basis of the selected spatial data sets and their habitat descriptions and will be formalised within graphic models for each habitat type. The methodology will be demonstrated in this chapter for Annex I habitat type 9150 "Medio-European limestone beech forests of the Cephalanthero-Fagion".

4.2.1 Habitat description

The habitat description in Annex I (European Commission, 1999) will constitute the basis for the definition of the decision rules or filters for each habitat. In Table 4.1 an example is given of the description for the habitat type 9150 "Medio-European limestone beech forests of the Cephanlanthero-Fagion". Especially, the general description and the characteristic plant species are essential in defining the decision rules for each habitat type. It should be emphasised that not all Annex I habitats have such a precise definition.

Table 4.1 Description of an Annex I habitat type as given in the Habitats Directive Interpretation Manual and with additional information from EUNIS (http://mrw.wallonie.be/dgrne/sibw/EUNIS/)

9150 Calcareous beech forests (Cephalanthero-Fagion) (41.16)

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 pubescenti-petraeae]. The bush-layer includes several calcicolous species ([Ligustrum vulgare, Berberis vulgaris]) and [Buxus sempervirens] can dominate.

The following sub-types are included:

Pal., 41.161 Middle European dry-slope limestone beech forests

Middle European sedge and orchid beech woods of slopes with reduced water availability.

Pal., 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 [Brachypodium pinnatum ssp. rupestre, Sesleria argentea ssp. hispanica, Carex brevicollis, Carex ornithopoda, Carex sempervirens, Carex caudata, Cephalanthera damasonium, Cephalanthera longifolia, Epipactis helleborine, Epipactis microphylla, Neottia nidus-avis].

Distribution

Austria, Belgium, Denmark, France, Germany, Greece, Luxemburg, Spain, Sweden.

Plants

Fagus sylvatica, Carex digitata, Carex flacca, Carex montana, Carex alba, Sesleria albicans, Brachypodium pinnatum, Cephalanthera spp., Neottia nidus-avis, Epipactis leptochila, Epipactis microphylla, Buxus semperviren].

Relationship to EUNIS classification

<	G1.6	[Fagus] woodland
=	G1.66	Medio-European limestone [Fagus] forests

Relationship to other classifications

Nordic classification 1994

?	2.2.2.3	[Fagus sylvatica-Mercurialis perennis-Allium ursinum] -typ

Palaearctic classification 1996

?	41.16	Medio-European limestone beech forests
?	41.161	Middle European dry-slope limestone beech forests

?	41.1611	Medio-European dry slope sedge beech forests
?	41.1612	Medio-European steep slope yew beech forests
?	41.1613	Medio-European blue moorgrass beech forests
?	41.1614	Medio-European naked basiphile beech forests
?	41.1615	Pannonic limestone beech forests
?	41.162	North-western Iberian xerophile beech woods
Habitat names in different languages		
Danish		Bøgeskove på kalkrig bund (Cephalanthero-Fagion)
German		Orchideen-Buchenwald (Cephalanthero-Fagion)
English		Medio-European limestone beech forests ([Cephalanthero-Fagion])
Spanish		Hayedos calcícolas (Cephalanthero-Fagion)
French		Hêtraies calcicoles (Cephalanthero-Fagion)
Italian		Faggeti calcicoli(Cephalanthero-Fagion)
Dutch		Kalkminnende beukenbossen (Cephalanthero-Fagion)
Portuguese		Faiais calcícolas(Cephalenthero-Fagion)

4.2.2 Decision rules or filters

At the first stage, indicators species were selected on the basis of the habitat description in Annex I interpretation manual (see also for the Habitats Directive 92/43/EEC website http://mrw.wallonie.be/dgrne/sibw/N2000) and on the basis of expert knowledge. The indicator species are listed in Appendix 11 for each Annex I habitat type. The indicator species have been selected on basis of being characteristic of the habitat type and being as far as possible stable in time. About 120 of the 196 Annex I habitat types (European Commission, 1999) have indicator species that are present in the Atlas Florae Europaeae (AFE). The limited amount of species in the AFE restricts the identification of all habitat types (see also paragraph 3.7). However, there are also other reasons that reduces the ability to determine the spatial identification of European habitats and these are: (1) weak description of the habitat type in Annex I or (2) the habitat is very limited in area and (3) very fragmented, (4) no species available in the AFE. In Appendix 12 an attempt has been made to indicate the mapping possibility of each Annex I habitat type and on basis of which data sources the identification is possible. Appendix 12 lists also the relations between Annex I habitat types and the CORINE land cover nomenclature. There are about a hundred Annex I habitat types for which a European habitat mapping exercise is possible. On the Natura 2000 website (http://mrw.wallonie.be/dgrne/sibw/N2000) it is possible to search the Annex I database on the basis of search criteria such as Natura 2000 habitat code, CORINE habitat code (Palaearctic), text string or country or a combination of these. A list (see Appendix 13) of the present Annex I habitat types per country can be useful to construct filters. However, the country list is limited to the EU15 hampering it's use for a pan-European approach. Nevertheless, it is interesting to see the number of Annex I habitat types per country (EU15) and these are summarised in Figure 4.3.

It is interesting to see that a small country like the Netherlands is quite rich in Annex I habitats compared to large countries as Finland, Sweden and the UK. Especially, the Mediterranean countries are very rich in Annex I habitats (see Appendix 13 for a full summary). The reason that France is scoring very high is that the country has most biogeographic regions (Atlantic, Continental, Mediterranean and Alpine) that implicitly determines the number of habitat types that can be registered.

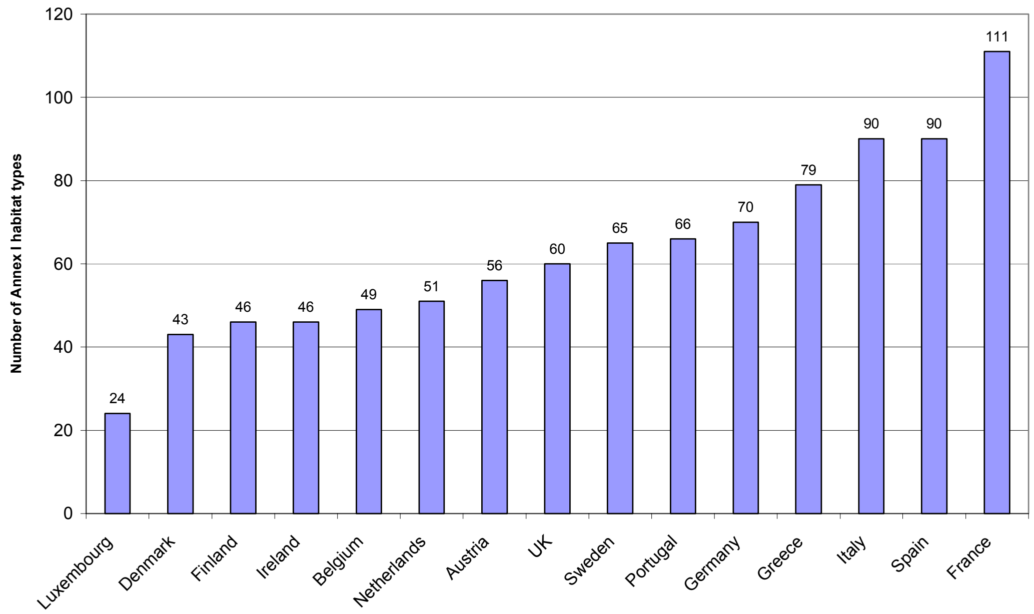

Figure 4.3 Number of Annex I habitat types per country (EU15)

As mentioned above the decision rules will consist of a combination of a number of filters on the basis of the selected spatial data sets and their habitat descriptions and will be formalised within graphic models for each habitat type. The exploitation of core data sets will be demonstrated now for the case of Annex I habitat type 9150 "Calcareous beech forests".

4.2.3 Core data sets to identify habitat type 9150

Annex I habitat 9150 "Calcareous beech forests (Cephalanthero-Fagion)" corresponds with the CORINE land cover class 3.1.1 "Broad-leaved forests". This land cover class can be derived from the 250m spatial resolution pan-European land cover database described in paragraph 3.6.4. Note from this paragraph that the CORINE land cover class 3.1.3 "Mixed forest" was added to the class 3.1.1. "Broad-leaved forest. This is considered as the first step in the spatial identification of habitat 9150 "Calcareous beech forests".

The next step is the *selection of indicator species*. For Annex I habitat 9150 the indicator species are Fagus sylvatica, Cephelanthera spp., Neottia nidus-avis and Carex digitata (See also appendix 11). Unfortunately, the AFE contains only Fagus sylvatica from this list and this species is therefore combined with the land cover to limit the broad-leaved forests to the regions where the beech tree (Fagus sylvatica) does occur.

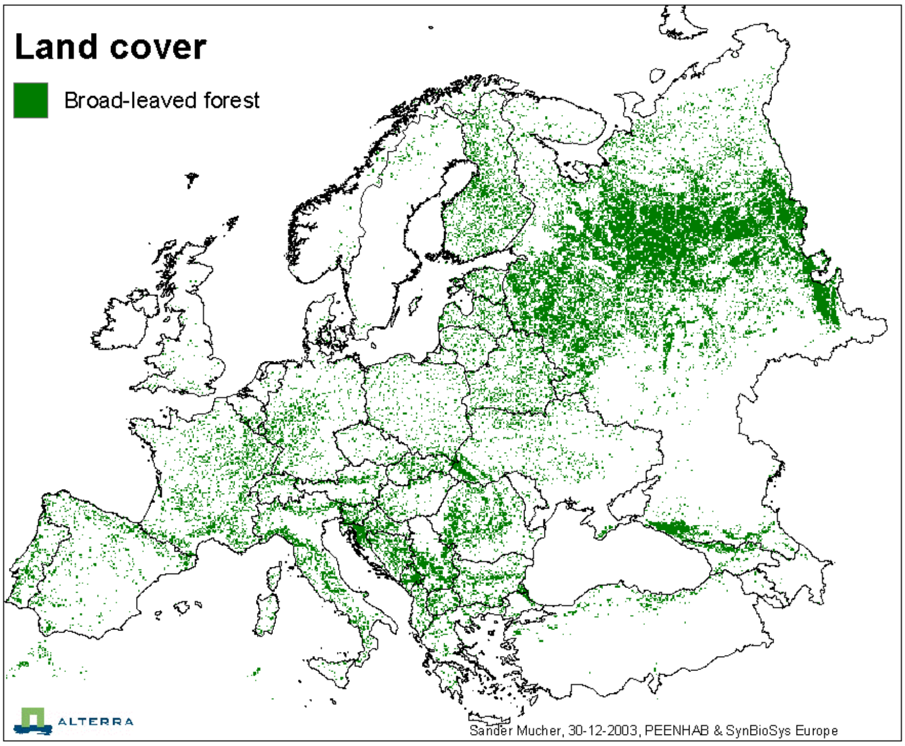

Figure 4.4 Broad-leaved forest derived from the 250m pan-European land cover database

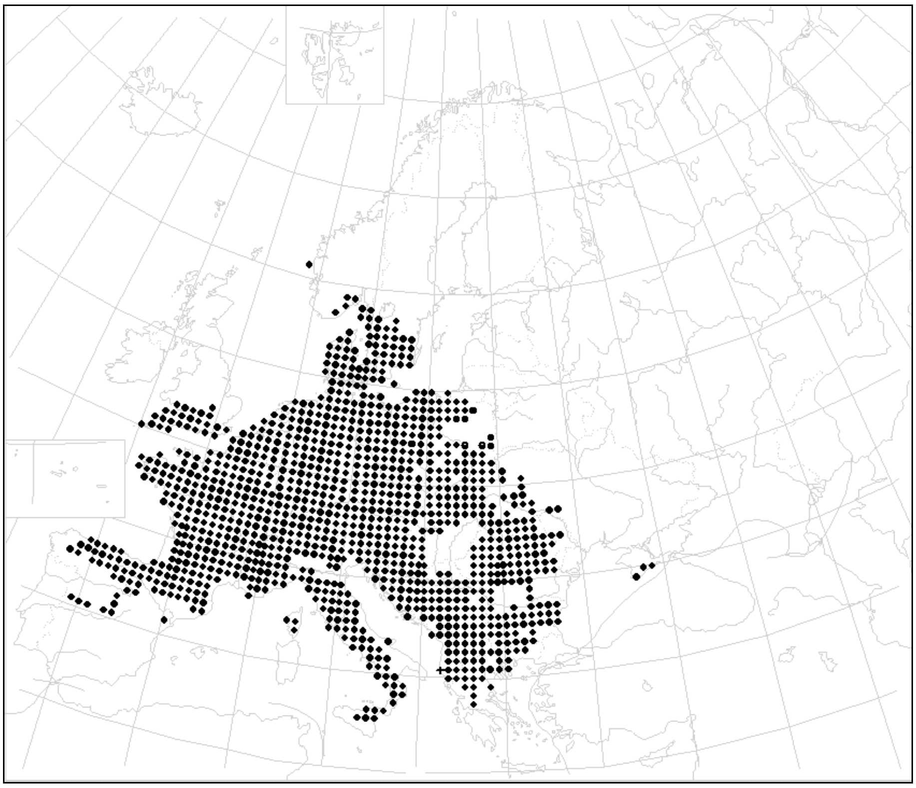

Figure 4.5 Spatial ditribution of the beech tree (Fagus sylvatica) in Europe according to the Atlas Flora Europaeae

The next step is to introduce the abiotic site conditions of the habitat. In the Annex I description it is mentioned that the xero-thermophile Fagus sylvatica forests develop on calcareous soils, often superficial soils, on steep slopes.

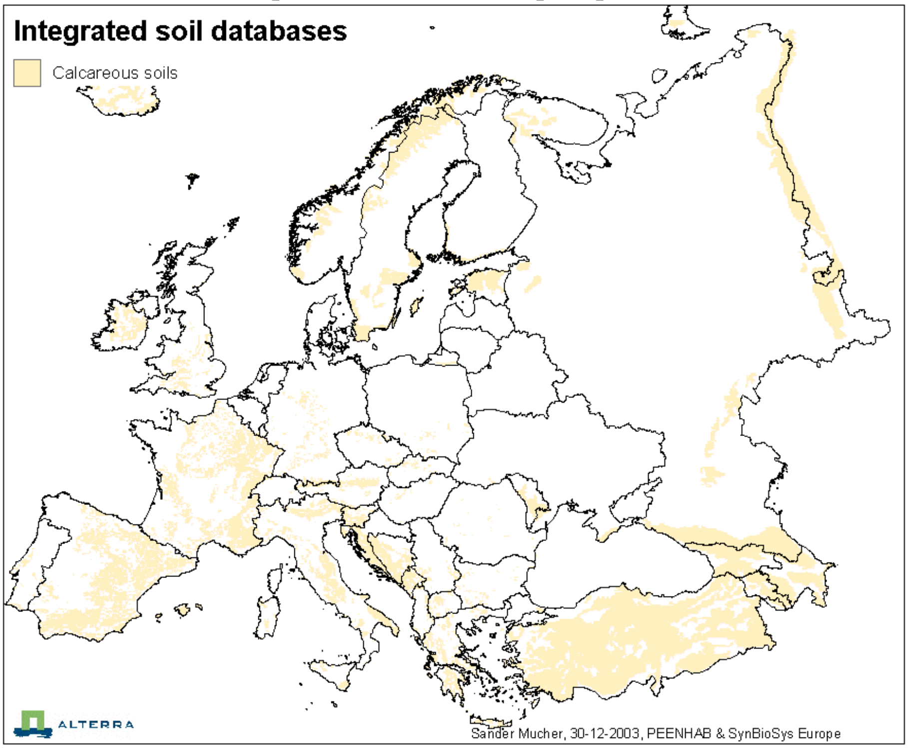

Figure 4.6 Calcareous soils in Europe

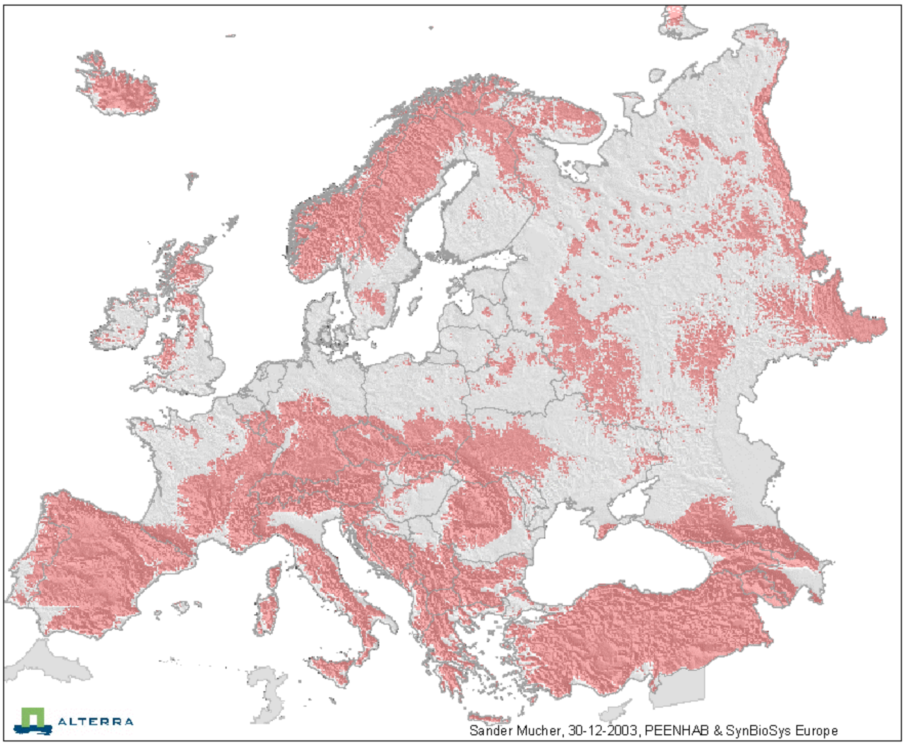

Figure 4.7 Digital Elevation Model with areas above 200m indicated in red

The calcareous soils can be derived from the integrated pan-European soil database. In paragraph 3.5.3. this integrated soil database has been described in detail and in Appendix 8 the soil types are mentioned that have been identified as calcareous (in this case having calcareous parent material).

