Task 1 - Defining and classifying grasslands in Europe

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Abbreviations

BDC	Biodiversity data centre
CAP	Common Agricultural Policy
CLC	CORINE Land Cover
CORINE	CO-oRdination of INformation on the Environment
EAGLE	EIONET Action Group on Land monitoring in Europe
EEA	European Environmental Agency
EO	Earth Observation
EUNIS	European Nature Information System
EW-MFA	Economy-wide material flow accounts
FAO	Food and Agricultural Organisation of the United Nations
FADN	Farm Accountancy Data Network
FSS	Farm Structural Survey
GLC	Global land cover
HNV	High Nature Value
HR	High Resolution
IACS	Integrated Administration and Control System
IPCC	Intergovernmental Panel on Climate Change
LAI	Leaf Area Index
LCCS	Land Cover Classification System
LPIS	Land Parcel Identification System
LUCAS	Land Use and Cover Area frame Survey
NUTS	Nomenclature of territorial units for statistics
OECD	Organisation for Economic Co-operation and Development
PASK	Pasture Knowledge Base
SAPM	Survey on Agricultural Production Methods
UAA	Utilized Agricultural Area
UNFCCC	United Nations Framework Convention on Climate Change

Summary

Grasslands are an important land use in Europe covering more than a third of the European agricultural area. Grasslands are very diverse in terms of management, yield and biodiversity value. Grasslands are very diverse in terms of management, yield and biodiversity value. A distinction can be made between production grassland, which have mainly a fodder production function, and semi-natural grasslands that provide a large range of ecosystem services including biodiversity. For production grasslands the main differentiation is between permanent and temporary grassland and in their level of intensification. Accurate data on grassland area, grassland production and nutrient contents are very important for calculation of gross nutrient balances in the EU and other agri-environmental indicators (e.g. greenhouse gas emissions) and policies (e.g. CAP reform, Nitrates Directive). This requires well-defined characterization of the grassland types, management of these grasslands and the productivity (both in terms of biomass and nutrients). The specific aim of this Task 1 report is to make a literature review of existing definitions and classifications of grasslands that are used in diverse domains, both statistical, administrative, scientific and other.

Chapter 3 provides an overview of the different sources of grassland information that cover the EU-27 or at least part of the EU-27 member states. Most of the statistical sources of grassland data deal with land use, whereas the remote sensing based sources refer to land cover. Land use is a description of how people utilize the land and socio-economic activity. Land use is often recorded via questionnaires and statistics. The assessment of the grassland data sources showed that there is no data source that scores well on all criteria. In general the remote sensing based sources have a low score on criteria as clear and harmonized definitions, the temporal coverage and resolution and the lack of data on grassland productivity. The statistical sources perform lower on the spatial resolution and most also lack data on data on grassland productivity. FSS and FADN statistics score both well, only FSS is lacking the grassland productivity data and has not an annual frequency. LPIS data only score bad at the clear harmonized definitions and on the public availability aspect. However, both could be improved with Eurostat support, which would make this a very valuable data source. For identification of detailed grassland areas the Corine Land Cover map and related products are most useful, while LUCAS is more valuable for general and regional trends in grassland areas and use, as this is the grassland data source that is most harmonized among EU member states.

Definitions of grassland can be found in the scientific literature, Common Agricultural Policy, Farm Structure Survey, FADN, FAOSTAT, IPCC guidelines, LUCAS, remote sensing based sources (CORINE, FAO-Land Cover Classification System, EAGLE) and, for habitat classification, in the EU Habitats Directive, and the EUNIS habitat classification. The statistical sources do have clear definitions for different grassland types. Although remote sensing sources have clear classification schemes, the usefulness is limited as the classification is focussed on land cover and not on land use (e.g. no distinction between permanent and temporary grassland).

There is a need for data about grassland in several European policies, i.e. Nitrates Directive, Common Agricultural Policy, EU Climate policies, Biodiversity policies, and the Renewable Energy Directive. The data considered are area and yield of grassland, biodiversity value, area grazed non-herbaceous grasslands, management options (permanency, grazing, fertilization, tillage and cutting. For the Nitrates Directive none of the current grassland classifications and definitions really fits the policy needs, as there is no clear distinction in the intensity and management level of the grasslands. The same holds for the climate policies, for which also data on grassland management would be needed. For the CAP the definition of permanent grassland and the FSS statistics are currently sufficient, but with the renewal of the CAP probably new data needs on grassland will be added. For biodiversity policies the corresponding classification is useful,

however, the mapping of the habitats at EU level still requires harmonisation, and there is not yet an overall EU map with all habitats according to this classification. Finally for the Renewable Energy Directive a definition and corresponding mapping of highly biodiverse grassland is needed, but none of the current definitions would fit, or all grassland classified under the habitat Directive should be included.

Based on the sources of grassland information and the review of current definitions and classifications of grassland the following conclusions and recommendations are derived:

- Spatial coverage for most grassland sources is sufficient and cover the EU-27. Spatial resolution differs largely, many statistical sources only provide data at national level, whereas the remote sensing sources can provide data at 100 meter grid cell resolution.

- Most statistical sources have already established a long time series and provide data at annual time steps. The remote sensing sources are often products produced for a certain year, although for the Corine Land Cover maps several time steps are available and updates are on-going.

- Few sources have clear and harmonized grassland definitions. The statistical sources of FADN, FSS and FAOSTAT do have clear definitions for different grassland types, although it remains unclear whether member states provide all information according to these definitions. Although remote sensing sources have clear classification schemes, the usefulness is limited as the classification is focussed on land cover and not on land use.

- Many EU policies require data on grasslands. Harmonization of grassland definitions and classifications would reduce the amount of data that has to be collected and would improve the data quality. None of the current grassland definitions and classifications does achieve the data needs of the different EU policies.

1   Introduction

1.1   Background

Grasslands are an important land use in Europe covering more than a third of the European agricultural area. Grasslands have a basic role in feeding herbivores and ruminants and provide important ecosystem services, including erosion control, water management and water purification. Grasslands also support biodiversity and cultural services, e.g. recreational values, and are an important stock of carbon (Smit et al., 2008).

Grasslands are very diverse in terms of management, yield and biodiversity value. They range from semi-natural grasslands with low yields and high biodiversity values to fertilised mono-cultural grasslands. Most of the grass in the EU originates from intensively managed grasslands, stimulated by fertiliser application. Extensive, high nature value grasslands have low yields. Examples of such areas are mountain summer grazing areas, semi-natural grasslands and other areas used for extensive grazing.

Accurate data on grassland area, grassland production and nutrient contents are very important for calculation of gross nutrient balances in the EU and other agri-environmental indicators (e.g. greenhouse gas emissions) and policies (e.g. CAP reform, Nitrates Directive). This requires well-defined characterization of the grassland types, management of these grasslands and the productivity (both in terms of biomass and nutrients).

Part of the natural and extensively used grasslands are not important from a nutrient perspective, because there is no input of nutrients and, by that, no or limited emissions to the environment. A gross nutrient balance expressed on basis of a hectare agriculture land should not include these types of grassland, as these balances are used for indicating the pressure on the environment by nutrients from agriculture. Including extensively used managed grasslands in these calculations may mimic high nutrient pressures on the environment. The definitions and characterization should be used in an uniform and harmonized way in the EU-27 so that the same information is gathered in the different member states. Such an uniform approach is needed to derive gross nutrient balances (and other agri-environmental indicators) based on the same methodology and type of data.

1.2   Objectives

The objective of this study for Eurostat[1] is to bring clarity into the issue of defining, classifying, collecting and disseminating data on European grassland areas, use and production. The specific aim of Task 1 and this report is to make a literature review of existing definitions and classifications of grasslands that are used in diverse domains, both statistical, administrative, scientific and other.

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[1] Methodological studies in the field of Agro-Environmental Indicators (2012/S 87-142068) Lot 2. Grassland areas, production and use

1.3   Outline report

According to the proposal Task 1 will deliver the following outputs, which have been integrated in this Task 1 report:
−   A report describing the different types of grasslands throughout Europe, describing key features. The report includes examples on how to best distinguish/differentiate the grassland types. An enlarged definition to pastures other than grasslands should also be explored.
−   A document reviewing the various definitions and classifications of grasslands used in different domains today. The document shall also contain various suggestions for possible ways to defining grasslands and other grazing areas, analysed for strengths and weaknesses in the proposed approaches.

First in Chapter 2 the different types of grassland in the EU-27 are described, including both the key categories and characteristics of grassland and grazing areas as well as areas other than grassland used for grazing by livestock. In Chapter 3 an overview of the different sources of grassland information is provided, which includes both statistical sources as remote sensing based sources. Chapter 4 reviews the current definitions and classifications of grassland. This Chapter also analyses the possible methods for data collection for grassland and the strengths and weaknesses of the possible approaches. In Chapter 6 the proposal of grassland definitions by the European Grassland Federation (EGF) will be included. Finally Chapter 5 will conclude with some recommendations, which are further elaborated in Task 3.

2 Overview of grasslands types in Europe

2.1 Introduction

In this Chapter we will provide a short overview of the different types of grassland in Europe. So far there exists no general overview and typology of grasslands in Europe. There are studies and maps of grassland based on land cover derived through remote sensing, e.g. the Corine Land Cover maps. There are also studies and data sources that focus on specific issues such as grassland productivity (e.g. Smit et al., 2008) or on biodiversity aspects with habitat classifications and mappings (see Chapter 4.2). However, there is no study that integrates all these aspects into one single grassland typology and grassland map for Europe. In this chapter we do not aim to develop such a typology, but we will give a short overview of the different grassland types in Europe and their distribution. We make a distinction between production grassland, which have mainly a fodder production function, and semi-natural grasslands that provide a large range of ecosystem services including biodiversity.

Figure 1. Distribution of grassland in Europe based on CORINE 2000 map (source EEA[2])

Grasslands are an important land use in Europe covering more than a third of the European agricultural area (Figure 1). Grasslands have a basic role in feeding herbivores and ruminants and provide important ecosystem services, including erosion control, water management and water purification. Grasslands also support biodiversity and cultural services and are an important stock of carbon. Grasslands are very diverse in terms of management, yield and biodiversity value. They range from semi-natural grasslands with low yields and high biodiversity values to fertilised mono-cultural grasslands. Cultivation of grasslands, and other modifications of grasslands through desertification and livestock grazing can be a significant source of carbon emissions.

2.2   Production grasslands

For production grasslands the main differentiation is between permanent and temporary grassland and in their level of intensification. The difference in permanent grassland and temporary grassland is relevant for soil carbon storage and also for biodiversity aspects. The level of intensification, i.e. the inputs of manure and fertilizer, grazing pressure, mowing frequency and grassland renewal, determines the grassland productivity, but can also be seen as a proxy for its biodiversity value.

Most of the grass in the EU originates from intensively managed grasslands, stimulated by fertiliser application. Extensive, high nature value grasslands have low yields (Reheul et al., 2007). The EU livestock sectors annually use around 500 million tonnes of animal feed. About 40% of this quantity expressed in dry matter is in grass (Lesschen et al., 2011). A grassland area of around 65 to 70 million hectares is needed to produce feed for the EU livestock sector. For beef and dairy, grass is certainly not the only feed type. In the dairy sector, the share of grass in total feed is even below 50%. It is estimated that only 4% of dairy production and around 20% of beef production is connected to feed that comes from high nature value grasslands (Westhoek et al., 2011).

Figure 2 shows the distribution of permanent grassland and fodder on arable land at NUTS 2 level in the EU-27. Permanent grassland as shown in this figure includes both the intensive grasslands and the rough grazing areas (see Section 3.1.3 on the Eurostat crop statistics). The share of permanent grassland is highest in the more wet and alpine areas of Europe, e.g. Ireland, the western part of the UK, Austria, and the western part of the Netherlands.
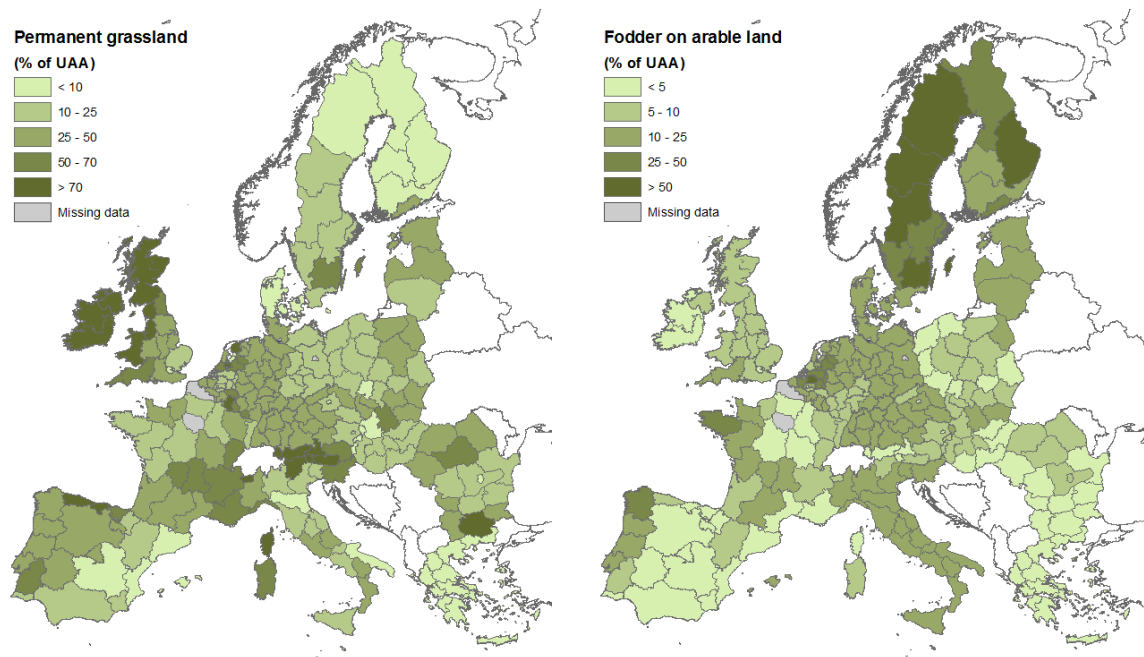
Figure 2. Distribution of permanent grassland (left) and fodder on arable land (right) at NUTS 2 level in EU-27, based on Eurostat Crop statistics data from 2010

The map at the right side of Figure 2 shows the share of fodder on arable land, which comprises temporal grassland but also fodder maize and crops like Lucerne are included in this category. However, for most countries the class 'temporary grasses and grazing' forms the main category. Temporary grassland is not distinguished at NUTS-2 level for in the Eurostat crop statistics, only at national level (see Section 3.1.3). Therefore as a proxy category 'fodder from arable land' is used. The share of this category is especially high in the Scandinavian countries and in some regions with high livestock densities, e.g. the Netherlands, Belgium and Bretagne.

Data on grassland productivity is scare and scattered. Smit et al. (2008) compiled a new data set on grassland productivity, based on from various regional, national and international census statistics for Europe. Results show large regional differences in grassland productivity and land use in Europe (Figure 3). The highest productivity, about 10 t ha^{-1}, is achieved in the Atlantic zones, comprising North Western Spain, Western France, Ireland, Wales and England, the Benelux, the North of Germany and the South Western parts of Norway. The highest yields recorded are in the Netherlands, which is due to the combination of a suitable climate and highly intensive pasture use. Grassland productivity is highly correlated with annual precipitation and less with annual temperature sum and growing season length (Smit et al., 2008).
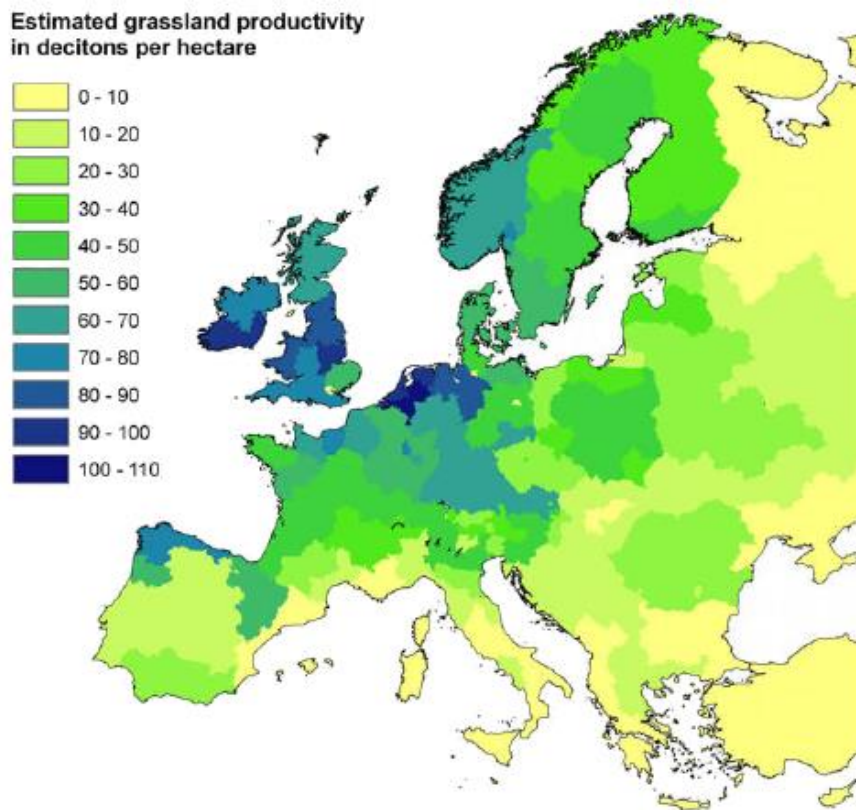
Figure 3. Spatial distribution of grassland productivity (dton ha^{-1}) in Europe (Smit et al., 2008)

Grasslands have a basic role in feeding herbivores and ruminants. In Figure 4 the grazing livestock density and distribution of the milk production is shown. High livestock grazing densities occur the Netherlands, Belgium, northern France, and the Po delta in Italy, which are areas with intensive livestock production. However, also some Mediterranean regions, i.e. Greece, Bulgaria and Murcia in Spain, have high grazing livestock densities compared to the fodder area. In these areas the livestock production is more depending on other feed sources and/or extensive grazing on non-grasslands, e.g. grazing of crop residues on arable land or grazing on semi-natural vegetation. In Figure 4 also the milk production in Europe is shown. The spatial pattern of milk productivity across Europe is similar to the productivity of grassland, suggesting that grassland productivity plays a major role in the distribution of milk productivity.
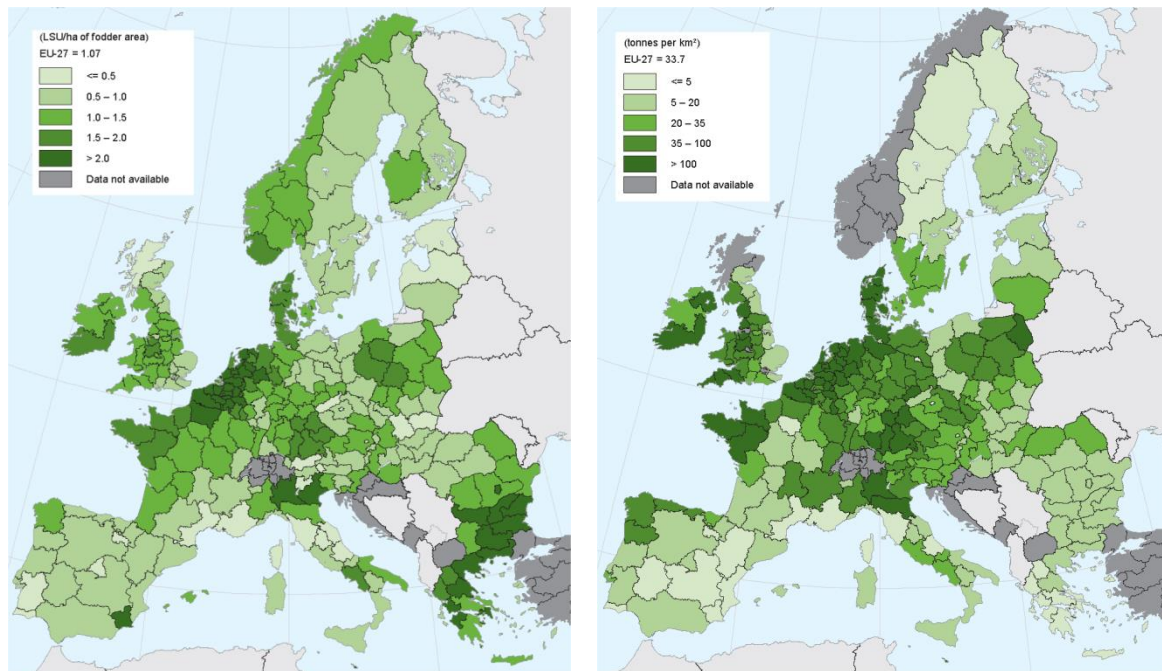
Figure 4. Grazing livestock density in livestock units (LSU) per ha of fodder area for 2007 (left) and milk production for 2010 (right) based on Eurostat data[3]

2.3   Semi-natural grasslands

Semi-natural grasslands include self-seeded herbaceous and shrub vegetation that are used for livestock grazing and/or mowing. Semi-natural pastures and meadows are typified by extensive farming using traditional breeds of livestock, and have a relatively low productivity compared with intensively managed grasslands. They are central to the concept of High Nature Value farming and are profoundly valuable for the large range of ecosystem services they provide. Such grasslands cover approximately a quarter of all EU farmland, but most are in poor condition (Collins and Beaufoy, 2012).