Since steep slopes are only occuring in regions outside the lowland we can use the 1 km digital elevetion model to exclude those areas. As shown in Figure 4.7 all areas above 200m are selected and are displayed in red colour.

On the basis of these sequential methodological steps it is already possible to estimate the spatial distribution of the calcareous beech forests in Europe as shown in Figure 4.8.

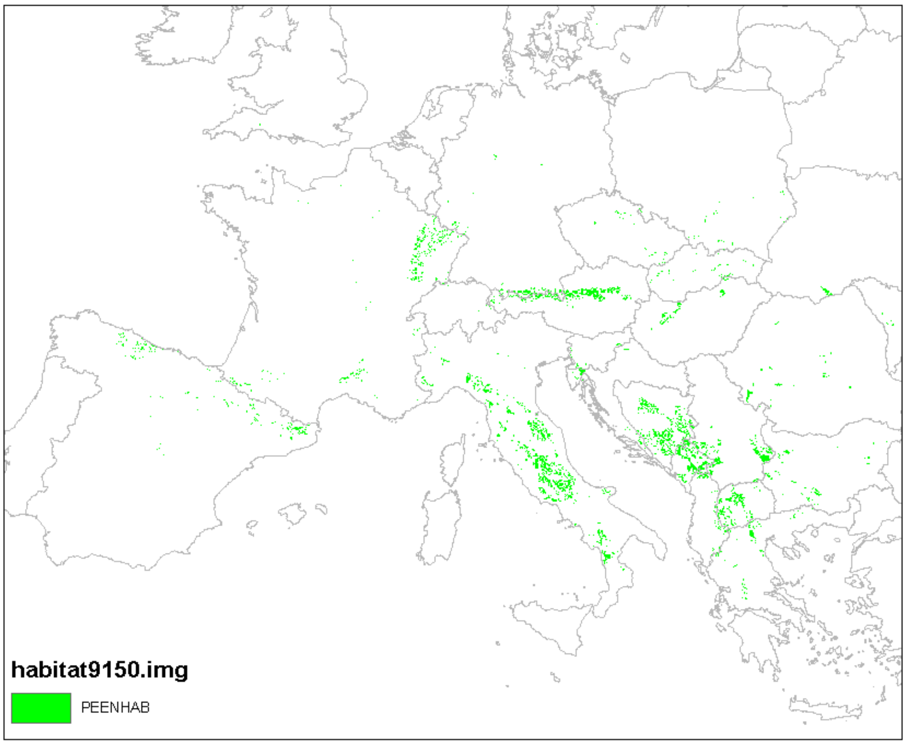

Figure 4.8 First result on the spatial distribution of calcerous beech forest (habitat 9150) in Europe on the basis of land cover, indicator species, and abiotic site conditions

The next paragraph describes the module predicting Natura 2000 habitat types of SynBioSys Europe. These results are also integrated in the present project to improve the spatial identification of the European habitats. In the final step these results are being combined with the former results, as shown in Figure 4.8.

4.2.4 Predicting Natura 2000 habitats using the map of the Natural Vegetation of Europe

One of the data sources that can used to predict Annex I habitat types is the Map of the Natural Vegetation of Europe, further being referred as the PNV map (Potential Natural Vegetation Map of Europe), scale 1 : 2.5 million (Bohn et al. 2001). This map has been incorporated within the present project with the help of SynBioSys Europe. The screen shot taken from SynBioSys Europe, as shown in Figure 4.9, demonstrates the list of plant species that are considered to be characteristic for 'Medio-European limestone beech forest of the Cephalanthero-Fagion' (Habitat 9150) and has its origin in Annex I habitat description. This list of species can now be compared with the typical species ('Diagnostically important species') mentioned for each mapping unit of the PNV map. Because it is most unlikely that all species mentioned for the habitat type are present in one mapping unit, a threshold must be defined for the minimum number of species that should be present in each mapping unit. For example, a threshold of two means that at least two species from the total list of species typical for the habitat type must be present in a mapping unit. On top of the species composition as criterion it is also possible to refine the selection by using other information. In the case of Habitat type 9150 it is also known that the type is restricted to limestone soils. Therefore an extra criterion can be the word 'limestone' which should be mentioned in the section 'Site conditions of the mapping unit' in the text description of the mapping units (see Appendix 14).

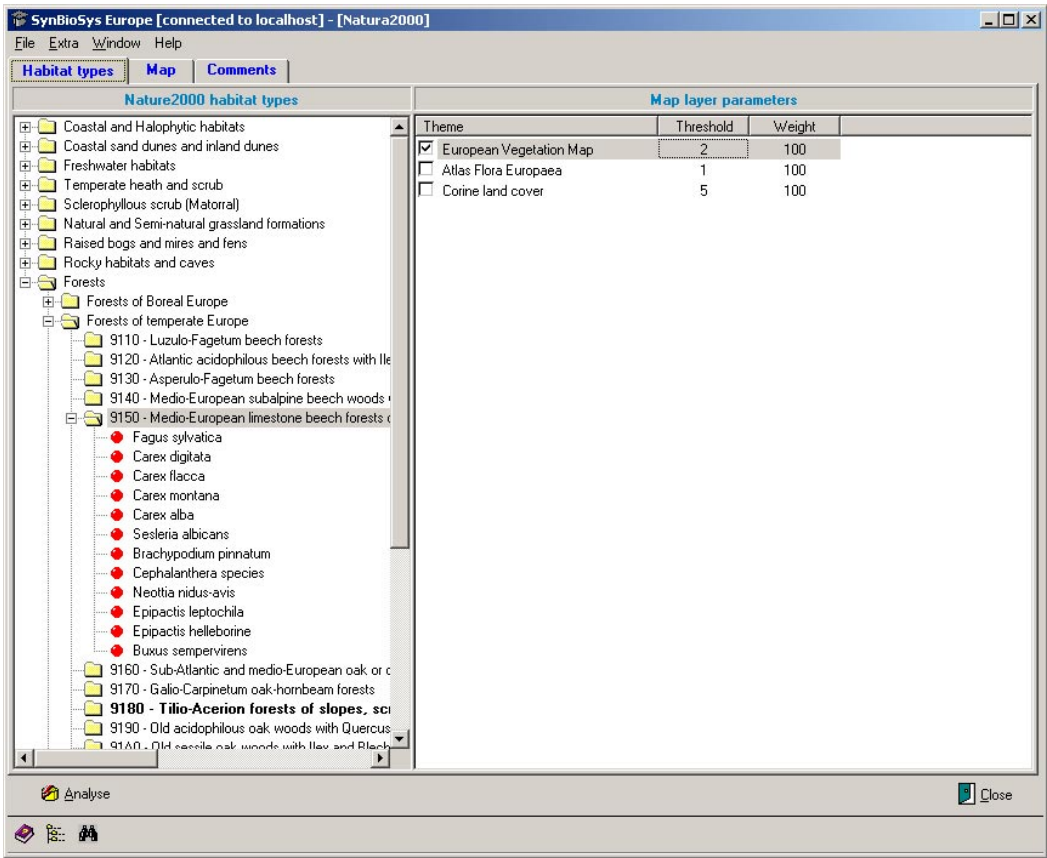

Figure 4.9 Screen shot of SynBioSys Europe showing the hierarchical organisation of Natura 2000 habitat types. At the lowest level the tree is opened at type 9150 showing a list of plant species that are considered to be characteristic for 'Medio-European limestone beach forest of the Cephalanthero-Fagion'. On the right site the threshold for the minimum number of speciesto be found in a mapping unit with in the European Vegetation Map is set to '2'

As a result of the defined criteria the spatial distribution of Annex I habitat 9150 'Medio-European limestone beach forest of the Cephalanthero-Fagion' is shown in Figure 4.10 and is based on the PNV Map. The resulting spatial distribution from SynBioSys Europe is considered as an important extra information layer within the whole methodological approach.

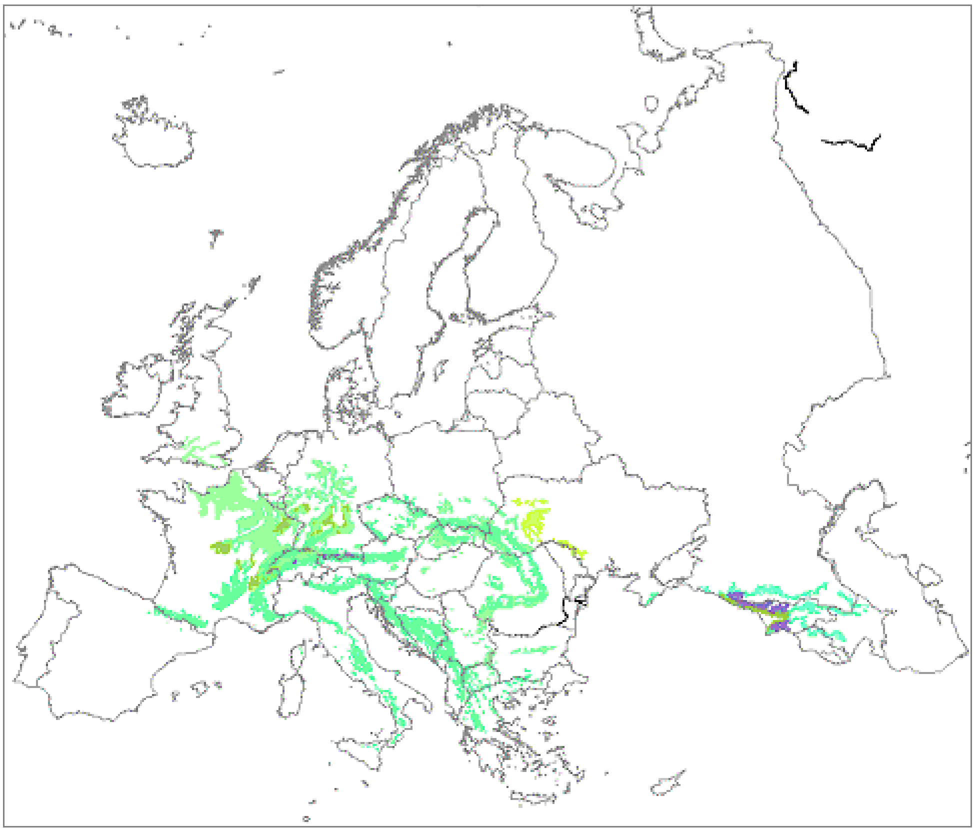

Figure 4.10 Estimated spatial distribution of Habitat 9150 'Medio-European limestone beach forest of the Cephalanthero-Fagion' Europe based on the Map of the Natural vegetation of Europe

4.2.5 Data infrastructure and graphic modeller

In the next stage, the result from SynBioSys Europe is combined with the 250m pan-European land cover database. All the processing steps are formalised within the Graphic modeller of ERDAS Imagine (ERDAS, 1997). All data sets are stored in a organised structure on one computer and are stored in raster format of ERDAS Imagine. The raster format guaranties fast calculation on different layers and the "run-length compression technique" in ERDAS (ERDAS, 1997) guaranties a major reduction in file size. For every Annex I habitat type a graphic model will be made in which the various data sources are being combined and the decisions taken are explicitly stored. When a threshold needs to be adjusted or a better input data layer has been produced, it is relatively easy to adapt the graphic model and run it again. In ArcGis 9 a similar graphic module option is becoming possible. Figure 4.11 is the graphic model that has been used to calculate the final estimate of the spatial distribution of calcareous beech forests in Europe (habitat 9150) on a 250m grid basis.

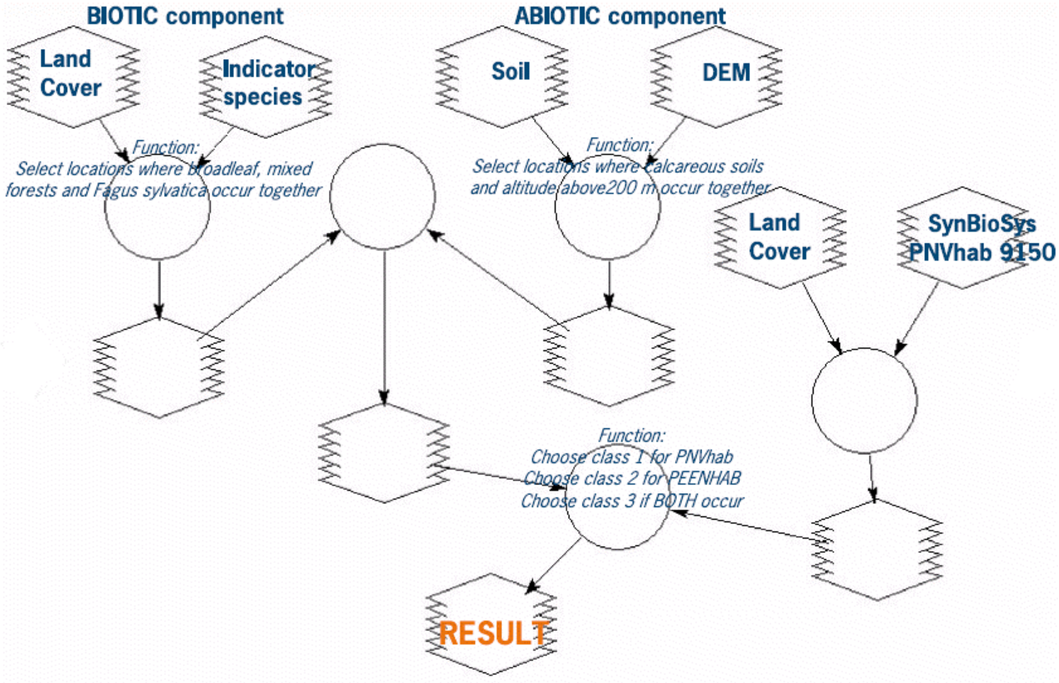

Figure 4.11 Graphic model of Erdas Imagine that has been used to calculate the final result on the spatial distribution of calcareous beech forests in Europe (habitat 9150) on a 250m grid basis. The circles contain the functions, the other objects the input or output

In the next Chapter the final result for the spatial distribution of calcareous beech forests in Europe (habitat 9150) will be discussed.

5 Results

The output of the graphic model is shown in Figure 5.1 for Annex I habitat type 9150 "Medio-European limestone beech forest of the Cephalanthero-Fagion". Class one "PNV habitat", displayed in blue colour, concerns the output result from SynBioSys in combination with the pan-European land cover database (extreme right part of the graphic model in figure 4.10). Class two "PEENHAB" concerns the left part of the graphic model (in figure 4.10) and is based on the combination of land cover, indicator species and abiotic site conditions (as discussed before). Class three "Both", displayed in red colour, indicates the overlap between the two former classes. Table 5.1 indicates that there is an overlap of 25.8% (class 3).