Semi-natural grasslands include lowland meadows and pastures including floodplain meadows, upland and alpine hay meadows, limestone grasslands, lowland acid grassland and heathland, steppe grassland, Alpine and other montane rangelands, Mediterranean scrub/grassland mosaic such as Phrygana, Garrigue, Maquis and Matorral, boreal grasslands, wooded grasslands such as Baltic wooded meadows, Dehesa, wood-pasture and maritime grasslands of dune, cliff and machair. Semi-natural pastures are of exceptional environmental value compared with cultivated grasslands. For example, they support the majority of EU farmland biodiversity, the majority of EU farmland carbon, and provide the majority of water catchment services on farmland (Collins and Beaufoy, 2012). The Common Agricultural Policy (CAP) does currently not recognise the existence of semi-natural pastures, since cultivated and uncultivated grasslands are lumped together without distinction in the single category of "permanent pastures".

Based on Annex 1 of the Habitats Directive the following types of grasslands can be distinguished in Europe: i) natural grasslands, which includes nine grasslands habitats that thrive without direct human intervention

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[3] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Agriculture_statistics_at_regional_level

and are limited by specific ecological, soil and climate conditions, e.g. Alpine grasslands, ii) semi-natural dry grasslands and scrubland facies, which includes 12 grasslands habitats that are to some extent managed, ranging from Mediterranean grasslands to Pannonic steppe and Fennoscandinavian grasslands, iii) sclerophillous grazed forests, which includes one grassland habitat known in Portugal montado and in Spain as dehesas, iv) semi-natural tall-herb humid meadows, which includes six grasslands habitats that have some soil water presence and v) mesophile grasslands, which includes three grasslands habitats comprising all meadows, see also Section 4.2.1.

Common land grazing

Common land is land owned collectively or by one person, but over which other people have certain traditional rights, such as to allow their livestock to graze upon it or to collect firewood. In some countries common land grazing is still very important. Although in many countries the area of common land has decreased drastically over the last centuries, there is still a surprising area of common land in Europe that survived. Even in more productive landscapes, for example in southern England, common land makes up a large proportion of the remaining semi-natural pasture land.

Table 1. Livestock numbers and common land grazing based on Survey on Agricultural Production Methods from 2010

Country	Total livestock	Grazing livestock	Common land grazing	
	LSU	LSU	% of total livestock	% of grazing livestock
Belgium	3798680	1876050	Not available	Not available
Bulgaria	1149470	744430	58.7	80.4
Czech Republic	1722460	1001070	0.0	0.0
Denmark	4919400	1199090	0.0	0.0
Germany	17792560	9653340	1.1	1.3
Estonia	306280	196580	0.0	0.0
Ireland	5787400	5303690	15.1	15.4
Greece	2406520	1826710	50.4	60.7
Spain	14830940	6312600	11.3	23.9
France	22674170	15099090	2.5	3.7
Italy	9911520	5302870	3.8	7.1
Cyprus	200750	91160	Not available	0.0
Latvia	474630	316100	0.0	0.0
Lithuania	900080	607630	0.0	0.0
Luxembourg	167660	148330	0.0	0.0
Hungary	2483790	711900	0.6	3.3
Malta	41650	14810	2.2	4.8
Netherlands	6711500	3038860	0.0	0.0
Austria		1546550	Not available	24.2
Poland	10377220	4648350	8.9	6.7
Portugal	2205950	1338750	2.5	3.9
Romania	5444180	3106480	46.1	63.0
Slovenia	518480	367100	0.6	2.0
Slovakia	668340	389480	0.0	0.0
Finland	1121050	694420	0.0	0.0
Sweden	1751890	1224860	0.0	0.0
United Kingdom	13308420	10465960	Not available	Not available
Croatia	1020180	487160	21.5	33.6

In the 2010 Survey on Agricultural Production Methods (SAPM) information was requested about grazing on common land (Table 1). Especially in Bulgaria, Greece and Romania common land grazing is very important

with at least 50% of the grazing livestock that grazes at least more than one month from common land. But also in countries like Ireland, Spain and Austria the grazing on common land is occurring frequently.

In a related project on "Aspects of data on diverse relationships between agriculture and the environment" (Contract No. 07-0307/2012/633993/ETU/B1), the data aspects around ecological valuable grasslands are investigated. That study deals with the grasslands that are of interest because of their biodiversity aspects. Therefore the current study for Eurostat is focussing more on agricultural grasslands and less on the semi-natural grasslands.

Dehasas

Dehesa is a sparse wood pasture made up principally of holm and evergreen cork oak, grazed by livestock, and without scrub undergrowth. It is unique to Iberia and Morocco. In Portugal these silvi-pastural systems are called montado. Dehesa can be defined as an agrosilvopastoral (or pastoral-silvo-agricultural) system developed on poor or non-agricultural land and aimed at extensive livestock raising. Silviculture is aimed at increasing the crown cover per tree and at producing acorns, browse and fuelwood. The typical environment of the dehesa is marked by two fundamental features: the Mediterranean character of the climate (dry summers and somewhat cold winters) and the low fertility of the soil (particularly P and Ca), making arable farming unsustainable and unprofitable (Olea and San Miguel-Ayanz, 2006).

3   Sources of grassland information

In this Chapter we will provide an overview of the different sources of grassland information that cover the EU-27 or at least part of the EU-27 member states. In the first part we discuss statistical sources that are based on surveys and other national data, next a section on sources based on specific studies, and lastly the sources based on remote sensing are discussed.

First we have to distinguish between land cover and land use, which have different meanings despite the two terms often being used interchangeably. Land cover is the physical material at the surface of the earth and includes e.g. grass, trees, bare ground, water, etc. The main method for capturing information on land cover is through analysis of remotely sensed imagery, but also field surveys can be used. Land use is a description of how people utilize the land and socio-economic activity. Land use is often recorded via questionnaires and statistics. Accordingly grassland is a land cover, while grazing or a golf course is a land use. Most of the statistical sources mentioned below deal with land use, whereas the remote sensing based sources refer to land cover.

3.1   Statistical sources

3.1.1   Farm Structural Survey (FSS)

The main EU wide statistical source of information on agricultural land use is the Farm Structural Survey (FSS)[4]. It provides EU wide harmonised data on agricultural holdings in the EU on:
  – Number of agricultural holdings
  – Land use and area (crops)
  – Livestock
  – Main crops
  – Farm Labour Force (including age, gender and relationship to the holder)
  – Economic size of the holdings
  – Type of activity
  – Other gainful activity on the farm
  – System of farming
  – Machinery
  – Organic farming

In addition to the FSS there is also **Survey on Agricultural Production Methods (SAPM)** which was carried out for the first time in 2010 to collect data at farm level on agri-environmental measures. European Union (EU) Member States could choose whether to carry out the SAPM as a sample survey or as an exhaustive survey. Data were collected on tillage methods, soil conservation, landscape features, animal grazing, animal housing, manure application, manure storage and treatment facilities and irrigation. The Member States collected information from individual agricultural holdings and, observing rules of confidentiality, data were transmitted to Eurostat. The results of the SAPM are linked at the level of individual

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[4] http://epp.eurostat.ec.europa.eu/portal/page/portal/farm_structure_survey/introduction

agricultural holdings to the data obtained from the Farm structure survey in 2010[5]. One of the most relevant parameters for this study is the data on common land grazing.

The basic unit underlying the SAPM is the agricultural holding: a technical-economic unit, under single management, engaged in agricultural production. The SAPM covers all agricultural holdings with a utilised agricultural area (UAA) of at least one hectare (ha) and also those holdings with a UAA of less than 1 ha where their market production exceeds certain natural thresholds.

Used definitions and classification of grassland
The definitions of all land use categories are specified in the Commission Regulation (EC) No 1200/2009, see Section 4.1.3. The classification of permanent grassland in FSS and SAPM is build up hierarchically. At the highest level there is one land use class 'Permanent grassland and meadow', which is sub-divided into three classes:
  – Pasture and meadow, excluding rough grazing
  – Rough grazing
  – Permanent grassland no longer used for production purposes and eligible for the payment of subsidies

Common Land
Up until 2009/2010, in some countries, the FSS did not cover particular types of land not belonging directly to agricultural holdings on which common rights apply - designated as common land. Generally these areas are used for grazing animals and the area used by each holding is not individualized but is part of the UAA.

In what concerns common land as it is defined above, countries can be classified into 3 different categories:
  A. Common land simply does not exist (Belgium, Czech Republic, Denmark, Estonia, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Slovakia, Finland and Sweden),
  B. Common land exists but it has always been perfectly measurable within the methodology used for covering the UAA within each agricultural holding in the FSS (Spain, Italy, Cyprus, Austria, Portugal, Romania and Norway).
  C. Common land exists but was not totally included in the FSS until 2007, and is included in FSS 2010 and onwards (Bulgaria, Germany, Ireland, Greece, France, Hungary, Slovenia and the United Kingdom). For this last group the differences between 2007 and 2010 in what concerns UAA, and grassland in particular, should take into account this change in the coverage.

Coherence
The FSS does not cover the whole territory. The coverage includes only land belonging to agricultural holdings. The total area of a holding covers utilized agricultural area (arable land, kitchen gardens, permanent grassland and permanent crops) and other land (unutilized agricultural area, wooded area, and other land occupied by buildings, farmyards, tracks, ponds, rock, etc.). The Utilized Agricultural Area (UAA) is also covered in other agricultural statistics, namely the annual crop statistics (Section 3.1.3). The crop statistics use a different methodology for collecting the data. Table 2 summarizes the main differences and the reasoning in the case of divergence in the UAA.