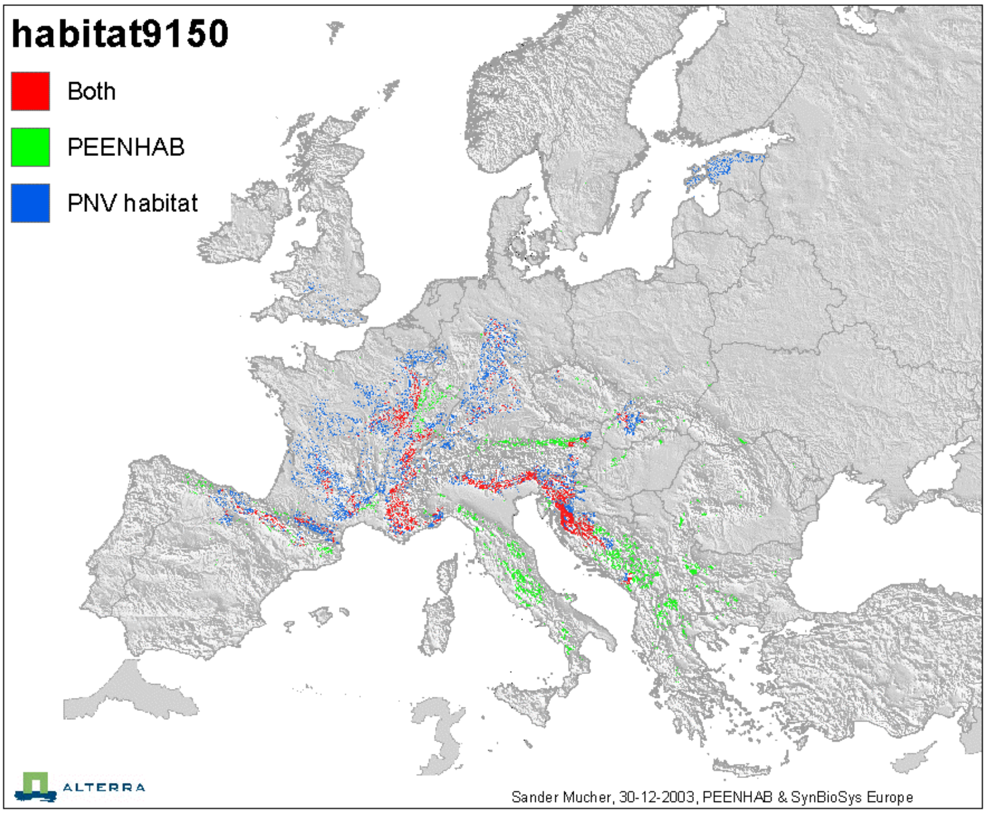

Figure 5.1 Final results of the proposed methodology concerning Annex I habitat type 9150 "Medio-European limestone beach forest of the Cephalanthero-Fagion" with a 250m spatial resolution

Table 5.1 Statistics of the Habitat 9150 map (see figure 5.1)

Class nr	Class name	Count	km2	%
1.	PNV habitat	1578847	98677.94	49.2
2.	PEENHAB	801753	50109.56	25.0
3.	Both	826052	51628.25	25.8
	Sum	3206652	200415.8	1

To be able to interpret these results some kind of validation has to be performed, which will be discussed in the next paragraph.

5.1 Validation

Concerning the validation of the proposed methodology and its results, the Natura 2000 sites are unfortunately still not available for the public for most countries, currently restricting validation using Natura 2000 sites.

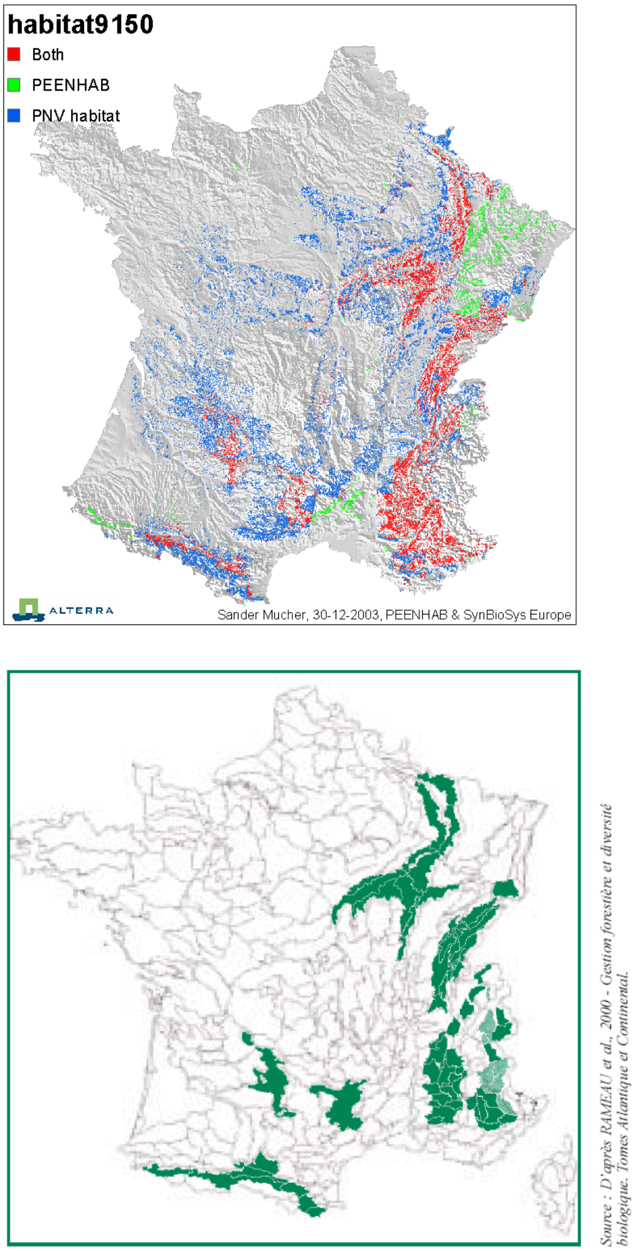

Figure 5.2 Visual comparison of the result (on top) with (below) a reference data source (http://Natura 2000.environnement.gouv.fr/habitats/cahiers.html) for France

Another possibility for validation is the use of the CORINE biotopes database but is limited because the data set is only available as a point database. A third option, derived from the internet, is the publication of Annex I habitat maps for all forest types in France. As a visual validation exercise, it is surprising to find a good match between the classification result and the reference data, specifically for class 3 (in red colour). This case suggests that the overlap between class 1 and class 2 is indicating a more realistic distribution of calcareous beech forests in France. Class one and two both overestimate the presence of calcareous beech forest in France. This proves that integration of the first two classes really adds information.

A second validation has been implemented by using the CORINE biotopes database. The biotope class 41.16 "Beech forests on limestone" is related to Annex I habitat 9150. A total number of 44 biotopes sites across Europe did have "beech forests on limestone". On basis of their acreage a buffer has been calculated and for each biotope site with buffer it has been checked if pixels of Annex I habitat 9150 (see figure 5.1) were present and to which class they did belong. Of the 44 sites there were 12 sites (27%) they were not identified by our classification, while 73% of the biotopes sites were identified by our habitat classification. Of these, only 9 biotopes sites were identified by class 3. The others were identified by class 1 (13) or class 2 (10).

Table 5.2 The number of CORINE biotopes sites (41.16) that were identified by our habitat classification (habitat 9150)

Class nr	Class name	Frequency
1	PNV Hab	13
2	PEENHAB	10
3	Both	9
	None	12
		44

6 Conclusions and outlook

The most important conclusions can be summarised as follows:

- A flexible methodology has been developed that integrates a top-down approach (starting with land cover) with a bottom-up approach (starting with vegetation relevés) as in the case of the SynBioSys Europe project.
- In the top-down approach the ecotope concept has been used combining vegetation structure with abiotic conditions.
- In the bottom-up approach a module has been made within SynBioSys Europe to predict the Annex I habitats using the Map of the Natural Vegetation of Europe.
- The habitat classes as given in Annex I of the Habitats Directive, better known as Natura 2000 habitats, are taken as the reference.
- On the basis of the Annex I habitat definitions knowledge rules were defined in a flexible manner using graphic models within a GIS environment to optimally combine existing spatial databases (such as land cover, soil data, topographic data and species distribution maps) to identify the spatial distribution of the major European habitats.
- The integration of various data sources to produce a land cover database with a pan-European coverage having a high accuracy and spatial detail did cost a lot of effort. The same holds for the integration of the two soil databases.
- On the basis of the newly established pan-European land cover (Figure 3.13) and the relationship between Annex I habitats and CORINE land cover it was already possible to map the Annex I habitats at the first level using the nine formations (Figure 3.14).
- The first results (Figure 5.1) for Annex I habitat 9150 "Medio-European limestone beech forests of the Cephalanthero-Fagion" are positive and give a well defined overview (250m spatial resolution), although no specific information was available of the spatial distribution of Cephalanthero species.
- Uncertainties in the results are foreseen in the cases of poor descriptions in Annex I habitat types, uncertainties in the core data, and absence of spatial distribution maps of specific indicator species.

Outlook:

- In 2004 25 major habitat types will be mapped for pan-Europe using the proposed methodology. The selection of these 25 habitat types is based on their priority and their area. Concerning the relative area, the forest and grassland habitats cover more than 75% of all habitat types.
- Methodology can be improved when also information is used on e.g. bird and butterfly distribution maps next to the current use of spatial distribution maps of specific plant indicator species.
- Abiotic stand factors should be described in such a way that the information is scientifically sound for ecologists but can be derived at the same time from soil data. From the descriptions in the Annex I it is not clear what is exactly meant with e.g. acid, basic, humid, dry, etc.

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Appendix 1 Level I and II of Annex I Habitats Directive

Annex I HABITATS DIRECTIVE	
Level I	Level II
1. COASTAL AND HALOPHYTIC HABITATS	
	11. Open sea and tidal areas
	12. Sea cliffs and shingle or stony beaches
	13. Atlantic and continental salt marshes and salt meadows
	14. Mediterranean and thermo-Atlantic salt marshes and salt meadows
	15. Salt and gypsum inland steppes
	16. Boreal Baltic archipelago, coastal and landupheaval areas
2. COASTAL SAND DUNES AND INLAND DUNES	
	21. Sea dunes of the Atlantic, North Sea and Baltic coasts
	22. Sea dunes of the Mediterranean coast
	23. Inland dunes, old and decalcified
3. FRESHWATER HABITATS	
	31. Standing water
	32. Running water
4. TEMPERATE HEATH AND SCRUB	
5. SCLEROPHYLLOUS SCRUB (MATORRAL)	
	51. Sub-Mediterranean and temperate scrub
	52. Mediterranean arborescent matorral
	53. Thermo-Mediterranean and pre-steppe brush
	54. Phrygana
6. NATURAL AND SEMI-NATURAL GRASSLAND FORMATIONS	
	61. Natural grasslands
	62. Semi-natural dry grasslands and scrubland facies
	63. Sclerophillous grazed forests (dehesas)
	64. Semi-natural tall herb humid grasslands
	65. Mesophile grasslands
7. RAISED BOGS AND MIRES AND FENS	
	71. Sphagnum acid bogs
	72. Calcareous fens
	73. Boreal mires
8. ROCKY HABITATS AND CAVES	
	81. Scree
	82. Rocky slopes with chasmophytic vegetation
	83. Other rocky habitats
9. FORESTS	
	90. Forests of Boreal Europe
	91. Forests of Temperate Europe
	92. Mediterranean deciduous forests
	93. Mediterranean sclerophyllous forests
	94. Temperate mountainous coniferous forests
	95. Mediterranean and Macaronesian mountainous coniferous forests

Appendix 2 European Vegetation Survey Formations

The formations on the first level are (Rodwell et al, 2002):

A	Coastal mud-flats and brakish waters
B	Salt-marsh, sand-dune and sea-cliff vegetation
C	Rock crevice, scree and boulder-field vegetation
D	Freshwater aaquatic vegetation
E	Springs, shoreline and swamp vegetation
F	Bogs and fens
G	Temperate grasslands, heath and fringe vegetation
H	Dry grasslands
I	Oromediterranean grasslands and shrubs
J	Montane tall-herb, grassland, fell-field and snowbed vegetation
K	Mediterranean garrigue, maquis, matorral, tomillar and phrygana
L	Temperate broadleaved forests and scrub
M	Montane heaths and coniferous forests
N	Weed communities
O	Zonal and endemic vegetation of Macaronesia

Appendix 3 The CORINE Biotope classification for the first and second level

1. Coastal and halophytic communities	11	Open sea
	12	Sea inlets
	13	Tidal rivers and estuaries
	14	Mud flats and sand flats
	15	Salt marshes, salt pastures, salt steppes
	16	Coastal sand dunes and sand beaches
	17	Shingle or stony beaches
	18	Sea cliffs
	19	Islets and rock stacks
	1A	Machair (1)
2. Non-marine waters	21	Lagoons
	22	Standing waters (fresh)
	23	Standing water (brakish)
	24	Running water
3. Srub and grasslands	31	Heath and scrub
	32	Sclerophyllous scrub, garrigue and maquis
	33	Phrygana
	34	Dry calcareous grasslands and pseudosteps
	35	Dry siliceous grasslands
	36	Alpine and boreal grasslands
	37	Humid grasslands and tall herb communities
	38	Mesophile grasslands
4. Woodland	41	Broadleaved decidous forests
	42	Native coniferous forests
	43	Mixed woodland
	44	Alluvial and very wet forest
	45	Broadleaved evergreen woodland
5. Bogs and marshes	51	Raised bogs
	52	Blanket bogs
	53	Water-fringe vegetation
	54	Other bogs and mires
6. Rocky habitats	61	Scree
	62	Exposed bedrock, inland cliffs
	63	Permanent ice and snow
	64	Inland sand dunes
	65	Caves (1)
	66	Volcanic features
8. Agricultural landscapes	81	Heavily fertlized, reseeded and improved grasslands
	82	Crops
	83	Orchards, groves and plantations of poplars or exotic trees
	84	Tree lines, hedges, small woods, bocages and parkland
	85	Urban parks and large gardens
	86	Urban and industrial (2)
	87	Fallow, ruderal and disturbed land (1)
	88	Mine galleries and other artificial underground habitats (1)
	89	Industrail lagoons and reservoirs, canals

Appendix 4 Nomenclature of the CORINE land cover database

Level 1	level 2	Level 3
1. Artificial surfaces	1.1 urban fabric	1.1.1 Continuous urban fabric
		1.1.2 Discontinuous urban fabric
	1.2 industrial, commercial and transport units	1.2.1 Industrial and commercial units
		1.2.2 Road and rail networks and associated
		1.2.3 Port areas
		1.2.4 Airports
	1.3 mine, dump and construction sites	1.3.1 Mineral extraction sites
		1.3.2 Dump sites
		1.3.3 Construction sites
	1.4 artificial non-agricultural vegetated areas	1.4.1 Green urban areas
		1.4.2 Port and leisure facilities
2. Agricultural areas	2.1 arable land	2.1.1 Non-irrigated arable land
		2.1.2 Permanently irrigated land
		2.1.3 Rice fields
	2.2 permanent crops	2.2.1 Vineyards
		2.2.2 Fruit trees and berry plantation
		2.2.3 Olive groves
	2.3 pastures	2.3.1 Pastures
	2.4 heterogeneous agricultural	2.4.1 Annual cops associated with permanent
		2.4.2 Complex cultivation patterns
		2.4.3 Land principally occupied by agriculture
		2.4.4 Agro-forestry areas
3. Forests and semi-natural Areas	3.1 forest	3.1.1 Broad-leaved forest
		3.1.2 Coniferous forest
		3.1.3 Mixed forest
	3.2 shrub and/or herbaceous vegetation associations	3.2.1 Natural grasslands
		3.2.2 Moors and heath lands
		3.2.3 Sclerophyllous vegetation
		3.2.4 Transitional woodland-scrub
	3.3 open spaces with little or no	3.3.1 Beaches, sand, dunes
		3.3.2 Bare rocks
		3.3.3 Sparsely vegetated areas
		3.3.4 Burnt areas
		3.3.5 Glaciers and perpetual snow
4. Wetlands	4.1 inland wetlands	4.1.1 Inland marshes
		4.1.2 Peat bogs
	4.2 coastal wetlands	4.2.1 Salt marshes
		4.2.2 Salines
		4.2.3 Intertidal flats
5. Water bodies	5.1 inland waters	5.1.1 Water courses
		5.1.2 Water bodies
	5.2 marine waters	5.2.1 Coastal lagoons
		5.2.2 Estuaries
		5.2.3 Sea and ocean

Appendix 5 Legend Potential Natural Vegetation (PNV) Map

Zonal and extra zonal vegetation	
A	Polar deserts and subnival-nival vegetation of high mountains
B	Arctic tundras and alpine vegetation
C	Subarctic, boreal and nemoral-montane open woodlands, as well as subalpine and oro-Mediterranean vegetation
D	Mesophytic and hygromesophytic coniferous and mixed broad-leaved-coniferous forests Western boreal spruce forests, partly with pine, birch, alder
E	Atlantic dwarf shrub heaths
F	Mesophytic deciduous broad-leaved and mixed coniferous-broad-leaved forests
G	Thermophilous mixed deciduous broad-leaved forests
H	Hygro-thermophilous mixed deciduous broad-leaved forests
J	Mediterranean sclerophyllous forests and scrub
K	Xerophytic coniferous forests and scrub
L	Forest steppes (meadow steppes or dry grasslands alternating with deciduous broad-leaved forests or xerophytic scrub)
M	Steppes
N	Oroxerophytic vegetation (thorn cushion communities, tomillares, mountain steppes, partly scrub)
O	Deserts
Azonal vegetation	
P	Coastal vegetation and inland halophytic vegetation
R	Tall reed and tall sedge swamps, aquatic vegetation
S	Mires
T	Fen and swamp forests
U	Vegetation of flood-plains, estuaries and freshwater polders

Appendix 6 Legend Digital Map of Ecological Regions (DMEER)

ECOREGION	Count	Ha
Aegean & West Turkey sclerophyllous and mixed forest	144	10616261.9
Alps conifer and mixed forests	1	14986285.9
Anatolian conifer and deciduous mixed forests	7	8639020.58
Appenine deciduous montane forests	39	1470344.97
Arabian desert and East Sahero-Arabian xeric shrub	2	5415047.42
Arctic desert	2	64904.7888
Azerbaijan shrub desert and steppe	1	6410144.97
Balkan mixed forests	1	25541622.2
Baltic mixed forests	42	11627276.3
Caledon coniferous forests	1	2211010.56
Cantabrian mixed forests	6	7843772.57
Carpathian montane coniferous forests	2	12533290.8
Caspian Hyrcanian mixed forests	10	597764.391
Caspian Lowland desert	8	16870680.9
Caucasus mixed forests	1	17053681.3
Celtic broadleaf forests	24	21000496.1
Central Anatolian deciduous forests	1	10148752.6
Central Anatolian steppe	5	2493434.77
Central European mixed forests	6	73040782.9
Corsican montane broadleaf and mixed forests	1	363354.906
Crete Mediterranean forests	4	819069.031
Crimean submediterranean forest complex	2	3021515.67
Cyprus Mediterranean forests	1	927075.123
Dinaric Mountains mixed forests	6	5800621.73
East European forest steppe	15	72860226.7
Eastern Anatolian deciduous forests	3	2588047.76
Eastern Anatolian montane steppe	1	8559254.73
Eastern Mediterranean coniferous/sclerophyllous/broadleaf forests	7	6597022.2
Elburz Range forest steppe	2	1223462.58
English Lowlands beech forests	2	4576833.23
Euxine-Colchic deciduous forest	4	7451080.93
Faroe Islands boreal grasslands	10	145652.871
Iberian conifer forests	13	3246338.84
Iberian sclerophyllous and semi-deciduous forests	2	30063804.9
Iceland boreal birch forest and alpine tundra	25	9205460.8
Illyrian deciduous forests	1	4083600.18
Italian sclerophyllous and semi-deciduous forests	6	10960195.2
Kazakh semi-desert	9	13049.7337
Kazakh steppe	9	24977.3701
Kola Peninsula tundra	8	5834746.33
Mesopotamian shrub desert	2	444867.705
Middle East steppe	6	568781.996
North Atlantic moist mixed forests	65	3883163.07
Northeastern Spain & Southern France Mediterranean	9	9081698.01
Northen Temperate Atlantic	6	11084817

Northern Anatolian conifer and deciduous forests	2	9872469.22
Northwest Iberian montane forests	6	5715064.43
Northwest Russian/Novaya Zemlya tundra	74	28080118.9
Pannonian mixed forests	1	30778579.4
Pindus Mountains mixed forests	6	3971926.46
Po Basin mixed forests	2	4245479.34
Pontic steppe	21	92568054.8
Pyrenees conifer and mixed forests	1	2593041.82
Red Sea Nubo-Sindian tropical desert and semi-dese	1	535403.315
Red Sea Nubo-Sindian tropical desert and semi-desert	1	226115.482
Rodope montane mixed forests	3	2823420.8
Sarmatic mixed forests	148	84626534
Scandinavian and Russian taiga	236	221491732
Scandinavian coastal coniferous forests	194	1938654.17
Scandinavian montane birch forest and grasslands	51	24422712.6
South Appenine mixed montane forests	28	824180.746
Southeastern Iberian shrubs and woodlands	4	327648.884
Southern Anatolian montane conifer and deciduous forests	9	7352221.28
Southern Temperate Atlantic	45	29317086
Southwest Iberian Mediterranean sclerophyllous and mixed forests	1	7169874.33
Tyrrhenian-Adriatic sclerophyllous and mixed forests	69	8398184.89
Urals montane tundra and taiga	7	14937790.4
Western European broadleaf forests	1	49381592.3
Yamalagydanskaja tundra	2	9275.64393
	Total	1083600455

Appendix 7 FAO-UNESCO Soil Units

A : ACRISOLS
Ao : Orthic Acrisols
Af : Ferric Acrisols
Ah : Humic Acrisols
Ap : Plinthic Acrisols
Ag : Gleyic Acrisols

B : CAMBISOLS
Be : Eutric Cambisols
Bd : Dystric Cambisols
Bh : Humic Cambisols
Bg : Gleyic Cambisols
Bx : Gelic Cambisols
Bk : Calcic Cambisols
Bc : Chromic Cambisols
Bv : Vertic Cambisols
Bf : Ferralic Cambisols

C : CHERNOZEMS
Ch : Haplic Chernozems
Ck : Calcic Chernozems
Cl : Luvic Chernozems
Cg : Glossic Chernozems

D : PODZOLUVISOLS
De : Eutric Podzoluvisols
Dd : Dystric Podzoluvisols
Dg : Gleyic Podzoluvisols

E : RENDZINAS

F : FERRALSOLS
Fo : Orthic Ferralsols
Fx : Xanthic Ferralsols
Fr : Rhodic Ferralsols
Fh : Humic Ferralsols
Fa : Acric Ferralsols
Fp : Plinthic Ferralsols

G : GLEYSOLS
Ge : Eutric Gleysols
Gc : Calcaric Gleysols
Gd : Dystric Gleysols
Gm : Mollic Gleysols
Gh : Humic Gleysols
Gp : Plinthic Gleysols
Gx : Gelic Gleysols

H : PHAEOZEMS
Hh : Haplic Phaeozems
Hc : Calcaric Phaeozems
Hl : Luvic Phaeozems
Hg : Gleyic Phaeozems

J : FLUVISOLS
Je : Eutric Fluvisols
Jc : Calcaric Fluvisols
Jd : Dystric Fluvisols
Jt : Thionic Fluvisols

K : KASTANOZEMS
Kh : Haplic Kastanozems
Kk : Calcic Kastanozems
Kl : Luvic Kastanozems

L : LUVISOLS
Lo : Orthic Luvisols
Lc : Chromic Luvisols
Lk : Calcic Luvisols
Lv : Vertic Luvisols
Lf : Ferric Luvisols
La : Albic Luvisols
Lp : Plinthic Luvisols
Lg : Gleyic Luvisols

M : GREYZEMS
Mo : Orthic Greyzems
Mg : Gleyc Greyzems

N : NITOSOLS
Ne : Eutric Nitosols
Nd : Dystric Nitosols
Nh : Humic Nitosols

O : HISTOSOLS
Oe : Eutric Histosols
Od : Dystric Histosols
Ox : Gelic Histosols

P : PODZOLS
Po : Orthic Podzols
Pl : Leptic Podzols
Pf : Ferric Podzols
Ph : Humic Podzols
Pp : Placic Podzols
Pg : Gleyic Podzols

Q : ARENOSOLS
Qc : Cambic Arenosols
Ql : Luvic Arenosols
Qf : Ferralic Arenosols
Qa : Albic Arenosols

R : REGOSOLS
Re : Eutric Gleysols
Rc : Calcaric Regosols
Rd : Dystric Regosols

S : SOLONETZ
So : Orthic Solonetz
Sm : Mollic Solonetz
Sg : Gleyic Solonetz

T : ANDOSOLS
To : Ochric Andosols
Tm : Mollic Andosols
Th : Humic Andosols
Tv : Vitric Andosols

U : RANKERS

V : VERTISOLS
Vp : Pellic Vertisols
Vc : Chromic Vertisols

W : PLANOSOLS
We : Eutric Planosols
Wd : Dystric Planosols
Wm : Mollic Planosols
Wh : Humic Planosols
Ws : Solodic Planosols
Wx : Gelic Planosols

X : XEROSOLS
Xh : Haplic Xerosols
Xk : Calcic Xerosols
Xy : Gypsic Xerosols
Xl : Luvic Xerosols

Y : YERMOSOLS
Yh : Haplic Yermosols
Yk : Calcic Yermosols
Yy : Gypsic Yermosols
Yl : Luvic Yermosols
Yt : Takyric Yermosols

Z : SOLONCHAKS
Zo : Orthic Solonchaks
Zm : Mollic Solonchaks
Zt : Takyric Solonchaks
Zg : Gleyic Solonchaks

I : LITHOSOLS

Rx : Gelic Regosols

Appendix 8 Abiotic soil conditions

Wet soils

Soil Unit	Soil Name	Wet
Ap	Plinthic Acrisols	1
Ag	Gleyic Acrisols	1
Be	Eutric Cambisols	1
Bh	Humic Cambisols	1
Bg	Gleyic Cambisols	1
Bv	Vertic Cambisols	1
Ge	Eutric Gleysols	1
Gc	Calcaric Gleysols	1
Gd	Dystric Gleysols	1
Gm	Mollic Gleysols	1
Gh	Humic Gleysols	1
Gp	Plinthic Gleysols	1
Gx	Gelic Gleysols	1
Je	Eutric Fluvisols	1
Jc	Calcaric Fluvisols	1
Jd	Dystric Fluvisols	1
Jt	Thionic Fluvisols	1
Lv	Vertic Luvisols	1
Lg	Gleyic Luvisols	1
Oe	Eutric Histosols	1

Soil Unit	Soil Name	Wet
Od	Dystric Histosols	1
Ph	Humic Podzols	1
Pg	Gleyic Podzols	1
Rd	Dystric Regosols	1
So	Orthic Solonetz	1
Sm	Mollic Solonetz	1
Sg	Gleyic Solonetz	1
Th	Humic Andosols	1
U4	Rankers	1
Vp	Pellic Vertisols	1
We	Eutric Planosols	1
Wd	Dystric Planosols	1
Wm	Mollic Planosols	1
Wh	Humic Planosols	1
Ws	Solodic Planosols	1
Zo	Orthic Solonchaks	1
Zm	Mollic Solonchaks	1
Zt	Takyric Solonchaks	1
Zg	Gleyic Solonchaks	1

Calcareous soils

Soil_Unit	Soil_Name	Calc.
Be	Eutric Cambisols	1
Bk	Calcic Cambisols	1
Ck	Calcic Chernozems	1
E2	Rendzinas	1
Gc	Calcaric Gleysols	1
I-	Lithosols	1
Kk	Calcic Kastanozems	1
Lk	Calcic Luvisols	1
Xk	Calcic Xerosols	1

Organic soils

Soil_Unit	Soil_Name	Peat
Oe	Eutric Histosols	1
Od	Dystric Histosols	1
Ox	Gelic Histosols	1

Soils with salt

Soil_Unit	Soil_Name	Sal
So	Orthic Solonetz	1
Sm	Mollic Solonetz	1
Sg	Gleyic Solonetz	1
Zo	Orthic Solonchaks	1
Zm	Mollic Solonchaks	1
Zt	Takyric Solonchaks	1
Zg	Gleyic Solonchaks	1

Appendix 9 Recoding of PELCOM and GLC2000 into the CORINE land cover nomenclature

Table A9.1 Recoding of the PELCOM land cover database into the CORINE nomenclature.

PELCOM		Corine		
code	classname	code	classname	Class nr
11	Broadleaf forest	3.1.1	broadleaf forests	23
12	Coniferous forest	3.1.2	coniferous forest	24
13	Mixed Forest	3.1.3	mixed forest	25
20	Grasslands	3.2.1	natural grasslands	26
31	Rainfed-arable	2.1.1	non-irrigated arable land	12
32	Irrigated land	2.1.2	permanently irrigated land	13
40	Permanent crops	2.2.1	vineyards	15
50	Shrubland	3.2.3	sclerophyllous vegetation	28
60	Barren land	3.3.3	sparsely vegetated areas	32
70	Permanent ice and snow	3.3.5	glaciers and perpetual snow	34
80	Wetlands	4.1.1	inland marshes	35
91	Inland waters	5.1.2	water bodies	41
92	Sea	5.2.3	sea and ocean	44
100	Urban areas	1.1.1	continuous urban fabric	1

Table A9.2 Recoding of the GLC2000 land cover database into the CORINE nomenclature.

GLC code	GLC2000	Corine code	Corine Classname	Clas nr
1	Tree Cover, broadleaved, evergreen	311	Broadleaf forests	23
2	Tree Cover, broadleaved, deciduous, closed	311	Broadleaf forests	23
3	Tree Cover, broadleaved, deciduous, open	311	Broadleaf forests	23
4	Tree Cover, needle-leaved, evergreen	312	Coniferous forest	24
5	Tree Cover, needle-leaved, deciduous	312	Coniferous forest	24
6	Tree Cover, mixed leaf type	313	Mixed forest	25
7	Tree Cover, regularly flooded, fresh	-		-
8	Tree Cover, regularly flooded, saline, (daily variation)	-		-
9	Mosaic: Tree cover / Other natural vegetation	312	Coniferous forest	24
10	Tree Cover, burnt	334	Burnt areas	33
11	Shrub Cover, closed-open, evergreen	324	Transitional woodland shrub	29
12	Shrub Cover, closed-open, deciduous	324	Transitional woodland shrub	29
13	Herbaceous Cover, closed-open	321	Natural grasslands	26
14	Sparse Herbaceous or sparse shrub cover	333	Sparsely vegetated areas	32
15	Regularly flooded shrub and/or herbaceous cover	411	Inland marshes	35
16	Cultivated and managed areas	211	Non-irrigated arable land	12
17	Mosaic: Cropland / Tree Cover / Other Natural Vegetation	211	Non-irrigated arable land	12
18	Mosaic: Cropland / Shrub and/or Herbaceous cover	211	Non-irrigated arable land	12
19	Bare Areas	333	Sparsely vegetated areas	32
20	Water Bodies (natural & artificial)	512	Inland water bodies	41
21	Snow and Ice (natural & artificial)	335	Glaciers and perpetual snow	34
22	Artificial surfaces and associated areas	111	Contnuous urban fabric	1
23	No data			

Appendix 10 Overview of published volumes of the Atlas Florae Europaeae (AFE)

(2039 pages and 3270 maps)

Vol. 1. Pteridophyta (Psilotaceae to Azollaceae).
121 pp, 3 + 150 maps + folded base map. 1972. Families: Psilotaceae, Lycopodiaceae, Selaginellaceae, Isoetaceae, Equisetaceae, Ophioglossaceae, Osmundaceae, Sinopteridaceae, Adiantaceae, Pteridaceae, Cryptogrammaceae, Hemionitidaceae (Gymnogrammaceae), Dicksoniaceae, Hypolepidaceae, Davalliaceae, Hymenophyllaceae, Thelypteridaceae, Aspleniaceae, Athyriaceae, Aspidiaceae, Elaphoglossaceae, Blechnaceae, Polypodiaceae, Marsileaceae, Salviniaceae and Azollaceae.

Vol.2. Gymnospermae (Pinaceae to Ephedraceae).
40 pp, 50 maps. 1973. Families: Pinaceae, Cupressaceae, Taxaceae and Ephedraceae.

Vol.3. Salicaceae to Balanophoraceae
128 pp, 1 + 183 maps. 1976. Families: Salicaceae, Myricaceae, Juglandaceae, Betulaceae, Corylaceae, Fagaceae, Ulmaceae, Moraceae, Cannabaceae, Urticaceae, Santalaceae, Loranthaceae, Aristolochiaceae, Rafflesiaceae (Cytinaceae) and Balanophoraceae.

Vol.4. Polygonaceae.
71 pp, 95 maps. 1979.

Vol.5. Chenopodiaceae to Basellaceae.
119 pp, 190 maps. 1980. Families: Chenopodiaceae, Amaranthaceae, Nyctaginaceae, Phytolaccaceae, Aizoaceae, Molluginaceae, Tetragoniaceae, Portulacaceae and Basellaceae.

Vol.6. Caryophyllaceae (Alsinoideae and Paronychioideae).
176 pp, 343 maps. 1983.

Vol.7. Caryophyllaceae (Silenoideae).
229 pp, 497 maps. 1986.

Vol.8. Nymphaeaceae to Ranunculaceae.
261 pp, 445 maps. 1989. Families: Nymphaeaceae, Nelumbonaceae, Ceratophyllaceae and Ranunculaceae.

Vol.9. Paeoniaceae to Capparaceae.
110 pp, 156 maps. 1991. Families: Paeoniaceae, Berberidaceae, Magnoliaceae, Lauraceae, Papaveraceae and Capparaceae.

Vol.10. Cruciferae (Sisymbrium to Aubrieta). 224 pp, 324 maps. 1994.

Vol.11. Cruciferae (Ricotia to Raphanus). 310 pp, 493 maps. 1996.

Vol. 12. Resedeaceae to Platanaceae.
250 pp, 343 maps. 1999. Families: Resedaceae, Sarraceniaceae, Droseraceae, Crassulaceae, Saxifragaceae, Parnassiaceae, Hydrangeaceae, Escalloniaceae, Grossulariaceae, Pittosporaceae and Platanaceae.