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[5] The legal basis for the SAPM is Regulation 1166/2008 of 19 November 2008 on farm structure surveys and the Survey on agricultural production methods, which repealed Council Regulation 571/88.

Table 2. Main differences and the reasoning in the case of divergence in the UAA between FSS and Eurostat annual crop statistics[6]

Member State	Data	Explanation
Belgium	UAA figures in annual statistics are lower than in the FSS	No reason given.
Bulgaria	UAA in annual statistics is much larger than in the FSS	– The Farm Structure Survey excludes the common land used by the farmers collectively, but this land is included under 'Permanent grassland" in the annual statistics table. BG considers that common land is not part of agricultural holdings. – The Farm Structure Survey excludes the farms under a certain threshold. – Some areas under the heading "Land under permanent crops", where clarification is needed as to the legal status of the area, are also excluded from the FSS. This is the case, for example, when the ownership is not clear, because descendants of the late owner did not divide up the land.
Germany	UAA figures in annual crops and in the FSS are almost identical	DE uses the FSS results to estimate the land use figures provided within the framework of annual statistics.
Greece	UAA figures in annual statistics are lower than in the FSS Some important data are missing.	No reason given.
Spain	UAA figures in annual statistics are lower than in the FSS for certain years	No reason given.
France	Crops under glass are missing	No reason given.
Italy	UAA in annual statistics is much larger than in the FSS	– The FSS excludes both the area of very small farms (under the fixed threshold) and the land not belonging to farms, whereas the annual surveys take into consideration all the areas in the country that are used for agriculture. – Annual surveys collect information on 'area under cultivation' (or 'harvested area' for permanent crops) for each crop requested in the first three tables of Regulation. 543/2009. However, in practice it is difficult to distinguish between the 'main area' and the 'secondary area' (for this reason, data on land use sent to Eurostat are in the form of estimates based on data collected as part of the annual surveys).
Cyprus	UAA figures in annual crops and in the FSS are almost identical	The FSS survey covers almost 100% of the UAA because the threshold used is the same for both annual and FSS surveys.
Latvia	The series L0004 Kitchen gardens is not available	The area of kitchen gardens has been allocated to the respective crop (mostly vegetables, potatoes or fruit trees).

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[6] http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/ef_esms.htm#meta_update

Member State	Data	Explanation
Luxembourg	UAA figures in annual crops and in the FSS are almost identical	– FSS is carried out every year in Luxembourg and the results are used to estimate the UAA in the annual statistics. – Due to the structure of the agricultural holdings in Luxembourg, the number of farms under the defined threshold is very low, with the result that the FSS data cover almost 100% of the UAA. FSS covers all the land (including permanent pastures).
Hungary	The figures for UAA in the annual statistics are much higher than the same figure in the Farm Structure Survey	No reason given.
Malta	UAA figures in annual crops and in the FSS are identical	– In Malta there are no permanent pastures. – The FSS does not apply any threshold.
The Netherlands	UAA figures in annual statistics are lower than in the FSS for certain years.	– UAA data are estimated on the basis of an annual sample survey of crop production. The scope of this survey is very similar to the FSS. Due to unavoidable survey errors, and in any event under the limits imposed by the legislation in force, the UAA reported in the framework of annual statistics is sometimes higher and sometimes lower than the UAA reported under the FSS framework. – Before 2007, the area of rough grazing was not included in the annual land use data. Since 2007, the FSS and the annual land use statistics are integrated and the differences no longer occur.
Austria	Some figures for UAA in the annual statistics are lower than the same figure in the Farm Structure Survey	– Common land is included in the FSS data. – The differences between the annual data and the FSS are small; this is due to the fact that different data sources are used for the land use data (FSS and administrative sources).
Poland	For some years, the figures for UAA in the annual statistics are much higher than the same figure in the Farm Structure Survey.	– Before 2002 the UAA in annual statistics also included non-farm land (the type is not clear). – Before 2008 the UAA in annual statistics also included unusable agricultural area.
Romania	Some figures for UAA in the annual statistics are lower than the same figure in the Farm Structure Survey. Kitchen gardens are not included before 2004.	– Romania does not use thresholds in the FSS and common pastures were not included in annual statistics before 2010. Therefore, the scope of the FSS and of the annual statistics survey was similar. – Since 2010, common pastures are included in the annual statistics but not in the FSS; it is therefore expected that UAA in the annual statistics will be higher than in the FSS. – Before 2004, data on kitchen garden areas were not collected separately and were attributed to the respective crop (mainly permanent crops).
Slovenia	Data on crops under glass are missing Data on kitchen gardens are missing	– The area of crops under glass is not significant – Data on kitchen gardens is not collected in Slovenia. Due to the structure of agricultural holdings and a large proportion of self-supply farming, it is impossible to separate the production consumed on farm and that intended for the market. Production for own needs is therefore included in each category of the annual data on crop production.
Slovakia	Some figures for UAA in	UAA data are estimated on the basis of an annual sample survey of crop

Member State	Data	Explanation
	the annual statistics are lower than the same figure in the Farm Structure Survey	production. The scope of this survey is very similar to the FSS. Due to survey errors that are impossible to avoid and in any case under the limits fixed by the legislation in force, the UAA reported in the framework of annual statistics is sometimes higher and sometimes lower than the UAA reported under FSS framework.
Finland	For some years, the figures for UAA in the annual statistics are lower than the same figure in the Farm Structure Survey.	– The figures in UAA and FSS data are almost identical because the FSS covers nearly 100% of UAA. – The UAA data are estimated on the basis of census data (the areas consists of the data of all farms). The FSS data are based on the sample survey (the areas are estimates). This is why for some years the figures may be different.
Sweden	For some years, the figures for UAA in the annual statistics are lower than the same figure in the Farm Structure Survey.	– There is no agricultural common land. – The data source for the UAA under FSS and the annual statistics is the same. UAA data are estimated on the basis of an annual sample survey on crop production. The scope of this survey is very similar to the FSS. Due to unavoidable survey errors, and in any case given the limits fixed by the legislation in force, the UAA reported in the framework of annual statistics is sometimes higher and other times lower than the UAA reported under the FSS framework.
United Kingdom	UAA in annual statistics is much larger than in the FSS	No reason given.

Further description

The frequency of data collection is every 2 years. This implies that the Member States are obliged to deliver the standard data every 2 years which can be based on a sample of farms but every 10 years a full scope survey is carried out in the form of an agricultural census. The most recent census took place in 2010 in all EU Member States. The data have been validated and most results are now published in the Eurostat database.

The survey data can only be derived in aggregated format at different geographic levels (Member States, regions, and for basic surveys also district level). The data can also be arranged by size class, area status, legal status of the holding, objective zone and farm type. The data are quality checked by the national collection offices and by Eurostat.

3.1.2 Farm Accountancy Data Network (FADN)

The Farm Accountancy Data Network (FADN)[7] is an annual survey carried out by all the Member States of the European Union. FADN data are collected every year from a sample of the agricultural holdings in the European Union. Holdings are selected to take part in the survey on the basis of sampling plans established at the level of each region in the Union. The methodology applied aims to provide representative data along three dimensions: region, economic size and type of farming. At this moment the FADN is the only source of microeconomic (farm level) data that is harmonised, i.e. the bookkeeping principles are the same in all

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[7] http://ec.europa.eu/agriculture/rica/index.cfm

countries. While the European Commission (DG-Agri) is the primary user of analyses based on FADN-data, aggregated data can be found in the Standard Results database[8].

Used definitions and classification of grassland
In FADN different types of grassland categories are specified for which data are collected. The definitions used in FADN are identical to those used in FSS (See Section 4.1.3). They include the three different permanent grassland categories:
1) Meadows and permanent pastures (var.150)
2) Rough grazing (var. 151)
3) Permanent grassland no longer used for production purposes and eligible for direct payments (var.314).

For these three types of grassland recorded some information is available on inputs and outputs. At least it is clear that only the meadows and permanent pastures (var. 150) are fertilised. The rough grazings are not fertilised, but only grazed. Additional data collected for these categories include:
1) The value of hay and/or grass sold off the farm is to be indicated under 'Sales'.
2) The value of hay and/or grass used as feeding stuffs for livestock can be indicated when marketable under 'Farm use'. This amount is also to be entered as costs of feeding stuffs produced on the farm
3) Costs of all purchased fertilisers and soil improvers

Unfortunately all three categories of additional information are only collected for the whole farm and are not attributable directly to the grassland categories above.

Further description
Currently, the annual FADN sample covers approximately 80,000 holdings. They represent a population of about 5 million farms in the 25 Member States, which cover approximately 90% of the total utilized agricultural area (UAA) and account for about 90% of the total agricultural production of the European Union. For the EU-27, that is including Bulgaria and Romania, the FADN represents about 6.4 million farms. This implies that the representation of the Utilised Agricultural area in FADN differs strongly per country because of the variation in economic size distribution of farms.

The stratification of the FADN sample is done using the information of the Farm Structure Survey (FSS) on distribution of the total EU farm population over size and (sectoral) type. The survey however does not cover all the agricultural holdings in the Union but only those which due to their size could be considered commercial. This implies that often part time farms and smaller extensive farms particularly occurring in Southern and Central and Eastern Europe are under-represented. However, because of the different farm structures in the European Union, it is necessary to specify separate size thresholds for each Member State.

The FADN data are available at individual farm level per FADN region. However, the accessibility to the individual farm data are restricted to FADN Liaison Agencies and permission to use the data needs to be obtained from DG-Agri. Data are only available at the FADN region level (Figure 5). Publication of the data in reports requires a minimal representation of the figure by more than 15 farms.