Appendix 11 List of indicator species for each Annex I habitat type

Annex I Habitat types	Indicator species	AFE
1110 Sandbanks which are slightly covered by sea water all the time	Zostera marina, Potamogeton pectinatus	
1120 * Posidonia beds (Posidonion oceanicae)	Posidonia oceanica	
1130 Estuaries	Ruppia maritima, Spartina maritima	
1140 Mudflats and sandflats not covered by seawater at low tide		
1150 *Coastal lagoons	Zostera spp., Ruppia maritima	
1160 Large shallow inlets and bays		
1170 Reefs		
1180 Submarine structures made by leaking gases		
1210 Annual vegetation of drift lines	Cakile maritima, salsola kali, Glaucium flavum, Matthiola sinuata	1
1220 Perennial vegetation of stony banks	Crambe maritima, Crithmum maritimum	
1230 Vegetated sea cliffs of the Atlantic and Baltic Coasts	Brassica oleracea, Cochlearia officinalis, Asplenium marinum, Inula crithmoides	1
1240 Vegetated sea cliffs of the Mediterranean coasts with endemic Limonium spp.	Crithmum maritimum, Asplenium marinum, Daucus carota ssp azorica	
1250 Vegetated sea cliffs with endemic flora of the Macaronesian coasts	Crithmum maritimum, Limonium spp.	
1310 Salicornia and other annuals colonizing mud and sand	Salicornia spp, Suaeda maritima, Sagina maritima, Sagina nodosa, Cochlearia danica	1
1320 Spartina swards (Spartinion maritimae)	Spartina maritima	
1330 Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	Spergularia marina, Potentilla anserina	1
1340 * Inland salt meadows	Aster tripolium, Atriplex hastata, Puccinellia distans, Salicornia spp. Spergularia salina	1
1410 Mediterranean salt meadows (Juncetalia maritimi)	Juncus maritimus, Aster tripolium	
1420 Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	Sarcocornetea fruticosi, Inula critmoides, Sarcocornia perennis	
1430 Halo-nitrophilous scrubs (Pegano-Salsoletea)	Peganum harmala, Atriplex halimus, Atriplex glauca	1
1510 * Mediterranean salt steppes (Limonietalia)	Limonium spp., Lygeum spartum, Salicornia patula	
1520 * Iberian gypsum vegetation (Gypsophiletalia)	Centaurea hyssopifolia, Gypsophila hispanica, Gypsophila hispanica, Gypsophila struthium, Reseda stricta, Teucrium?	1
1530 * Pannonic salt steppes and salt marshes	Artemisia santonicum, Suaeda corniculata, Suaeda pannonica, Puccinellia peisonis	
1610 Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation	Calluna vulgaris, Empetrum nigrum, Honkenya peploides, Juniperus communis	1
1620 Boreal Baltic islets and small islands	Agrostis stolonifera, Allium schoenoprasum, Cochleria danica, Juniperus communis, Silene viscosa	1
1630 * Boreal Baltic coastal meadows	Blysmus rufus, Juncus gerardii, Ophioglossum vulgatum, Plantago maritima, Spergularia salina	1
1640 Boreal Baltic sandy beaches with perennial vegetation	Ammophila arenaria, Atriplex littoralis, Cakile maritima	1
1650 Boreal Baltic narrow inlets	Phragmites australis, Sagittaria sagittifolia	
2110 Embryonic shifting dunes	Elymus farctus, Pancratium maritimum	
2120 Shifting dunes along the shoreline with Ammophila arenaria ('white dunes')	Ammophila arenaria, Euphorbia paralias	
2130 * Fixed coastal dunes with herbaceous vegetation ('grey dunes')	Gentiana campestris, Ononis repens, Carex arenaria, Salix repens	1
2140 * Decalcified fixed dunes with Empetrum nigrum	Carex arenaria, Empetrum nigrum	
2150 * Atlantic decalcified fixed dunes (Calluno-Ulicetea)	Calluna vulgaris, Carex arenaria	
2160 Dunes with Hippophaë rhamnoides	Hippophae rhamnooides	
2170 Dunes with Salix repens ssp. argentea (Salicion arenariae)	Salix repens spp. Argentea	1

Annex I Habitat types	Indicator species	AFE
2180 Wooded dunes of the Atlantic, Continental and Boreal region	Crataegus monogyna, Fraxinus exelsior, Acer pseudoplatanus	1
2190 Humid dune slacks	Potametum pectinati, Juncenion bufonii, Salix rosmarinifolia, Salix arenaria	1
21A0 Machairs (* in Ireland)		
2210 Crucianellion maritimae fixed beach dunes	Crucianella maritima, Ephedra distachya, Silene nicaeensis	
2220 Dunes with Euphorbia terracina	Euphorbia terracina, Ephedra distachya, Silene nicaeensis	1
2230 Malcolmietalia dune grasslands	Malcolmia lacera, Anthyllis hamosa	
2240 Brachypodietalia dune grasslands with annuals	Brachypodium spp.	
2250 * Coastal dunes with Juniperus spp.	Juniperus turbinata spp. Turbinata, J. macrocarpa, J. navicularis, J. communis, J. oxycedrus	1
2260 Cisto-Lavenduletalia dune sclerophyllous scrubs		
2270 * Wooded dunes with Pinus pinea and/or Pinus pinaster	Pinus pinea, Pinus pinaster (?)	1
2310 Dry sand heaths with Calluna and Genista	Calluna vulgaris, Genista anglica	
2320 Dry sand heaths with Calluna and Empetrum nigrum	Calluna vulgaris, Empetrum nigrum	
2330 Inland dunes with open Corynephorus and Agrostis grasslands	Corynephorus canescens, Carex arenaria	
2340 * Pannonic inland dunes	Thymus serpyllum, Cerastrium semidecandrum, Spergularia morisonii, Alyssum montanum spp., Cynodon dactlylon	1
3110 Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	Isoetes lacustris, Isoetus echinospora, Lobelia dortmanna, Deschampsia setacea	1
3120 Oligothrophic waters containing very few minerals generally on sandy soils of the West Mediterranean, with Isoetes spp.	Isoetes velata, Isoetes setacea, Serapias spp.	1
3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	Littorella uniflora, Pilularia globulifera, Juncus bulbosus ssp. Bulbosus, Sparganium minimum	1
3140 Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.		
3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation	Hydrocharis morsus-ranae, Utricularia australis	
3160 Natural dystrophic lakes and ponds	Utricularia minor, Rhynchospora alba, Nuphar lutea, Nuphar pumila, Nymphaea candida	1
3170 * Mediterranean temporary ponds		?
3180 * Turloughs		
3210 Fennoscandian natural rivers		
3220 Alpine rivers and the herbaceous vegetation along their banks		
3230 Alpine rivers and their ligneous vegetation with Myricaria germanica	Myricaria germanica, Salix daphnoides, Salix nigricans	1
3240 Alpine rivers and their ligneous vegetation with Salix elaeagnos	Salix elaeagnos, Salix purpurea ssp. Gracilis	1
3250 Constantly flowing Mediterranean rivers with Glaucium flavum	Myricaria germanica, Glaucium flavum	1
3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	Ranunculus fluitans, Ranunculus aquatilis, Callitriche spp. Zannichellia palustris	1
3270 Rivers with muddy banks with Chenopodion rubri p.p. and Bidention p.p. vegetation	Chenopodium rubrum, Bidens frondosa, Polygonum lapathifolium	1
3280 Constantly flowing Mediterranean rivers with Paspalo-Agrostidion species and hanging curtains of Salix and Populus alba	Paspalum paspaloides, Cyperus fuscus	
3290 Intermittently flowing Mediterranean rivers of the Paspalo-Agrostidion	Polygonum amphibium, Ranuncilus fluitans, Potamogeton natans	1
4010 Northern Atlantic wet heaths with Erica tetralix	Erica tetralix, Narthecium ossifragum	
4020 * Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix	Erica ciliaris, Ulex minor var. lusitanicus	
4030 European dry heaths	Caluna vulgaris, Genista anglica, Erica cinerea	
4040 * Dry Atlantic coastal heaths with Erica vagans	Erica vagans, Ulex europaeus	
4050 * Endemic macaronesian heaths	Daboecia azorica, Erica arborea, Teline canarienis	
4060 Alpine and Boreal heaths		

Annex I Habitat types	Indicator species	AFE
4070 * Bushes with Pinus mugo and Rhododendron hirsutum (Mugo-Rhododendretum hirsuti)	Pinus mugo, Rhodendendron chamaecistus, Rhodondendron hirsutum	
4080 Sub-Arctic Salix spp. scrub	Salix lapponum, Salix myrsinites	1
4090 Endemic oro-Mediterranean heaths with gorse		
5110 Stable xerothermophilous formations with Buxus sempervirens on rock slopes (Berberidion p.p.)	Buxus sempervirens, Prunus mahaleb	
5120 Mountain Cytisus purgans formations	Cytisus purgans	
5130 Juniperus communis formations on heaths or calcareous grasslands	Juniperus communis	1
5140 * Cistus palhinhae formations on maritime wet heaths	Cistus palhinhae	
5210 Arborescent matorral with Juniperus spp.	Juniperus oxycedrus, J. phoenicea, J. exelsea	1
5220 * Arborescent matorral with Zyziphus	Zyziphus lotus, Withania frutescens	1
5230 * Arborescent matorral with Laurus nobilis	Laurus nobilis, Quercus ilex	1
5310 Laurus nobilis thickets	Laurus nobilus	1
5320 Low formations of Euphorbia close to cliffs	Pistacia lenticus, Euphorbia pithyusa, Thymelaea passerina	
5330 Thermo-Mediterranean and pre-desert scrub	Euphorbia dendroides, Chamaerops humilis	
5410 West Mediterranean clifftop phryganas (Astragalo-Plantaginetum subulatae)	Astragalus massiliensis, Plantago subulatum	
5420 Sarcopoterium spinosum phryganas	Sarcopoterium spinosum, Centaurea spinosa	
5430 Endemic phryganas of the Euphorbio-Verbascion		
6110 * Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi	Alyssum alyssoides, Hornungia petraea	1
6120 * Xeric sand calcareous grasslands	Alyssum montanum ssp germelinii, Astragalus arenarius, Dianthus deltoides, Gypsophila fastigiata, Helichrysum arenarium, Koelerion glauca	1
6130 Calaminarian grasslands of the Violetalia calaminariae	Viola calamineria, Thlaspi caeulescens, Cochleria alpina, Festuca ovina, Minuartia verna	1
6140 Siliceous Pyrenean Festuca eskia grasslands	Festuca eskia, Arnica montana, Ranunculus pyrenaeus	1
6150 Siliceous alpine and boreal grasslands	Juncus trifidus, Carex bigelowii	
6160 Oro-Iberian Festuca indigesta grasslands	Festuca indigesta	
6170 Alpine and subalpine calcareous grasslands	Dryas octopetala, Gentiana nivalis, Draba aizoides	1
6180 Macaronesian mesophile grasslands	Holcus rigidus, Festuca jubata, Cardamine caldeirarum, Dryopteris azorica	1
6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	Arabis hirsuta, Dianthus carthusianorum, Ophrys apifera, Orchis mascula, Bromus erecta, Adonis vernalis	1
6220 * Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea	Brachypodium distachym, Brachypodium retusum	
6230 * Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	Antennaria dioica, Galium saxatile	
6240 * Sub-Pannonic steppic grasslands	Alyssum alyssoides, Astragalus austriacus, Iris humilis ssp. Arenaria, Stipa capillata	1
6250 * Pannonic loess steppic grasslands	Artyemesia pontica, Ornithogalum pannonicum, Achillea pannonica	
6260 * Pannonic sand steppes	Helychrysum arenarium, Dianthus serotinus, Alyssum montanum ssp. Gmelinii, Cynodon dactylon	1
6270 * Fennoscandian lowland species-rich dry to mesic grasslands	Botrychium spp., Dianthus deltoides, Gentianella campestris, Primula veris	1
6280 * Nordic alvar and precambrian calcareous flatrocks	Asperula tinctoria, Potentilla tabernaemontani, Saxifraga tridactylites, Hornungia petraea	1
6310 Dehesas with evergreen Quercus spp.	Quercus suber, Quercus ilex, Quercus rotundifolia	1
6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	Molininia caerulea, Potentilla erecta	
6420 Mediterranean tall humid grasslands of the Molinio-Holoschoenion	Scirpus holoschoenus, Molinia caerulea, Orchis laxiflora	
6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels		
6440 Alluvial meadows of river valleys of the Cnidion dubii	Cnidium dubium, Viola persicifolia	
6450 Northern boreal alluvial meadows	Salix triandra, Thalictrum simplex subsp. Boreale, Trollius europaeus	1

Annex I Habitat types	Indicator species	AFE
6510 Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)		
6520 Mountain hay meadows	Trisetum flavescens, Astrantia major, Silene vulgaris, Trollius europaeus	1
6530 * Fennoscandian wooded meadows	Orchis mascula, Primula veris, Ranunculus ficaria	1
7110 * Active raised bogs	Andromeda polifolia, Vaccinium oxycoccos, Drosera anglica, Drosera intermedia	1
7120 Degraded raised bogs still capable of natural regeneration		
7130 Blanket bogs (* if active bog)	Drosera rotundifolia, Eriophorum vaginatum, Empetrum nigrum, Rubus chamaemorus	1
7140 Transition mires and quaking bogs	Scheuchzeria palustris(?), Carex rostrata, Menyanthes trifoliata	
7150 Depressions on peat substrates of the Rhynchosporion		
7160 Fennoscandian mineral-rich springs and springfens		
7210 * Calcareous fens with Cladium mariscus and species of the Caricion davallianae	Cladium mariscus, Schoenus nigrans, Salix repens	1
7220 * Petrifying springs with tufa formation (Cratoneurion)		
7230 Alkaline fens		
7240 * Alpine pioneer formations of the Caricion bicoloris-atrofuscae	Carex atrofusa, Carex bicolor, Juncus triglumis	
7310 * Aapa mires	Saxifraga hirculus	1
7320 * Palsa mires	Eriophorum russeolum, Betula nana, Vaccinium microcarpum	1
8110 Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	Androsacae alpina, Oxyria digyna, Saxifraga bryoides, Cryptogramma crispa, Anthyrium alpestre	1
8120 Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii)	Campanula cenisia, Saxifraga biflora, Thlaspi rotundifolium, Hutchinsia alpina, Galium villarsi	1
8130 Western Mediterranean and thermophilous scree		
8140 Eastern Mediterranean screes	Drypis spinosa, Ranunculus brevifolius, Senecio thapsoides, Arenaria serpentini	1
8150 Medio-European upland siliceous screes	Epilobium collinum, Galeopsis segetum, Cryptogramma crispa	1
8160 * Medio-European calcareous scree of hill and montane levels	Dryopteris robertiania, Rumex scutatus, Petasites paraduxus	1
8210 Calcareous rocky slopes with chasmophytic vegetation	Ramonda myconi, Potentilla caulescentis, Cystopteris fragilis, Asplenium thrichomanes, Asplenium viride, Woodsia glabella	1
8220 Siliceous rocky slopes with chasmophytic vegetation	Phyteuma scheuchzeri, Asplenium septentrionale, Saxifraga pedemontana	1
8230 Siliceous rock with pioneer vegetation of the Sedo-Scleranthion or of the Sedo albi-Veronicion dillenii		
8240 * Limestone pavements	Gymnocarpium robertianum, Dryopteris villarii	1
8310 Caves not open to the public		
8320 Fields of lava and natural excavations		
8330 Submerged or partially submerged sea caves		
8340 Permanent glaciers		
9010 * Western Taïga		
9020 * Fennoscandian hemiboreal natural old broad-leaved deciduous forests (Quercus,Tilia, Acer, Fraxinus or Ulmus) rich in epiphytes	Anemone nemorosa, Dentaria bulbifera, Hepatica nobilis, Mercurialis perennis	1
9030 * Natural forests of primary succession stages of landupheaval coast		
9040 Nordic subalpine/subarctic forests with Betula pubescens ssp. czerepanovii	Betula pubescens ssp. czerepanovii, Empetrum hermaphroditum, Vaccinium myrtillus, Aconitum lycoctonum	1
9050 Fennoscandian herb-rich forests with Picea abies	Picea abies, Actaea spicata, Geranium sylvaticum, Paris quadrifolia, Matteuccia struthiopteris	1
9060 Coniferous forests on, or connected to, glaciofluvial eskers	Antennaria dioeca, Pteridium aquilinum, Pinus sylvestris	1
9070 Fennoscandian wooded pastures		
9080 * Fennoscandian deciduous swamp woods	Fraxinus excelsior, Alnus glutinosa, Alnus icana, Lycopus europaeus, Lysimachia thyrsiflora	1
9110 Luzulo-Fagetum beech forests	Fagus sylvatica, Luzula luzuloides, Pteridium aquilinum, Vaccinium myrtillus	1

Annex I Habitat types	Indicator species	AFE
9120 Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)	Fagus sylvatica, Ilex aquifolium (?), Taxus baccata, Deschampsia flexuosa, Pteridium aquilinum, Vaccinium myrtillus	1
9130 Asperulo-Fagetum beech forests	Fagus sylvatica, Anemone nemorosa, Lamium galeobdolon, Dentaria spp.	1
9140 Medio-European subalpine beech woods with Acer and Rumex arifolius	Fagus sylvatica, Acer pseudoplatanus, Rumex acrifolius	1
9150 Medio-European limestone beech forests of the Cephalanthero-Fagion	Fagus sylvatica, Carex digita, Cephalantera spp., Neotttia nidus-avis	1
9160 Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	Quercus robur, Quercus petraea, Carpinus betulus, Stellaria holostea, Ranunculus nemorosus	1
9170 Galio-Carpinetum oak-hornbeam forests	Quercus petraea, Carpinus betulus, Sorbus torminalis, Convallaria majalis	1
9180 * Tilio-Acerion forests of slopes, screes and ravines	Acer pseudoplatanus, Tilia cordata (?)	
9190 Old acidophilous oak woods with Quercus robur on sandy plains	Quercus robur	
91A0 Old sessile oak woods with Ilex and Blechnum in the British Isles	Ilex aquifolium, Arbutus unedo, Quercus petraea	1
91B0 Thermophilous Fraxinus angustifolia woods	Fraxinus angustifolia, Quercus pubescens, Quercus pyrenaica	
91C0 * Caledonian forest	Pinus sylvestris	1
91D0 * Bog woodland	Betula pubescens, Picea abies, Pinus sylvestris	1
91E0 * Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Alnus incanae, Populus nigra, Salix alba, Cirsium oleraceum, Filipendula ulmaria, Rumex sanguineus	1
91F0 Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers (Ulmenion minoris)	Quercus robur, Ulmus laevis, Ulmus minor, Ulmus glabra, Fraxinus exelsior, Tamus communis, Phalaris arundinacea	1
91G0 * Pannonic woods with Quercus petraea and Carpinus betulus	Quercus petraea, Carpinus betulus	1
91H0 * Pannonian woods with Quercus pubescens	Quercus pubescens, Fraxinus ornus, Sorbus domestica, Cornus mas	1
91I0 * Euro-Siberian steppic woods with Quercus spp.	Quercus cerris, Quercus pubescens, Tanacetum corybosum, Vincetoxicum hirundinaria	1
91J0 * Taxus baccata woods of the British Isles	Taxus baccata	
9210 * Apeninne beech forests with Taxus and Ilex	Fagus sylvatica, Taxus baccata, Ilex aquifolium	1
9220 * Apennine beech forests with Abies alba and beech forests with Abies nebrodensis	Fagus sylvatica, Abies alba, Abies nebrodensis, Daphne laureola	1
9230 Galicio-Portuguese oak woods with Quercus robur and Quercus pyrenaica	Quercus robur, Quercus pyrenaica	1
9240 Quercus faginea and Quercus canariensis Iberian woods	Quercus faginea, Quercus canariensis	1
9250 Quercus trojana woods	Quercus trojana	1
9260 Castanea sativa woods	Castanea sativa	1
9270 Hellenic beech forests with Abies borisii-regis	Fagus sylvatica, Abies borisii-regis	1
9280 Quercus frainetto woods	Fagus sylvatica, Quercus frainetto	1
9290 Cupressus forests (Acero-Cupression)	Cupressus atlantica, Cupressus sempervirens	1
92A0 Salix alba and Populus alba galleries	Salix alba, Populus alba	1
92B0 Riparian formations on intermittent Mediterranean water courses with Rhododendron ponticum, Salix and others	Rhodondendron ponticum ssp. Baeticum, Betula parvibracteata	
92C0 Platanus orientalis and Liquidambar orientalis woods (Platanion orientalis)	Platanus orientalis, Liquidambar orientalis, Ranunculus ficaria, Helleborus cyclophyllus, Pteridium aquilinum	1
92D0 Southern riparian galleries and thickets (Nerio-Tamaricetea and Securinegion tinctoriae)	Nerium oleander, Tamarix spp.	
9310 Aegean Quercus brachyphylla woods	Quercus brachaphylla	1
9320 Olea and Ceratonia forests	Olea europaea ssp. Sylvestris, Ceratonia siliqua	1
9330 Quercus suber forests	Quercus suber	1
9340 Quercus ilex and Quercus rotundifolia forests	Quercus ilex, Quercus rotundifolia	1
9350 Quercus macrolepis forests	Quercus macrolepsis	1
9360 * Macaronesian laurel forests (Laurus, Ocotea)	Laurus azoricae, Hedera canariensis, Prunus lusitanica	1

Annex I Habitat types	Indicator species	AFE
9370 * Palm groves of Phoenix	Phoenix canariensis, Phoenix theophrasti	1
9380 Forests of Ilex aquifolium	Ilex acuifolium	1
9410 Acidophilous Picea forests of the montane to alpine levels (Vaccinio-Piceetea)	Picea abies, Picea orientalis	1
9420 Alpine Larix decidua and/or Pinus cembra forests	Larix decidua, Pinus cembra, Vaccinium myrtillus	1
9430 Subalpine and montane Pinus uncinata forests (* if on gypsum or limestone)	Pinus uncinata, Lycopodium annotium, Huperzia selago, Arctostaphylos alpina, Rodondendrum ferrugineum	1
9510 * Southern Apennine Abies alba forests	Abies alba	1
9520 Abies pinsapo forests	Abies pinsapo	1
9530 * (Sub-) Mediterranean pine forests with endemic black pines	Pinus nigra	1
9540 Mediterranean pine forests with endemic Mesogean pines	Pinus pinaster ssp. Pinaster, P. halepensis, P. pityusa, P. stankewiczii, P. eldarica, P. brutia	1
9550 Canarian endemic pine forests	Pinus canariensis	1
9560 * Endemic forests with Juniperus spp.	Juniperus brevifolia, J. cedrus, J. drupacea, J. exelsa, J. foetidissima, J. oxycedrus, J. phoenicera, J. thurefera	1
9570 * Tetraclinis articulata forests	Tetraclinus articulata	1
9580 * Mediterranean Taxus baccata woods	Taxus baccata	1

Appendix 12 List of related CORINE land cover classes and indication of mapping possibility for each Annex I habitat type

Habitat type	Corine LC	Mapping with	Mapping possibility
1110 Sandbanks which are slightly covered by sea water all the time	523	with species	+-
1120 * Posidonia beds (Posidonion oceanicae)	523	with species	+-
1130 Estuaries	522	with species	+-
1140 Mudflats and sandflats not covered by seawater at low tide	423	with lc	+-
1150 *Coastal lagoons	521	with species	+-
1160 Large shallow inlets and bays	421	with species	-
1170 Reefs		not possible	--
1180 Submarine structures made by leaking gases		not possible	--
1210 Annual vegetation of drift lines	331	with species+clifs	+-
1220 Perennial vegetation of stony banks	331	with species	+-
1230 Vegetated sea cliffs of the Atlantic and Baltic Coasts	331	with species+clifs	+-
1240 Vegetated sea cliffs of the Mediterranean coasts with endemic Limonium spp.	331	with species+clifs	+-
1250 Vegetated sea cliffs with endemic flora of the Macaronesian coasts	331	clifs+macaronesia	+
1310 Salicornia and other annuals colonizing mud and sand	421	with mudflats+species	+-
1320 Spartina swards (Spartinion maritimae)	421	S. townsendii expanding	+
1330 Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	421		++
1340 * Inland salt meadows	411		+
1410 Mediterranean salt meadows (Juncetalia maritimi)	421	with EnC	+
1420 Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	421	with EnC	+
1430 Halo-nitrophilous scrubs (Pegano-Salsoletea)	322		+
1510 * Mediterranean salt steppes (Limonietalia)	321	with species	+
1520 * Iberian gypsum vegetation (Gypsophiletalia)	322		+
1530 * Pannonic salt steppes and salt marshes	321	with species	+
1610 Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation	331	with boreal baltic+lc	+-
1620 Boreal Baltic islets and small islands			+-
1630 * Boreal Baltic coastal meadows	231		+-
1640 Boreal Baltic sandy beaches with perennial vegetation	331		+-
1650 Boreal Baltic narrow inlets	523		+-
2110 Embryonic shifting dunes	331	with species	+
2120 Shifting dunes along the shoreline with Ammophila arenaria ('white dunes')	331	with species	+
2130 * Fixed coastal dunes with herbaceous vegetation ('grey dunes')	331		--
2140 * Decalcified fixed dunes with Empetrum nigrum	331	with species	+
2150 * Atlantic decalcified fixed dunes (Calluno-Ulicetea)	331	with species	+
2160 Dunes with Hippophaë rhamnoides	331	with species	++
2170 Dunes with Salix repens ssp. argentea (Salicion arenariae)	331	with species	++
2180 Wooded dunes of the Atlantic, Continental and Boreal region	331	with lc forest+dunes	+
2190 Humid dune slacks	331	with species	+
21A0 Machairs (* in Ireland)	321	local info	+
2210 Crucianellion maritimae fixed beach dunes	331	with species	++

2220 Dunes with Euphorbia terracina	331	with species	++
2230 Malcolmietalia dune grasslands	321	with species	++
2240 Brachypodietalia dune grasslands with annuals	321	which brachypodium spp?	-
2250 * Coastal dunes with Juniperus spp.	331	with species	++
2260 Cisto-Lavenduletalia dune sclerophyllous scrubs	323	No info	--
2270 * Wooded dunes with Pinus pinea and/or Pinus pinaster	312	lc+spp	++
2310 Dry sand heaths with Calluna and Genista	322	coastal buffer	+-
2320 Dry sand heaths with Calluna and Empetrum nigrum	322	coastal buffer	+-
2330 Inland dunes with open Corynephorus and Agrostis grasslands	321	with species	+
2340 * Pannonic inland dunes	331	with species+pannonic	+
3110 Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	411	lakes+spp	+
3120 Oligothrophic waters containing very few minerals generally on sandy soils of the West Mediterranean, with Isoetes spp.	411	lakes+spp	+-
3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	411	overlap with 3110	+-
3140 Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	512	No info	--
3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation	512	lakes+spp	+-
3160 Natural dystrophic lakes and ponds	512	lakes+spp, if boreal	+-
3170 * Mediterranean temporary ponds	512	No spp	--
3180 * Turloughs	512	No spp	--
3210 Fennoscandian natural rivers	511	Biogeo+rivers	+
3220 Alpine rivers and the herbaceous vegetation along their banks	511	Biogeo+rivers	+
3230 Alpine rivers and their ligneous vegetation with Myricaria germanica	511	with species	+-
3240 Alpine rivers and their ligneous vegetation with Salix elaeagnos	511	riv+alp+salix	+
3250 Constantly flowing Mediterranean rivers with Glaucium flavum	511	riv+med+spp	+
3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	511	spp	+
3270 Rivers with muddy banks with Chenopodion rubri p.p. and Bidention p.p. vegetation	511	spp	+
3280 Constantly flowing Mediterranean rivers with Paspalo-Agrostidion species and hanging curtains of Salix and Populus alba	511	riv+med+spp	+-
3290 Intermittently flowing Mediterranean rivers of the Paspalo-Agrostidion	511	riv+med+spp	+-
4010 Northern Atlantic wet heaths with Erica tetralix	322	atl+lc+spp	+
4020 * Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix	322	atl+lc+spp	+
4030 European dry heaths	322	lc+podsolic soils	+
4040 * Dry Atlantic coastal heaths with Erica vagans	322	coast+spp	+
4050 * Endemic macaronesian heaths	322	lc+macaronesian	++
4060 Alpine and Boreal heaths	322	lc+biogeo	++
4070 * Bushes with Pinus mugo and Rhododendron hirsutum (Mugo-Rhododendretum hirsuti)	322	With spp+EnC	+
4080 Sub-Arctic Salix spp. scrub	322	biogeo+spp	+
4090 Endemic oro-Mediterranean heaths with gorse	322	too many spp to be indicative	-
5110 Stable xerothermophilous formations with Buxus sempervirens on rock slopes (Berberidion p.p.)	322	with spp	+
5120 Mountain Cytisus purgans formations	322	with spp	+
5130 Juniperus communis formations on heaths or calcareous grasslands	322	poorly defined	-
5140 * Cistus palhinhae formations on maritime wet heaths	323	with expert info	+-
5210 Arborescent matorral with Juniperus spp.	323	lc+spp	+
5220 * Arborescent matorral with Zyziphus	323	lc+spp	+
5230 * Arborescent matorral with Laurus nobilis	323	lc+spp	+
5310 Laurus nobilis thickets	323	spp	+

5320 Low formations of Euphorbia close to cliffs	323	spp	-
5330 Thermo-Mediterranean and pre-desert scrub	323	regions given+spp	+
5410 West Mediterranean clifftop phryganas (Astragalo-Plantaginetum subulatae)	323	with spp	+
5420 Sarcopoterium spinosum phryganas	323	with spp	+
5430 Endemic phryganas of the Euphorbio-Verbascion	323	regions given, not with spp.	+-
6110 * Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi	321	very local	-
6120 * Xeric sand calcareous grasslands	321	with spp	+
6130 Calaminarian grasslands of the Violetalia calaminariae	321	very local, too small	-
6140 Siliceous Pyrenean Festuca eskia grasslands	321	EnC+spp.	+
6150 Siliceous alpine and boreal grasslands	321	with spp	+
6160 Oro-Iberian Festuca indigesta grasslands	321	weak info	+
6170 Alpine and subalpine calcareous grasslands	321	EnC+rocktype	+
6180 Macaronesian mesophile grasslands	321	macaro+spp	++
6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	321	weak indicators	+-
6220 * Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea	321	with spp	+-
6230 * Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	321	weak info, in Alpine in EUNIS	-
6240 * Sub-Pannonic steppic grasslands	321	EnC+spp	+
6250 * Pannonic loess steppic grasslands	321	EnC+spp	+
6260 * Pannonic sand steppes	321	EnC+spp	+
6270 * Fennoscandian lowland species-rich dry to mesic grasslands	321	EnC+spp	+
6280 * Nordic alvar and precambrian calcareous flatrocks	321	may be too small	+-
6310 Dehesas with evergreen Quercus spp.	244	dehesa+spp	+-
6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	321	with spp	+-
6420 Mediterranean tall humid grasslands of the Molinio-Holoschoenion	321	EnC+spp.	+-
6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	321	Too small	--
6440 Alluvial meadows of river valleys of the Cnidion dubii	321	May be too small	+-
6450 Northern boreal alluvial meadows	321	Altitude+Rivers+N-Boreal	-
6510 Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	321	Largely disappeared, too small	--
6520 Mountain hay meadows	321	Weak distribution pattern ?	--
6530 * Fennoscandian wooded meadows	311	Weak distribution pattern ?	--
7110 * Active raised bogs	412	weak indicators, but indication pot. Loc.	-
7120 Degraded raised bogs still capable of natural regeneration	412	State required, but indication pot. Loc.	--
7130 Blanket bogs (* if active bog)	412	State required, but indication pot. Loc.	--
7140 Transition mires and quaking bogs	412	local, weak indicators, but indication pot. Loc.	--
7150 Depressions on peat substrates of the Rhynchosporion	412	Too small, but indication pot. Loc.	--
7160 Fennoscandian mineral-rich springs and springfens	411	Too small, but indication pot. Loc.	--
7210 * Calcareous fens with Cladium mariscus and species of the Caricion davallianae	411	with spp, but indication pot. Loc.	+-
7220 * Petrifying springs with tufa formation (Cratoneurion)	411	Too small, but indication pot. Loc.	+-
7230 Alkaline fens	411	with spp., but indication pot. Loc.	+-
7240 * Alpine pioneer formations of the Caricion bicoloris-atrofuscae	411	too small, but indication pot. Loc.	+-
7310 * Aapa mires	412	EnvC+peat soils	+

7320 * Palsa mires	412	EnC+peat soils	+
8110 Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	332	lc+spp	+-
8120 Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii)	332	lc+spp	+-
8130 Western Mediterranean and thermophilous scree	332	too much info, EnC+mountains	+-
8140 Eastern Mediterranean screes	332	Greece+Mountains+spp	+
8150 Medio-European upland siliceous screes	322	small	+
8160 * Medio-European calcareous scree of hill and montane levels	332	too small	-
8210 Calcareous rocky slopes with chasmophytic vegetation	332	weak description, too wide spread, with spp.	+-
8220 Siliceous rocky slopes with chasmophytic vegetation	332	weak indicators, with spp.	+-
8230 Siliceous rock with pioneer vegetation of the Sedo-Scleranthion or of the Sedo albi-Veronicion dillenii	332	too small+state required	--
8240 * Limestone pavements	332	Rock type+EnC+spp, or local info	--
8310 Caves not open to the public			--
8320 Fields of lava and natural excavations		lc?	+-
8330 Submerged or partially submerged sea caves			--
8340 Permanent glaciers	335	lc	++
9010 * Western Taïga	311	with BioGeo, very large	+
9020 * Fennoscandian hemiboreal natural old broad-leaved deciduous forests (Quercus,Tilia, Acer, Fraxinus or Ulmus) rich in epiphytes	311	weak indicators	-
9030 * Natural forests of primary succession stages of landupheaval coast	311	state required, no spp defined	--
9040 Nordic subalpine/subarctic forests with Betula pubescens ssp. czerepanovii	311	with spp	+
9050 Fennoscandian herb-rich forests with Picea abies	312	with spp (+picea abies)	+
9060 Coniferous forests on, or connected to, glaciofluvial eskers	312	weakly defined	-
9070 Fennoscandian wooded pastures	231	state required	--
9080 * Fennoscandian deciduous swamp woods	311	weakly defined (+faxinus excelsior)	+-
9110 Luzulo-Fagetum beech forests	311	with spp	+
9120 Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)	311	with spp.	+
9130 Asperulo-Fagetum beech forests	311	with spp	+
9140 Medio-European subalpine beech woods with Acer and Rumex arifolius	311	weakly defined	-
9150 Medio-European limestone beech forests of the Cephalanthero-Fagion	311	with spp	+-
9160 Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	311	with spp ?	+
9170 Galio-Carpinetum oak-hornbeam forests	311	weak indicator	+-
9180 * Tilio-Acerion forests of slopes, screes and ravines	311	too local	--
9190 Old acidophilous oak woods with Quercus robur on sandy plains	311	State required	--
91A0 Old sessile oak woods with Ilex and Blechnum in the British Isles	311	State required, spp+EnC+soil-> zone	--
91B0 Thermophilous Fraxinus angustifolia woods	311		-
91C0 * Caledonian forest	312	Pinus Sylvestris+EnC	++
91D0 * Bog woodland	312	Peat+spp.+EnC	+-
91E0 * Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	311	small linear	+-
91F0 Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers (Ulmenion minoris)	311	small linear	+-
91G0 * Pannonic woods with Quercus petraea and Carpinus betulus	311	BioGeo+spp	+
91H0 * Pannonian woods with Quercus pubescens	311	BioGeo+spp	+
91I0 * Euro-Siberian steppic woods with Quercus spp.	311	BioGeo+spp	+