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[8] http://ec.europa.eu/agriculture/rica/diffusion_en.cfm
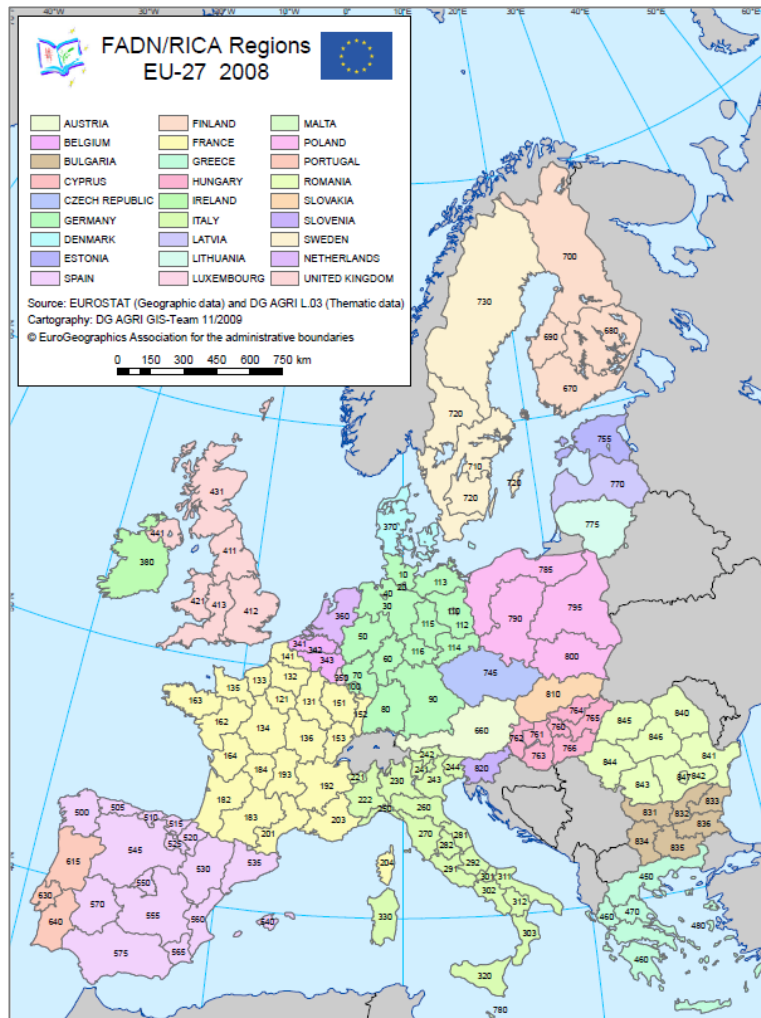
Figure 5. FADN regions

Data quality

First the National Liaison Agencies that are responsible for the collection of the FADN data apply their own quality control measures that may be higher or lower than the standard required by the Commission. When the data are considered error-free by the national Liaison Agencies they transmit the data to the Commission and submit it for inclusion with the quality procedures implemented by the Commission. The Commission then applies several control procedures on the aggregate data:

1) Check whether all farms are classified according to European Union typology
2) The coherence test: consists of several hundred tests that try to detect and identify possible errors, inconsistent data and improbable values.
3) The homogeneity test: helps to create sub-samples that are appropriate for special analyses. It identifies outliers, i.e. farms for which the value of one or more variables is significantly different from the mean value of the category to which the farm belongs.
4) Continuity test: computes the percentage of deviation between X and Y and if the result exceeds a predefined threshold an extra check on the data is made.
5) Correction procedure: data that need correction are returned to the National Liaison Agencies to either correct or to deliver a new farm return.

3.1.3   Eurostat Crop Statistics

Eurostat compiles a range of crop and land use statistics at both national and regional level[9]. Previous Council Regulations (EEC No 837/90 and EEC No 959/93) concerning statistical information on agricultural production to be supplied by the Member States have been amended several times. In 2009 these were replaced by one single act (EC No 543/2009). In order to ensure that the common agricultural policy is properly administered, the Commission requires that data on area, yield and production of crops are regularly provided.

Member States shall provide the Commission annually with the data on and on 1) crops from arable land 2) vegetables, melons and strawberries, 3) permanent crops and 4) agricultural land use, as defined in the Annex of EC No 543/2009. For crops marked with 'R' in the Annex data must be provided for the NUTS 1 and NUTS 2 territorial units defined in Regulation (EC) No 1059/2003. For Germany and United Kingdom there is an exception to report only at NUTS 1 territorial units. The reference period is the harvest year, and the first reference year is 2010.

Under Crops from arable land "Temporary grasses and grazing" is included, but reporting is only required at national level for area data, production data is not required. Under Agricultural land use "Permanent Grassland" is included, for which the area should be reported at regional level. However, the current available data set is not complete, as demonstrated by Table 3, especially at the NUTS 2 level the data coverage is lower.

Data quality
Member States have to provide every three years, and for the first time by 2011, the Commission (Eurostat) with reports on the quality of the data transmitted. The quality report should describe the organisation of the surveys and the methodology applied, the level of precision achieved for the sample surveys and the quality of sources other than surveys which are used.

Table 3. Frequency of reported statistics for Permanent grassland area for the period 2000-2010, based on the regional land use statistics (agr_r_landuse) from Eurostat website

Country	NUTS 0	NUTS 1	NUTS 2
Austria	100%	100%	100%
Belgium	82%	82%	82%
Bulgaria	64%		27%
Cyprus	91%		
Czech Republic	64%		73%
Denmark	100%		45%
Estonia	55%		
Finland	100%	100%	100%
France	91%	82%	82%
Germany	73%	97%	9%
Greece	45%		
Hungary	100%	100%	100%
Ireland	100%		100%
Italy	91%	82%	82%

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[9] http://epp.eurostat.ec.europa.eu/portal/page/portal/agriculture/data/database

Country	NUTS 0	NUTS 1	NUTS 2
Latvia	82%		18%
Lithuania	82%		
Luxembourg	82%		
Malta	9%		
Netherlands	100%	100%	100%
Poland	100%	100%	100%
Portugal	100%	100%	100%
Romania	100%	100%	100%
Slovakia	82%		100%
Slovenia	91%		36%
Spain	64%	55%	55%
Sweden	91%	36%	36%
United Kingdom	64%	91%	

3.1.4 Land Parcel Identification System (LPIS)

The land parcel information system (LPIS)[10] is the spatial register within the Integrated Administration and Control System (IACS). The IACS ensures that payments of the EU Common Agricultural Policy (CAP) are made correctly. LPIS identifies and quantifies agriculture land for the purpose of targeting CAP payments. The IACS/LPIS is operationalized by the paying agencies of each member state. The data is gathered each year through beneficiaries application forms that are filled out by each farmer receiving CAP payments. A minimum percentage of farms are cross checked in the field (Devos and Pavel, 2010).

Used definitions and classification of grassland
The CAP payments can only be targeted to agricultural land which is 'eligible'. Therefore the CAP Regulation defines agricultural area and categorizes land for "eligible hectares". Agricultural area is defined as any area taken up by arable land, permanent pasture or permanent crops. There is a clear distinction between temporary grassland (grassland less than 5 years without ploughing), categorized under 'arable land' and permanent pasture (grassland 5 years or more without ploughing).

LPIS distinguishes different types of permanent pasture:
- Permanent pasture (sown), defined as permanently cropped area with graminoid crop(s)
- Permanent pasture (selfseed), defined as closed medium to tall grassland
- Permanent pasture (selfseed with shrubs), defined as medium to tall grassland with medium high shrubs
- Permanent pasture (selfseed with sparse trees), defined as medium to tall grassland with low trees

Data quality
Each member state is obliged to maintain a reference layer for the LPIS data, in that way the parcel information can be cross-checked. Each Member State is free to choose the approach for the reference layer, so there exist differences in the quality check. Although following a framework of requirements laid down in the Regulations, LPIS is not standardised across Member States. The land cover codes used by the different Member States vary considerably. The Joint Research Centre (JRC) of the European Commission

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[10] http://ies.jrc.ec.europa.eu/our-activities/support-for-member-states/lpis-iacs.html

has reviewed all of the codes used and produced a list of ten standardised codes that are the most used. However, 70% of all the LPIS systems in the EU apply more codes than these 10 standardised codes[11].

3.1.5   LUCAS

Following a decision of the European Parliament, the European Statistical Office (EUROSTAT) in close cooperation with the Directorate General responsible for Agriculture and the technical support of the JRC, is organising regular, harmonised surveys across all Member States to gather information on land cover and land use. LUCAS stands for Land Use and Cover Area frame Survey. The aim of the LUCAS survey is to gather harmonised data on land use/cover and their changes over time. In addition the survey provides territorial information facilitating the analysis of the interactions between agriculture, environment and countryside.

LUCAS is an in-situ survey area frame survey, which means that the data is gathered through direct observations by the surveyors on the ground. Land cover data can also be obtained by photo interpreting satellite images or orthophotos as is done in the Corine Land Cover. The land cover/use statistics derived from the LUCAS survey are unique as they are fully harmonised (same definitions and methodology) and comparable over time and among Member States.

Used definitions and classification of grassland
The land cover and the visible land use are classified according to the harmonized LUCAS land cover and land use nomenclatures (see Section 4.1.6). The full survey supporting documents consist of field form, where all the measured variables are listed, surveyors' instructions, which give detailed instructions to the field surveyors and of the quality control procedures. The full description of the statistical data set is available in the land cover/use statistics metadata attached to the data[12].

Further description
The latest survey was carried out in 2012 of which the results are now available. In this LUCAS survey 265000 geo-referenced points were visited by more than 500 field surveyors on the spot. The points were selected from a standard 2 km grid including in total around 1 million points all over the EU. The selection of points is done on the basis of stratification information. The LUCAS 2009 survey included a soil survey. A top soil sample was collected at about 10% of the points (22000 locations). The objective of the soil survey is to improve the availability of harmonised data on soil parameters in Europe. The LUCAS soil survey was implemented in co-operation with DG Environment and DG Joint Research Centre. The soil samples have been analysed and the results are available[13]. Furthermore, there are maps produced on basis of LUCAS like grassland in agricultural use as share of land cover, by NUTS 2 regions for 2009 (Figure 6).

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[11] http://www.efncp.org/download/hungen2012/devos.pdf

[12] http://epp.eurostat.ec.europa.eu/portal/page/portal/lucas/introduction

[13] http://eusoils.jrc.ec.europa.eu/projects/Lucas/Data.html
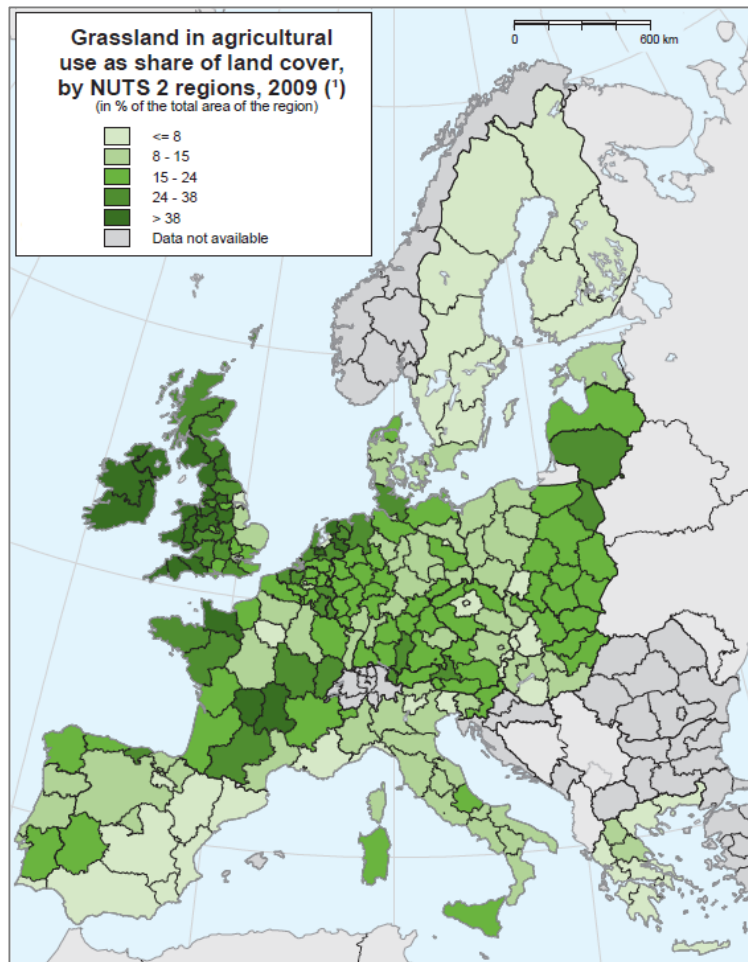
Figure 6. Grassland share at NUTS2 region based on 2009 LUCAS survey data

3.1.6   Economy-wide material flow accounts (EW-MFA)

The theory of Economy-wide material flow accounts (EW-MFA) includes compilations of the overall material inputs into national economies, the changes of material stock within the economic system and the material outputs to other economies or to the environment. In EW-MFA two types of material flows across system boundaries are relevant:

1. Material flows between the national economy and the natural environment: this consists of the extraction of primary (i.e., raw, crude or virgin) materials from and the discharge of materials to the natural environment;
2. Material flows between the national economy and other national economies. This encompasses imports and exports. Only flows that cross the system boundary on the input-side or on the output-side are counted. Material flows within the economy are not represented in EW-MFA.

EW-MFA are meta-compilations of data from various official statistics, most of which are regularly provided and updated by national statistical offices. It is mainly based on data from agricultural, forestry, fishery production, mining, and energy statistics. Import and export data are typically taken from foreign trade statistics although some countries use national accounts as the primary data source for the trade data. The

EW-MFA statistics are compiled by Eurostat[14], which provides guidance to the member states on the data collection.

EW-MFA has been included as one of three modules in Regulation (EU) No 691/2011 on European Environmental Economic Accounts which will enter into force with the 2013 data collection. This 2012 version of the EW-MFA Compilation Guide includes already all the provisions related to the legal base.

These accounts include data on domestic extraction of biomass (Eurostat, 2009). Biomass comprises organic non-fossil material of biological origin. The category A.1.2.2. "Fodder crops and grazed biomass" includes different types of roughage including fodder crops, biomass harvested from grassland and biomass directly grazed by livestock. Coverage of these large flows in statistics is usually poor. The most important types of fodder crops may be reported in harvest statistics (e.g. maize for silage, leguminous fodder crops, hay) and for some countries national feed balances exist from which data on biomass harvested from grassland and grazed biomass can be derived.

In case no reliable data for both fodder crops (A 1.2.2.1) and grazed biomass (A 1.2.2.2) exist, guidance is provide to estimate the total amount of biomass subsumed under A 1.2.2 (Eurostat, 2012). All grass type fodder crops and biomass harvested from meadows can be used either fresh (i.e. with a high moisture content; for immediate feeding or silage production) or at air dry weight (hay). These crops are accounted for at air dry weight, i.e., at a standardised moisture content of 15%.

Table 4. Classification of Eurostat crop and land use categories that belong to fodder crops and grazed biomass for EW-MFA statistics

Fodder crops (incl. biomass harvest from grassland)	C1381	Fodder beet
	C1383	Fodder kale
	C1384	Swedes
	C1385	Carrots for stockfeeding
	C1386	Turnips for stockfeeding
	C2611	Annual green fodder
	C2671	Clover and mixtures
	C2672	Lucerne
	C2673	Other legumes (sainfoin, sweet clover)
	C2681	Temporary grasses
	C2710	Permanent meadows
Grazed biomass	C2682	Temporary grazings
	C2721	Grassland
	C2722	Common pasture, heathland, rough grazings

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[14] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Material_flow_accounts
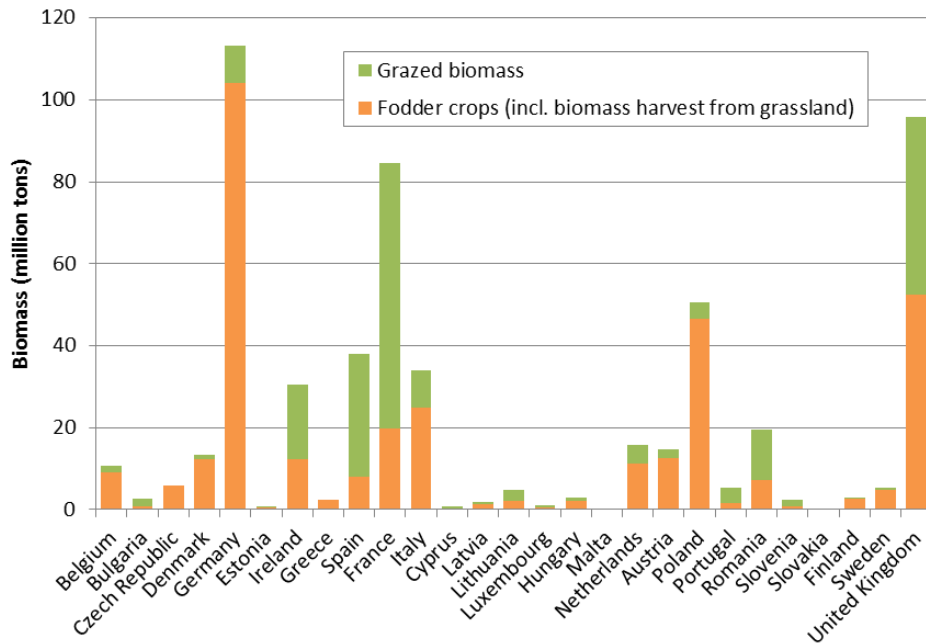
Figure 7. Biomass extraction per country for 2008, standardised at 15% moisture content

3.1.7 FAOSTAT

In FAOSTAT[15] under the land statistics (part of the Resource statistics), grassland categories are distinguished. The main distinction is between temporal and permanent grassland and also irrigated versus non-irrigated is distinguished and also the area under organic agriculture is indicated. However, for many countries these detailed classes are not available, see

Table 5. The used definitions and classification is explained in Section 4.1.4.

In the crop production statistics of FAOSTAT no data is available for grass, neither for other forage crops.

Table 5. EU member states reporting specific land categories related to grassland in FAOSTAT (for 2009)

Land category	Count
Agricultural area	27
Perm. meadows & pastures - Cultivated	11
Perm. meadows & pastures - Nat. grown	7
Perm. meadows & pastures Cult. & irrig	1
Perm. meadows & pastures Cult. non-irrig	1
Permanent meadows and pastures	26
Permanent meadows and pastures area certified organic	8
Permanent meadows and pastures area in conversion to organic	7
Permanent meadows and pastures organic, total	9
Temporary meadows and pastures	17

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[15] http://faostat3.fao.org/home/index.html#HOME

3.1.8 UNFCCC

Annex 1 countries[16] have to reported their GHG emissions annually to the UNFCCC for both the convention as for the Kyoto Protocol. In the Sector Land Use Land Use Change and Forestry (LULUCF) emissions from land use, land use change and forestry are reported. Here countries also have to report the areas of the main land use categories, of which grassland is well. These areas can be found in the national CRF tables. The IPCC guidelines give a definition for grasslands (see Section 4.1.5), but many countries use their own definition, depending on their national circumstances and data availability.

Area data on grassland remaining grassland, and land converted to grassland are reported in Table 5C. Grassland converted to forest land, cropland, settlements, wetlands and other land is reported in Tables 5A, 5B, 5D, 5E and 5F. Some countries make a sub-division of the category grassland, e.g. the Netherlands distinguishes 'Grassland' and 'Nature' in this category, where nature refers to the heathlands.

3.1.9 OECD

The data in the OECD Environmental data compendium are mainly derived from FAO, and have been supplemented by data from other international and national sources. OECD states that particularly for permanent grassland the comparability of data among countries is unsatisfactory.

Permanent grassland refer to land use for five years or more for herbaceous forage, either cultivated or growing wild.

Another data set by OECD is the Environmental Performance of Agriculture. This dataset provides the latest and most comprehensive data across OECD countries on the environmental performance of agriculture from 1990-2004, but seems to be no longer updated. A set of agri-environmental indicators has been developed through several specific theme-focused workshops involving OECD country analysts and scientific experts, complemented with thorough reviews of the literature.

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[16] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php

3.2 Study based sources

3.2.1 Pasture Knowledge Base (PASK)

The Pasture Knowledge Base (PASK)[17] is developed for the MARS (Monitoring Agriculture with Remote Sensing) STAT Action at DG-JRC EC. It contains a monograph on pasture systems in use in Europe, descriptions at national level and of the main varieties in use, mainly basing on a collection of existing information. It is divided into three main parts:

1. Overview of pasture resources and forage production systems at European level;
2. Main species description;
3. Review of main agro-meteorological models for grassland biomass estimation.

The PASK study describes, through an extensive review of literature, the pasture resources of EU 15 Member States and 13 Accession and Candidate Countries. The scope of the work was the collection of information on pastures and related agronomic practices, and the description of the most common species occurring in permanent and temporary grasslands. The trend analysis of grassland data on area, production and yield and the review of agro-meteorological models for the estimation of grassland biomass were also part of this study. The reference statistical data utilised in the study were those collected and harmonised by the statistical office of the European Union, EUROSTAT. Additional National sources have been included, whenever possible, to complement EUROSTAT information especially for Eastern European countries.

The PASK study faced a number of constraints such as a non-homogeneous level of information available by country, both qualitatively and quantitatively, different approaches adopted by the scientific communities to study and report on pastures and the existence of an uneven terminology. They concluded that there is a lack of standardised or comparable information and that the EUROSTAT categorisation of grassland data rarely corresponds to the classes adopted at national level for pasture and fodder crops.