91J0 * Taxus baccata woods of the British Isles	312	too specific	--
9210 * Apeninne beech forests with Taxus and Ilex	311	weak info	-
9220 * Apennine beech forests with Abies alba and beech forests with Abies nebrodensis	312	weak info	+
9230 Galicio-Portuguese oak woods with Quercus robur and Quercus pyrenaica	311	weak indicators, but good description	+
9240 Quercus faginea and Quercus canariensis Iberian woods	311	weak info	-
9250 Quercus trojana woods	311	weak info	-
9260 Castanea sativa woods	311	weak info	-
9270 Hellenic beech forests with Abies borisii-regis	311	with spp.	+
9280 Quercus frainetto woods	311	species may not be in forest	-
9290 Cupressus forests (Acero-Cupression)	312	species may not be in forest	-
92A0 Salix alba and Populus alba galleries	311	species may not be in forest	-
92B0 Riparian formations on intermittent Mediterranean water courses with Rhododendron ponticum, Salix and others	311	with spp.	+
92C0 Platanus orientalis and Liquidambar orientalis woods (Platanion orientalis)	311	with geog description	+
92D0 Southern riparian galleries and thickets (Nerio-Tamaricetea and Securinegion tinctoriae)	311	weakly defined	+
9310 Aegean Quercus brachyphylla woods	311	weakly defined	+
9320 Olea and Ceratonia forests	311	weakly defined	-
9330 Quercus suber forests	311	only potential zone	+-
9340 Quercus ilex and Quercus rotundifolia forests	311	only potential zone	+-
9350 Quercus macrolepis forests	311	only potential zone	+-
9360 * Macaronesian laurel forests (Laurus, Ocotea)	311	Laurus azoricae	+
9370 * Palm groves of Phoenix	311		++
9380 Forests of Ilex aquifolium	311	too small	--
9410 Acidophilous Picea forests of the montane to alpine levels (Vaccinio-Piceetea)	312	with EnC+soil	+
9420 Alpine Larix decidua and/or Pinus cembra forests	312	with spp+soil	+
9430 Subalpine and montane Pinus uncinata forests (* if on gypsum or limestone)	312		+
9510 * Southern Apennine Abies alba forests	312	too small	-
9520 Abies pinsapo forests	312	very local 50 ha	++
9530 * (Sub-) Mediterranean pine forests with endemic black pines	312	with spp.	+
9540 Mediterranean pine forests with endemic Mesogean pines	312	too much info, potential zone only	+
9550 Canarian endemic pine forests	312		+
9560 * Endemic forests with Juniperus spp.	312		+
9570 * Tetraclinis articulata forests	312		+
9580 * Mediterranean Taxus baccata woods	312	too small	--

Appendix 13 Summary of Annex I habitat types per country (EU15)

ANNEX I HABITATS DIRECTIVE	BE	AT	LU	DK	FI	FR	DE	GR	IE	IT	NL	PT	ES	SE	UK	SUM
1110 Sandbanks which are slightly covered by sea water all the time	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	13
1120 * Posidonia beds (Posidonion oceanicae)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1130 Estuaries	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	13
1140 Mudflats and sandflats not covered by seawater at low tide	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	3
1150 *Coastal lagoons	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	2
1160 Large shallow inlets and bays	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	13
1170 Reefs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1180 Submarine structures made by leaking gases	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2
1210 Annual vegetation of drift lines	0	0	0	1	1	1	1	1	1	1	0	1	1	1	1	11
1220 Perennial vegetation of stony banks	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2
1230 Vegetated sea cliffs of the Atlantic and Baltic Coasts	0	0	0	1	1	1	1	0	1	0	0	1	1	1	1	9
1240 Vegetated sea cliffs of the Mediterranean coasts with endemic Limonium spp.	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
1250 Vegetated sea cliffs with endemic flora of the Macaronesian coasts	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2
1310 Salicornia and other annuals colonizing mud and sand	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	12
1320 Spartina swards (Spartinion maritimae)	1	0	0	1	0	1	1	1	1	1	1	1	1	0	1	11
1330 Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	1	0	0	1	0	1	1	0	1	0	1	1	1	1	1	10
1340 * Inland salt meadows	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	3
1410 Mediterranean salt meadows (Juncetalia maritimi)	0	0	0	0	0	1	0	1	0	1	0	1	1	0	1	6
1420 Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	0	0	0	0	0	1	0	1	0	1	0	1	1	0	1	6
1430 Halo-nitrophilous scrubs (Pegano-Salsoletea)	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	4
1510 * Mediterranean salt steppes (Limonietalia)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1520 * Iberian gypsum vegetation (Gypsophiletalia)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1530 * Pannonic salt steppes and salt marshes	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1610 Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1620 Boreal Baltic islets and small islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1630 * Boreal Baltic coastal meadows	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1640 Boreal Baltic sandy beaches with perennial vegetation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1650 Boreal Baltic narrow inlets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2110 Embryonic shifting dunes	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	13
2120 Shifting dunes along the shoreline with	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	13

Ammophila arenaria ('white dunes')																
2130 * Fixed coastal dunes with herbaceous vegetation ('grey dunes')	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2140 * Decalcified fixed dunes with Empetrum nigrum	0	0	0	1	1	1	1	0	0	0	1	0	0	1	1	7
2150 * Atlantic decalcified fixed dunes (Calluno-Ulicetea)	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
2160 Dunes with Hippophaë rhamnoides	1	0	0	1	0	1	1	0	1	0	1	0	0	0	1	7
2170 Dunes with Salix repens ssp. argentea (Salicion arenariae)	1	0	0	1	0	1	1	0	1	0	1	1	0	1	1	9
2180 Wooded dunes of the Atlantic, Continental and Boreal region	1	0	0	1	1	1	1	0	0	0	1	1	1	1	0	9
2190 Humid dune slacks	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	13
21A0 Machairs (* in Ireland)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
2210 Crucianellion maritimae fixed beach dunes	0	0	0	0	0	1	0	1	0	1	0	0	1	0	0	4
2220 Dunes with Euphorbia terracina	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
2230 Malcolmietalia dune grasslands	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
2240 Brachypodietalia dune grasslands with annuals	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
2250 * Coastal dunes with Juniperus spp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	2
2260 Cisto-Lavenduletalia dune sclerophyllous scrubs	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
2270 * Wooded dunes with Pinus pinea and/or Pinus pinaster	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	3
2310 Dry sand heaths with Calluna and Genista	1	0	0	1	0	1	1	0	0	0	1	0	0	1	0	6
2320 Dry sand heaths with Calluna and Empetrum nigrum	0	0	0	1	1	0	1	0	0	0	1	0	0	1	0	5
2330 Inland dunes with open Corynephorus and Agrostis grasslands	1	1	0	1	0	1	1	0	0	0	1	0	0	1	1	8
2340 * Pannonic inland dunes	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3110 Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	13
3120 Oligothrophic waters containing very few minerals generally on sandy soils of the West Mediterranean, with Isoetes spp.	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	14
3140 Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	14
3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
3160 Natural dystrophic lakes and ponds	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	14
3170 * Mediterranean temporary ponds	0	0	0	0	0	1	0	1	0	1	0	1	1	0	1	6
3180 * Turloughs	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
3210 Fennoscandian natural rivers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3220 Alpine rivers and the herbaceous vegetation along their banks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3230 Alpine rivers and their ligneous vegetation with Myricaria germanica	0	1	0	0	1	1	1	0	0	1	0	0	1	1	0	7

3240 Alpine rivers and their ligneous vegetation with Salix elaeagnos	0	1	0	0	0	1	1	1	0	1	0	0	1	0	0	6
3250 Constantly flowing Mediterranean rivers with Glaucium flavum	0	0	0	0	0	1	0	1	0	1	0	0	1	0	0	4
3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
3270 Rivers with muddy banks with Chenopodion rubri p.p. and Bidention p.p. vegetation	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	11
3280 Constantly flowing Mediterranean rivers with Paspalo-Agrostidion species and hanging curtains of Salix and Populus alba	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
3290 Intermittently flowing Mediterranean rivers of the Paspalo-Agrostidion	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
4010 Northern Atlantic wet heaths with Erica tetralix	1	0	0	1	0	1	1	0	1	0	1	1	1	1	1	10
4020 * Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	4
4030 European dry heaths	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	14
4040 * Dry Atlantic coastal heaths with Erica vagans	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
4050 * Endemic macaronesian heaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4060 Alpine and Boreal heaths	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1	11
4070 * Bushes with Pinus mugo and Rhododendron hirsutum (Mugo-Rhododendretum hirsuti)	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	4
4080 Sub-Arctic Salix spp. scrub	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	3
4090 Endemic oro-Mediterranean heaths with gorse	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
5110 Stable xerothermophilous formations with Buxus sempervirens on rock slopes (Berberidion p.p.)	1	0	1	0	0	1	1	1	0	1	0	0	1	0	1	8
5120 Mountain Cytisus purgans formations	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2
5130 Juniperus communis formations on heaths or calcareous grasslands	1	1	1	1	0	1	1	1	1	1	1	0	0	1	1	12
5140 * Cistus palhinhae formations on maritime wet heaths	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
5210 Arborescent matorral with Juniperus spp.	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
5220 * Arborescent matorral with Zyziphus	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
5230 * Arborescent matorral with Laurus nobilis	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	3
5310 Laurus nobilis thickets	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	3
5320 Low formations of Euphorbia close to cliffs	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
5330 Thermo-Mediterranean and pre-desert scrub	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
5410 West Mediterranean clifftop phryganas (Astragalo-Plantaginetum subulatae)	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	4
5420 Sarcopoterium spinosum phryganas	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2
5430 Endemic phryganas of the Euphorbio-Verbascion	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	3
6110 * Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi	1	1	1	0	0	1	1	0	0	1	0	0	1	1	0	8

6120 * Xeric sand calcareous grasslands	1	1	1	1	0	1	1	0	0	0	1	0	0	1	0	8
6130 Calaminarian grasslands of the Violetalia calaminariae	1	0	0	0	0	1	1	0	1	1	0	0	0	0	1	6
6140 Siliceous Pyrenean Festuca eskia grasslands	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2
6150 Siliceous alpine and boreal grasslands	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	3
6160 Oro-Iberian Festuca indigesta grasslands	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
6170 Alpine and subalpine calcareous grasslands	0	1	0	0	0	1	1	1	0	1	0	0	1	1	1	8
6180 Macaronesian mesophile grasslands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6220 * Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
6230 * Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	0	0	1	0	1	0	0	0	0	0	1	0	0	1	0	4
6240 * Sub-Pannonic steppic grasslands	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
6250 * Pannonic loess steppic grasslands	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
6260 * Pannonic sand steppes	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
6270 * Fennoscandian lowland species-rich dry to mesic grasslands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6280 * Nordic alvar and precambrian calcareous flatrocks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6310 Dehesas with evergreen Quercus spp.	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	14
6420 Mediterranean tall humid grasslands of the Molinio-Holoschoenion	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	13
6440 Alluvial meadows of river valleys of the Cnidion dubii	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3
6450 Northern boreal alluvial meadows	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6510 Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	14
6520 Mountain hay meadows	0	1	0	0	1	1	1	0	0	1	0	1	0	1	1	8
6530 * Fennoscandian wooded meadows	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7110 * Active raised bogs	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	12
7120 Degraded raised bogs still capable of natural regeneration	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	12
7130 Blanket bogs (* if active bog)	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	4
7140 Transition mires and quaking bogs	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	12
7150 Depressions on peat substrates of the Rhynchosporion	1	1	0	1	0	1	1	0	1	1	1	0	1	0	1	10
7160 Fennoscandian mineral-rich springs and springfens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7210 * Calcareous fens with Cladium mariscus and species of the Caricion davallianae	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2
7220 * Petrifying springs with tufa formation (Cratoneurion)	1	1	1	0	1	1	1	0	1	1	0	0	0	1	0	9

7230 Alkaline fens	0	0	1	0	1	1	1	0	1	0	0	1	0	1	0	7
7240 * Alpine pioneer formations of the Caricion bicoloris-atrofuscae	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	2
7310 * Aapa mires	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	2
7320 * Palsa mires	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	2
8110 Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	1	1	1	0	1	1	1	1	1	1	0	0	0	1	1	11
8120 Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii)	0	1	0	0	0	1	1	0	1	1	0	0	1	1	1	8
8130 Western Mediterranean and thermophilous scree	0	1	0	0	0	1	0	0	0	1	0	1	1	0	0	5
8140 Eastern Mediterranean screes	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
8150 Medio-European upland siliceous screes	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4
8160 * Medio-European calcareous scree of hill and montane levels	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	5
8210 Calcareous rocky slopes with chasmophytic vegetation	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	14
8220 Siliceous rocky slopes with chasmophytic vegetation	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	13
8230 Siliceous rock with pioneer vegetation of the Sedo-Scleranthion or of the Sedo albi-Veronicion dillenii	1	1	0	0	1	1	1	1	0	1	0	1	1	1	0	10
8240 * Limestone pavements	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	3
8310 Caves not open to the public	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
8320 Fields of lava and natural excavations	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
8330 Submerged or partially submerged sea caves	0	0	0	1	0	1	1	1	1	1	0	1	1	1	1	10
8340 Permanent glaciers	0	1	0	0	0	1	1	0	0	0	0	0	0	1	0	4
9010 * Western Taïga	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	2
9020 * Fennoscandian hemiboreal natural old broad-leaved deciduous forests (Quercus,Tilia, Acer, Fraxinus or Ulmus) rich in epiphytes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9030 * Natural forests of primary succession stages of landupheaval coast	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9040 Nordic subalpine/subarctic forests with Betula pubescens ssp. czerepanovii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9050 Fennoscandian herb-rich forests with Picea abies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9060 Coniferous forests on, or connected to, glaciofluvial eskers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9070 Fennoscandian wooded pastures	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9080 * Fennoscandian deciduous swamp woods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9110 Luzulo-Fagetum beech forests	1	1	1	0	0	1	1	0	0	1	1	0	1	1	0	9
9120 Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
9130 Asperulo-Fagetum beech forests	1	1	1	1	0	1	1	0	0	0	1	0	0	1	1	9
9140 Medio-European subalpine beech woods with Acer and Rumex arifolius	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	4

9150 Medio-European limestone beech forests of the Cephalanthero-Fagion	1	1	0	1	0	1	1	1	0	0	0	0	1	1	0	8
9160 Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	1	1	1	1	0	1	1	1	0	1	1	0	1	1	1	12
9170 Galio-Carpinetum oak-hornbeam forests	0	1	0	1	0	1	1	0	0	0	0	0	0	1	0	5
9180 * Tilio-Acerion forests of slopes, screes and ravines	1	1	0	0	1	1	1	0	0	1	1	0	1	1	1	10
9190 Old acidophilous oak woods with Quercus robur on sandy plains	1	0	0	1	1	1	1	0	0	1	1	0	0	1	1	9
91A0 Old sessile oak woods with Ilex and Blechnum in the British Isles	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
91B0 Thermophilous Fraxinus angustifolia woods	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	3
91C0 * Caledonian forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91D0 * Bog woodland	1	1	0	0	1	1	1	1	1	1	0	0	0	1	1	10
91E0 * Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91F0 Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers (Ulmenion minoris)	1	1	0	0	0	1	1	1	0	1	1	0	0	1	0	8
91G0 * Pannonic woods with Quercus petraea and Carpinus betulus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
91H0 * Pannonian woods with Quercus pubescens	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
91I0 * Euro-Siberian steppic woods with Quercus spp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
91J0 * Taxus baccata woods of the British Isles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9210 * Apeninne beech forests with Taxus and Ilex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9220 * Apennine beech forests with Abies alba and beech forests with Abies nebrodensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9230 Galicio-Portuguese oak woods with Quercus robur and Quercus pyrenaica	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	3
9240 Quercus faginea and Quercus canariensis Iberian woods	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2
9250 Quercus trojana woods	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2
9260 Castanea sativa woods	0	1	0	0	0	1	0	1	0	1	0	1	1	0	0	6
9270 Hellenic beech forests with Abies borisii-regis	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
9280 Quercus frainetto woods	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2
9290 Cupressus forests (Acero-Cupression)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
92A0 Salix alba and Populus alba galleries	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
92B0 Riparian formations on intermittent Mediterranean water courses with Rhododendron ponticum, Salix and others	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2
92C0 Platanus orientalis and Liquidambar orientalis woods (Platanion orientalis)	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2
92D0 Southern riparian galleries and thickets (Nerio-Tamaricetea and Securinegion tinctoriae)	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5