The PASK study used the grassland categories as defined by EUROSTAT (Table 6), as officially published in "Methods and nomenclature. Crop Production, Glossary 2001" and in the "Manual for current statistics on crop products". As the PASK study was published in 2003, the harmonisation of data collected at country level was well ahead for EU 15 Member States but for the EU-12 member states, the official harmonisation process carried out by EUROSTAT was still underway. In national statistical publications a different nomenclature for grassland land use is often found. Frequently, national nomenclatures give emphasis to the peculiar resources of the country.

Table 6. EUROSTAT definitions of grassland categories as used for the PASK study

C2670	Perennial green fodder	They occupy the soil in a temporary way and are defined especially by the predominance of the legumes at the level of 80%. For this reason they are seldom grazed. It is accepted that legumes can be associated with graminaceous plants: – at the time of the establishment when the germination of the legume is protected by an annual graminaceous plant; – at the time of the establishment with a view to an association between the two families of plants; – after some years, when graminaceous plants take over

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[17] http://www.marsop.info/marsopdoc/pask/00000000.HTM

			spontaneously. The word fodder by definition implies animal feed which is cut to conserve or to feed fresh.
	C2671	Clovers and mixtures	Include the various species of clover, annual or perennial: Crimson red, white, Egyptian, of Persia (*Trifolium spp.*: *T. incamatum L., T.pratense L., T.repens L., T.alexandrinum, T.resupinatum*) and mixture will normally include grass species such as *Lolium perenne*.
	C2672	Lucerne	Types of lucerne cultivated alone, of major economic importance, the principal of which is *Medicago sativa L,* with *M.falcata* and hybrids.
	C2673	Other legumes for fodder	Include, inter alia: Sainfoin (*Onobrychis vicifolia* Scop.), sweet clover (*Lotus corniculatus* L.), vetches (*Vicia sativa, villosa, panonica*), chicking vetch (*Lathyrus sativus*), trefoil (*Medicago lupulina* L.), melilot (*Melilotus alba Lam*), sweet lupins (*Luoinus albus, angustifolius, luteus),* serradella (*Omithopus sativus),* fenugreek (*Trigonella foenum-graecum*), sulla (*Hedysarium coronarium*), etc.
C2680		Temporary grasses and grazings	They occupy the soil from one to five years and are made up of graminaceous plants or of grasses mixed with legumes and other species but graminaceous are the majority. Species generally include: perennial raygrasses (*Lolium perenne L. x boucheanum Kunth),* brome-grasses (*Bromus catharticus* Vahl, *B.sitchensis* Trin.), the cocksfoot (*Dactylis glomerata L.*), fescues meadows (*Festuca pratensis* Hudson) tall (*F.arundinacea* Schreber), other graminaceous plants such as perennial sorghum (*Sorghum sudanense* Piper Stapf.), timothy (*Phleum pratense),* tall oat grass (*Arrhenaterum elatius* Mert.), meadow foxtail (*Alopecurus pratensis L.).*
	C2681	Temporary grasses	Mainly harvested by mowing.
	C2682	Temporary grazings	Mainly harvested by grazing.
C0002		Permanent grassland (areas always covered by grass)	Grassy areas, sown or natural, in place for at least 5 years.
	C2710	Permanent meadows (grasses)	Data are collected on a land given to this use for at least 5 years, even if they are subject to manure or to some farming procedures. The flora is various and established according to biological communities by the natural environment and the land use. Includes: fescues: sheep's (*Festuca ovina*), and red (*F.rubra* L.), bents (*Agrostis canina* L., *A.stolonifera* L.), phalaris (*Phalaris aquatica* L.), meadowgrasses (*Poa* spp., *Poa arundinacea*), flying bentgrass (*Molinia coerulea* Moench), sweet vernal grass (*Anthoxanthum odoratum*), the small clovers (*T. subterraneum, T.campestre*). Other families are represented by the yarrow (Achillea), the plantain (Plantago spp.), Sanguisorba, the dandelion (Taraxacum dens-leonis): these have little or no grazing value, but may be used domestically or for traditional medicines. Meadows are used primarily for conservation as hay, but will also be grazed seasonally.
	C2720	Permanent grazings	The land has the same cover overall as above but they are devoted to the pasture. Primarily grazed, conservation, if any, is a secondary function.

C2721	Herbages	Areas devoted to pasture having a rather high yield of about 1500 fodder units per hectare. They are subject to farming interventions.
C2722	Rough grazings	Includes grassland areas, moors (grassland areas mixed of bushes as heathers (*Erica, Calluna*) or gorses (*Ilex*)), mountain pastures (alpine or high altitude pastures used in summer), all extensive pastures often located in fragile areas. They have low productivity, with yields below 1500 fodder units per hectare. 1500 fodder units meet the needs of one ABU (adult bovine unit) during 6 months.

3.2.2   FAO country pasture profiles

Similar to the PASK database of JRC there is also a website by FAO[18] with country pasture profiles worldwide. This is an initiative of the Grassland and Pasture Crops Group to make basic information about the pasture and forage resources of countries available on the internet. Each profile provides a broad overview of relevant general, topographical, climatic and agro-ecological information with focus on livestock production systems and the pasture /forage resource.

However, for the EU the coverage is not complete with information being available for only 12 member states (Belgium, Bulgaria, Czech Republic, Estonia, France, Hungary, Ireland, Latvia, Lithuania, Poland, Slovakia and United Kingdom).

Each country profile contains the following sections: introduction, soils and topography, climate and agro-ecological zones, ruminant and livestock production systems, pasture resource, opportunities for improvement of pasture resource and research and development organizations and personnel. Most information is descriptive and often tables with some statistics for specific years are included. However, the level of detail and information varies per country and no standard definitions for grasslands are used.

3.2.3   Biodiversity data centre

The Biodiversity data centre (BDC) managed by the European Environmental Agency (EEA) provides data and information on species and habitat types of European importance, red listed species in Europe, Natura 2000 sites and nationally designated areas in European countries. At the website of the BDC[19] several data sources and maps can be found. One of the maps is the overview of protected sites in Europe, including Natura 2000 sites and nationally designated areas (CDDA), see Figure 8. Natura 2000 is the key instrument to protect biodiversity in the European Union. It is an ecological network of protected areas, set up to ensure the survival of Europe's most valuable species and habitats. Nationally designated areas is a European inventory of protected areas designated by the national authorities.

In addition databases are available on the Annex 1 habitat and EUNIS habitat types, which classify amongst other habitat types the natural and semi-natural grasslands, see also section 4.2.1 and 4.2.2. Data on area of coverage and in which Natura 2000 site these habitats occur is available.

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[18] http://www.fao.org/ag/AGP/AGPC/doc/pasture/forage.htm

[19] http://biodiversity.europa.eu/data
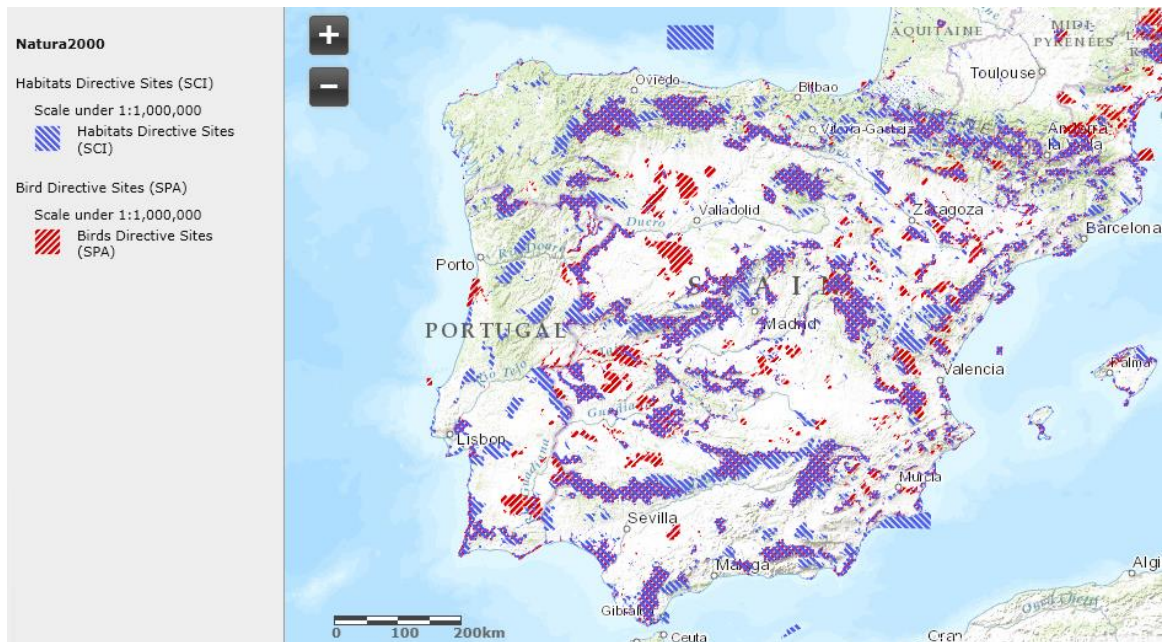
Figure 8. Example of mapped protected areas for Spain and Portugal (source EEA)

3.2.4 High Nature Value farmland

JRC/EEA updated the High Nature Value (HNV) farmland indicator (Paracchini, et al., 2008) and in 2012 a further update of the indicator was produced by the ETC-SIA for the EEA[20]. The HNV farmland indicator in this work refers to estimates of the share of agricultural land that is likely to be HNV, the so-called likelihood score. This assessment is based as much as possible on existing European wide datasets (CLC 2006, Natura 2000 sites, Important Bird Areas (IBAs), Prime Butterfly Areas (PBAs)). The selection of the classes per database allocated to HNV farmland are specific per environmental zone. For some countries also national specific information was used[21]. As the data is collected at the regional (NUTS 1 / 2) level, maps can be produced to demonstrate the geographic distribution of HNV farmland in the EU-27 and can be considered the best proxy for HNV farmland currently. They take account of the different levels of uncertainty associated with the mapping in different parts of Europe, by illustrating the likelihood of HNV farmland present. Table 7 provides a summary per country of the most recent estimate of the HNV farmland likelihood score[22].

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[20] The detailed description of the methodology and the data sources will be published by EEA in 2012: 'Updated High Nature Value Farmland in Europe - An estimate of the distribution patterns on the basis of CORINE Land Cover 2006 and biodiversity data'.