	BE	AT	LU	DK	FI	FR	DE	GR	IE	IT	NL	PT	ES	SE	UK	
9310 Aegean Quercus brachyphylla woods	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
9320 Olea and Ceratonia forests	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
9330 Quercus suber forests	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	4
9340 Quercus ilex and Quercus rotundifolia forests	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
9350 Quercus macrolepis forests	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2
9360 * Macaronesian laurel forests (Laurus, Ocotea)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9370 * Palm groves of Phoenix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9380 Forests of Ilex aquifolium	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
9410 Acidophilous Picea forests of the montane to alpine levels (Vaccinio-Piceetea)	0	1	0	0	0	1	1	1	0	1	0	0	0	0	0	5
9420 Alpine Larix decidua and/or Pinus cembra forests	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	3
9430 Subalpine and montane Pinus uncinata forests (* if on gypsum or limestone)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9510 * Southern Apennine Abies alba forests	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9520 Abies pinsapo forests	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
9530 * (Sub-) Mediterranean pine forests with endemic black pines	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2
9540 Mediterranean pine forests with endemic Mesogean pines	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	5
9550 Canarian endemic pine forests	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9560 * Endemic forests with Juniperus spp.	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	3
9570 * Tetraclinis articulata forests	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
9580 * Mediterranean Taxus baccata woods	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
	49	56	24	43	#	111	70	79	46	#	41	66	#	65	#	
	BE	AT	LU	DK	FI	FR	DE	GR	IE	IT	NL	PT	ES	SE	UK	
	49	56	24	43	#	111	70	79	46	#	51	66	#	65	#	

(Source: http://mrw.wallonie.be/dgrne/sibw/N2000/)

Appendix 14 Explanation of the Data Sheets for the Mapping Units

Formation/number and name of the mapping unit
The Code is composed of the letters of the formation (A-U) and the running number of the Mapping Unit (MU) within the formation. The order of the mapping units as a rule runs from west to east and north to south.

The names of the mapping units contain the dominant vegetation types with characteristic and dominant plant species as well as individual diagnostically important geographical or ecological differential species, along with information on the distribution (mainly phytogeographical regions and provinces, see Map 3 and glossary) and site characteristics. The order of the species in the name generally follows their proportion and frequency in the natural vegetation type. Example: Spruce-fir forest (Abies alba, Picea abies) = predominant fir with interspersed spruce; low creeping shrub-lichen tundra (Cladonia spp., Salix nummularia) = lichen tundra with interspersed low creeping shrubs, where Salix nummularia is the most common low creeping shrub.

- **Geographical distribution** (country/territory, area covered, frequency)
  The complete range of a mapping unit is displayed by country, and within each country by state or province (location; natural landscape unit or specific region within a country); total area in km²; number of all polygons on the 1:2.5 million scale map.

- **Scientific names of main plant communities and their most common synonyms** (with author citation)
  Scientific designation of the syntaxa of the main components of the mapping unit, mainly associations, in part also subassociations or alliances, according to the applied phytosociological system with the name of the author(s); synonyms are only given where they can be clearly assigned to a known unit; regional associations of different countries and authors are given often next to each other. Outside of the areas of Braun-Blanquet nomenclature, the locally customary syntaxa are used (mainly species combinations of dominant and site-characterising species); applies especially to the United Kingdom, Sweden, Finland, Bulgaria, Turkey, Russia and other countries of the former Soviet Union (Ukraine, Baltic and Caucasus states, Kazakhstan).
  The list provides an overview of the plant communities and their scientific names considered to be important and relevant by the various authors. The syntaxa were mainly not checked to see whether or not they are correct under the International Code of Phytosociological Nomenclature (Weber, Moravec & Theurillat 2000).

- **Structural feature of the main community(ies)** (layers, life-forms, etc.)
  Brief description of structural features (stand closure, height of the dominant layer, layering, cover) of the main plant communities and – where it is given – the

composition and spatial distribution of the components of vegetation complexes and mosaics.

- **Dominant and most frequent species in different layers**
  First and second tree layers, shrub layer (0.5-5 m), lianas (woody or herbaceous), herb layer (dwarf shrubs, grasses and herbs), moss layer (also referred to as the ground or cryptogam layer), including lichens. The species are listed in order of constancy and cover, and in part differentiated according to their habitat indicator attributes or ecological and phytosociological aspects.

- **Diagnostically important species**
  The species list contains the characteristic combination of species for the main plant community/communities of a mapping unit, including dominants, character species, site indicators and as necessary geographical differential species in the order of the layers where they are found. Where several vegetation units dominate a mapping unit, the assignment of the species to the units is indicated with small letters (a, b, c, …).

- **Ecological variants**
  Site-related subcommunities (subassociations, variants) and forms of the main vegetation unit(s) with information on their habitat attributes and in part differentiating species. In the case of several subassociations of one association: units are enumerated as 1), 2), 3), etc. In the case of several subassociations and several associations in a single mapping unit, small letters are added: a1), a2), a3); b1), b2); c1), c2), etc. The letters refer to the associations and the numbers refer to the subassociations.

- **Geographical variants** (geogr. differential species)
  In the case of geographic deviations within the mapping unit (vicariants, local "races"), naming of the region in question, with the listing of differential species or geographically differentiating communities (in some cases also altitudinal belts).

- **Natural accompanying vegetation** (most important units in complex with the name giving mapping unit, scientific names)
  Listing of the natural vegetation types that occur within the mapping unit on aberrant (azonal or extrazonal) sites and are typical for the mapping unit, or are small pockets of zonal units that can not be displayed due to the map scale.

- **Adjoining climax and permanent vegetation** (with numbers of mapping units)
  Listing of the (most important) mapping units (with code number) that border on the mapping unit in question on the 1:2.5 million scale map.

- **Land use, substitute communities**
  Information on the current land cover and human land use citing typical cultivated plants and widely distributed substitute communities of the natural vegetation (where known).
    - **forestry** (substitute communities, plantations of economic tree-species, scrub)
      Stands altered by human influence: coppices with standards, coppices, grazed forest, plantations (planted forest stands composed of primarily non-site-indigenous tree species), scrub, also dwarf shrub heaths, communities of forest clearings.
    - **grassland** (meadows, pastures, herb-rich communities)
      Meadows, pastures, hay pastures, unfertilised grasslands, where possible with scientific names (syntaxa) and the most important species.
    - **arable land** (characteristic weed communities)
      Information on the most important crops and the accompanying weed communities.
    - **settlements** (typical ruderal vegetation)
      The most important non-cultivated plant communities of settlements, industrial and traffic areas.

- **Site conditions of the mapping unit**
    - **Landscape type, geomorphology**
      Lowlands, hills, uplands, high mountains, and further specification of site (whether level, slightly undulating, steep, rough, or characterised by outcrops)
    - **Altitudinal belt and/or altitudinal range**
      Assignment to altitudinal belts: lowland (planar), colline, submontane, montane, alti-montane, subalpine, alpine, nival; in the Mediterranean region further thermo-, meso-, supra-, oro-, and cryoro-Mediterranean; also altitudinal range in metres above mean sea level.
    - **Geology (bedrock)**
      Various geological maps at scales ranging from 1 : 1,000,000 to 1 : 2,000,000 served as base maps for the determination of geological parent material, as well as the Geological Overview Map of Europe at the scale 1 : 5,000,000 (see map references under Literature). As much as was possible, the corresponding parent bedrocks were provided for every mapping unit as well as (in parentheses) the geological formation to which they belong. However, because the maps are in many cases not very detailed, the information sometimes had to be limited to simply stating the geological formation.

- **Soil conditions**
    - **soil type**, also the depth of fine textured earth (soil), stone content; (international nomenclature)
      Information on the soils refers exclusively to the soil type, which in turn allows relationships to be inferred on the texture, moisture regime, soil reaction and trophic levels. Owing to the non-uniform approach to soil

systematics in Europe and the differing soil nomenclature that results from this, the names according to the international soil nomenclature of the FAO (1974, 1990) were provided in parentheses in addition to the data provided from national contributors and/or the names of the soil types according to German soil systematics. The FAO data were derived from the FAO & UNESCO "Soil map of the world" (1978) at the scale 1 : 5,000,000 with the corresponding legend (1974) (for other maps used, see map references under Literature). Since the first edition of the world soil map the soil type groups of the lithosols, rendzinas, rankers and xerosols were replaced by others. The soil types mentioned in the standardised data sheets under the heading soil type as well as the international FAO nomenclature are further explained in the glossary of technical terms.

- **soil texture**
  Information on the texture of the mineral components of the soil: sand, silt, loam, clay; grainy, stony, gravelly, bouldery, rocky**.**
- **Soil moisture, water**
  Information on the predominant moisture class according to the following list: peaty-swampy, very wet, wet, moist, periodically moist, mesic (fresh), periodically dry, moderately dry, dry, very dry. balance.
- **soil reaction**
  Data on the range of soil pH reactions correspond to established pH classes: extremely acidic (pH CaCl2 <3.0); very strongly acidic (3.0-3.9), strongly acidic (4.0-4.9), moderately acidic (5.0-5.9), weakly acidic (6.0-6.9), neutral (7.0), weakly alkaline (7.1-8.0), moderately alkaline (8.1-9.0), strongly alkaline (9.1-10.0). The categorisation is mostly not very precise and is only an approximation; pH figures are only provided where more exact data were available.
- **soil fertility**
  Information on the natural nutrient status of the soils of very nutrient-poor and base-poor (dystrophic) to nutrient-rich and base-rich (eutrophic). Established classes are: dystrophic, oligotrophic, oligo-mesotrophic, mesotrophic, meso-eutrophic, eutrophic.

- **Climate incl. local climate**
  - **climate type (following Walter & Lieth)**
    The climatic data are largely derived from the Klimadiagramm-Weltatlas of Walter & Lieth (1967) (additional data for the Iberian Peninsula derived from Rivas-Martínez 1987). In this work, ten different climate zones (= climate types) were differentiated and provided with Roman numerals (I-X). Table 1 provides an overview of the relevant climate types for the vegetation map of Europe. In general, there is a good correspondence between climatically defined zones and zonal soil types, which is why both are listed side by side in Table 1.

Table 1: Comparison of the climate types and the corresponding soil type groups (following FAO classification) and the formations of the Map of the Natural Vegetation of Europe (modified from Hintermaier-Erhard & Zech 1997).

Climate type	**Climatic conditions**	**Zonal vegetation / formation**	**Soil type (following FAO 1990)**
III	arides, subtropisches Wüstenklima, spärliche Regenfälle (Jahresniederschlag <200mm), gelegentlich Strahlungsfr	O p.p.	Calcisols, Gypsisols (= Xerosols, Yermosols); Solonchaks, Solonetz
IV	mediterranes Klima mit Winterregen und Sommerdürre, nicht ganz frostfrei, aber keine ausgesprochen kalte Jahreszeit	G, J, K	Chromic, Calcic Cambisols; Chromic Luvisols; Regosols; Andosols; Vertisols; Leptosols; Calcisols, Gypsisols
V	Warmtemperiertes Klima, immerfeuchte Zone, oft mit Sommerregenmaximum oder mild-maritim, nur gelegentliche Fröste	H, F p.p.	Acrisols; Luvisols; Cambisols
VI	typisch gemäßigtes Klima mit ausgeprägter, aber nicht sehr langer Winterkälte	E, F	Cambisols; Luvisols; Podzols; Leptosols
VII	kontinentales Klima mit heißen Sommern und kalten Wintern	L, M, O, P p.p.	Phaeozems; Greyzems; Chernozems; Kastanozems; Solonchaks; Solonetz; Calcisols, Gypsisols
VIII	Boreales, kalt gemäßigtes Klima mit kühlen Sommern und langen, sehr kalten Wintern	C, D	Podzols (mit Übergangsformen zu Cambisols); Podzoluvisols (meist rohhumusreich), Dystric Histosols
IX	arktisches Klima mit kurzen Sommern und kurzer frostfreier Jahreszeit (wärmster Monat unter 10 °C) und langer, sehr kalter Winternacht	A, B p.p.	Gelic Regosols, Gelic Podzols, Gelic Gleysols, Gelic Histosols (tundra and permafrost soils)

The climates of higher mountain ranges (X) assume a special position that owing to their distinct altitudinal belts deviates from the prevailing zonal climate type. A Roman numeral is typically added to the climate type X in parentheses, from which can be deduced to which climatic zone the mountain range actually belongs (for instance, the climate of the mountain 'Zugspitze' in the northern Alps is characterised as X[VI]). Since there are as a rule no sharp delineations of climate, there are often fluid transitions between the different climate types. These transitional areas are indicated through the addition of a second Roman numeral in parentheses. The climate type IV(III) indicates for instance a Mediterranean type with low precipitation, while the type V(IV) corresponds to a warm temperate climate with predominating winter rains. A further subclassification in the form of Arabic numerals and/or letters (e.g. VI3, VI7a) is viewed by the authors as provisional and is provided where necessary for the relevant overview map in the climate atlas.

The occurence of wide precipitation or temperature spans in the data sheets can have various reasons:
- large scale horizontal extent or widespread distribution of a mapping unit (e.g. D52),
- large vertical distribution of a mapping unit (e.g. C10),
- azonal vegetation, which is spread across different climate types (e.g. formations T and U).

Since the network of meteorological stations is not evenly distributed, it is often the case that not every mapping unit has exact climatic data. This applies especially for spatially small and locally distributed mapping units in all formations. In these cases the corresponding climatic data were interpolated from the next adjacent climatic stations.

In the case of azonal and geographically little-differentiated formations, specifically R (reed beds and sedge swamps) and T (swamp and fen forests), more specific climatic data than the climate type were not provided, since these would not have made much sense due to the wide distribution of the units (for instance, R1 occurs from the Caspian Sea to the North Sea; T1, T4 from the Atlantic to the Urals).

- **average annual temperature**

Span within the area of the mapping unit primarily for the period between 1900 and 1960; where there are large differences within a mapping unit, data are provided separately for individual countries or regions (mainly following Walter & Lieth 1967).

- **average annual precipitation**

Span within the area of the mapping unit primarily for the period between 1900 and 1960; where there are large differences within a mapping unit, data are provided separately for individual countries or regions (mainly following Walter & Lieth 1967).

- **average temperature of the warmest month**

Data for the warmest month and its average temperature (mainly following Walter & Lieth 1967).

- **average temperature of the coldest month**

Data for the coldest month and its average temperature (mainly following Walter & Lieth 1967).

- **local climate or other climatic peculiarities**

Information on macro- or local climatic peculiarities (very diverse comments).

- **Importance for nature protection**

  - **Present state and development trend of natural vegetation** (degree of endangerment)
    Information on the state of preservation (degree of anthropogenic alteration) and the endangerment situation of the natural vegetation is provided as far as known.
  - **endangered communities, species worthy of protection in natural vegetation**
    Mostly rather general comments on the various vegetation types within the mapping units and/or on the relevant species.
  - **causes of endangerment**
    Causes of the decline, the modification (degradation), threat or destruction of the natural vegetation include logging/clearing, forest pasturing, use of (fire)wood, modern silviculture, agricultural use, development, fire, nutrient and pollution influxes.
  - **required measures for protection and restitution**
    Measures required for the conservation or restoration of natural/near-natural vegetation.

- **Localities of representative stands (loci typici) with state of protection**
  - **of the natural vegetation**
  - Country, area (state of protection); areas with or without state of protection, in which representative stands of the natural/semi-natural vegetation of the mapping unit are present. Often only very general comments, partly citing protected areas. Categories include: nature reserve (German: NSG), national park (NP), biosphere reserve (BR), natural forest reserve, Bannwald (BW), Zapovednik (strictly protected area in Russia);
  - **of characteristic substitute communities worthy of protection**
    Information on areas with representative and protection-worthy/protected substitute communities (e.g. coppices with standards, grazed forests, extensive grasslands, moist meadows, sedge swamps). Country: area (state of protection).

- **Most important references** (author, year)
  Authors listed in alphabetical order. Only the publications that are more directly concerned with the communities of the specific mapping units are given, and which contain species lists or vegetation tables, descriptions of communities and information on the sites and which were used or analysed during filling out of the data sheets.

- **Compiled by**
  Names of the contributors who processed or expanded on the national data sheets and/or the syntheses for the individual mapping units (see list of contributors).
  ADDIN