[21] The methodology applied for the update was the same as that used for the JRC/EEA HNV assessment based on CLC 2000 (Paracchini et al., 2008). It was based on CORINE land cover data available for the year 2006. It includes data for Malta that was previously missing and other updated datasets, e.g. the most recent Natura 2000 data. Data for Greece are still missing.

[22] The detailed description of the methodology and the data sources will be published by EEA in 2013: 'Updated High Nature Value Farmland in Europe - An estimate of the distribution patterns on the basis of CORINE Land Cover 2006 and biodiversity data'.

Table 7. Estimated share of HNV farmland in farmed area Source: EEA, forthcoming

Country[1]	HNV 2006 farmland area derived CLC 2006 - ha	Agricultural land (CLC 2006 agricultural classes + HNV areas) - ha	Utilized agricultural area - UAA- from EUROSTAT - ha	Area share of HNV - %
Austria	2,140,879	3,340,014	3,189,120	64.1
Belgium	435,153	1,780,001	1,374,450	24.4
Bulgaria	2,578,005	6,745,380	3,050,730	38.2
Cyprus	343,209	629,220	146,000	54.5
Czech Republic	1,190,319	4,625,715	3,518,070	25.7
Germany	3,248,177	21,508,158	16,931,890	15.1
Denmark	191,262	3,433,650	2,662,590	5.6
Estonia	531,554	1,605,575	906,830	33.1
Spain	18,820,501	33,698,696	24,834,240	55.8
Finland	1,268,980	2,992,428	2,292,280	42.4
France	8,023,118	35,204,602	27,355,830	22.8
Hungary	1,935,454	6,768,833	4,228,580	28.6
Ireland	1,154,495	5,729,074	4,139,240	20.2
Italy	6,196,451	18,393,993	12,744,200	33.7
Lithuania	640,277	4,011,830	2,648,950	16.0
Luxembourg	13,637	140,317	130,880	9.7
Latvia	569,534	2,848,613	1,773,840	20.0
Malta	1,034	15,666	10,330	6.6
Netherlands	390,551	2,570,614	1,914,320	15.2
Poland	4,488,811	19,750,026	15,477,190	22.7
Portugal	2,854,853	4,881,341	3,357,030	58.5
Romania	5,221,251	14,401,453	13,753,050	36.3
Sweden	1,166,103	4,311,707	3,118,010	27.0
Slovenia	570,551	754,220	488,770	75.6
Slovakia	479,205	2,413,272	1,936,620	19.9
United Kingdom	5,376,637	19,281,655	16,130,520	27.9

[1] Data for Greece are not yet available

There are three HNV types distinguished:
 − Type 1: Farmland with a high proportion of semi-natural vegetation.
 − Type 2: Farmland with a mosaic of low intensity agriculture and natural and structural elements, such as field margins, hedgerows, stone walls, patches of woodland or scrub, small rivers etc.
 − Type 3: Farmland supporting rare species or a high proportion of European or World populations.

As to the role of permanent grassland in the HNV farmland indicator it can be stated that this was not the purpose of the indicator development. So additional analysis is required to identify the permanent grassland share and location in this data set. Nevertheless it is clear that HNV farmland indicator could be a helpful data layer to be used to identify the location of particularly the semi-natural, rough and/or extensive permanent grassland categories in the EU. First of all it is clear that a majority of the HNV farmland consists of permanent grassland which is a logical result of the way it is mapped. The land cover approach adopted for HNV type 1 (and partly type 2) allows an approximation of the localisation of semi-natural vegetation, and to smaller degree of mosaics of low-intensity agriculture. The land cover classes selection is already prioritising to grassland and rough grazing areas while the arable mosaic land cover classes only make up a small proportion of the selected surface. This of course differs per country and environmental zone in the EU. In order to cover HNV type 3, information is needed on the location of farmland which supports rare species or a high proportion of European or World populations. This is gathered from various sources in which again the permanent and rough grazing areas dominate:

1. **NATURA 2000 network**, which provides information on protected sites that support rare, endangered or vulnerable natural habitats and species of plants or animals (areas designated under the Habitats Directive) and areas supporting significant numbers of wild birds and their habitats (protected sites designated under the Birds Directive). From the Natura 2000 sites in the EU-25, only those have been selected for which at least one Annex I habitat type related to agricultural activities is recorded. The overall selection comprises 11,293 sites that cover a total of 534,867 km^2 in the EU-25. Once the Natura 2000 sites had been selected, relevant agricultural areas within the site boundaries were mapped on the basis of agricultural CORINE Land Cover classes. This approach was also applied to IBAs and PBAs.

2. **Important Bird Areas (IBAs)**, which provide information on significant populations of one or more globally or regionally threatened, endemic or congregatory bird species, or highly representative bird assemblages. Data are compiled by BirdLife International and Partners. Important Bird Areas are identified on the basis of standard criteria agreed by the international BirdLife network. In Europe, the criteria take into account the requirements of regional conservation treaties such as the Emerald Network under the Bern Convention, the Helsinki Convention, the Barcelona Convention, as well as the Wild Birds Directive of the European Union.

3. **Prime Butterfly Areas** (PBAs) (Van Swaay and Warren 2003), which are an initial selection of important butterfly areas in Europe, focussing on target species that are conservation priorities across the European continent, and including both marginal and core populations.

4. **National biodiversity datasets** (when made available and suitable for inclusion). These refer mainly to national inventories of agricultural biotopes or semi-natural grasslands (e.g. in the Czech Republic, Sweden, Estonia, Lithuania and England). These have been added where national patterns of HNV farmland could not be captured by the presented land cover approach. An example of this is the parcels of semi-natural grasslands scattered through forested environments in the Nordic countries.

In all the data sets used the permanent grassland coverage is mostly dominating. This is also further enhanced by the national specific corrections that were applied once the selection of the EU wide data sources was made in the process of producing the HNV farmland indicator.
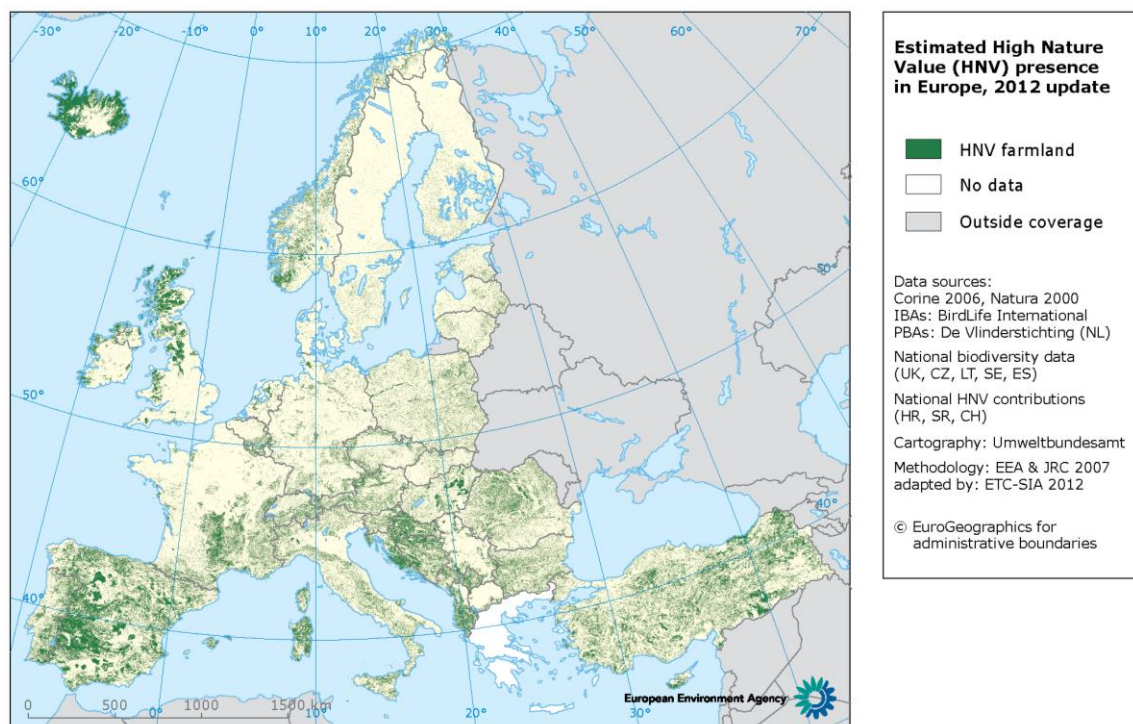
Figure 9. HNV Farmland areas 2012 update based on CLC 2006 data (Paracchini et al., 2008)

In order to use the HNV farmland map to derive the location of low input grassland areas one could overlay it with the HNV grassland and rough grazing categories to identify them spatially. Within the Natura 2000 areas there is also the possibility to select the mapped sites that refer to an Annex I site Annex I habitat type related to agricultural grassland activities.

3.3   Remote sensing based sources

In the sections below the following remote sensing based sources of grassland information are discussed: GlobCover, Global Land Cover 2000, CORINE, GIO HR grassland and Geoland2 HR grassland. Besides these sources other global land cover maps are available as well, such as the IGBP land cover map, the AVHRR Global Land Cover Classification by the University of Maryland and the USGS Global Land Cover Characteristics Data Base. However, these sources are based on remote sensing data from before 2000 and have not been updated anymore. Therefore we focus only on the most recent and Europe specific sources.

3.3.1   GlobCover

The GlobCover Land Cover Map was created by the ESA's GlobCover Project. The map displays land classification information for most of the Earth's surface at a resolution of 300 meter (9 ha per pixel) and contains 22 different land cover types, which are based on the predominant type of vegetation found at that location. The data was collected from the MERIS sensor on the ENVISAT satellite during 2009. There is also an older map, the Global Land Cover Product from the period 2005-2006. Both maps can be obtained from the ESA GlobCover website[23].

Figure 10.GlobCover database for the year 2009

GlobCover legend:
- 10 Rainfed croplands
- 11 Post-flooding or irrigated croplands
- 13 Post-flooding or irrigated croplands

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[23] http://ionia1.esrin.esa.int/

- 14 Rainfed croplands
- 20 Mosaic cropland (50-70%) /vegetation (grassland/shrubland/forest) (20-50%)
- 30 Mosaic vegetation (grassland/shrubland/forest) (50-70%) / cropland (20-50%)
- 40 Closed to open (>15%) broadleaved evergreen and/or semi-deciduous forest (>5m)
- 50 Closed (>40%) broadleaved deciduous forest (>5m)
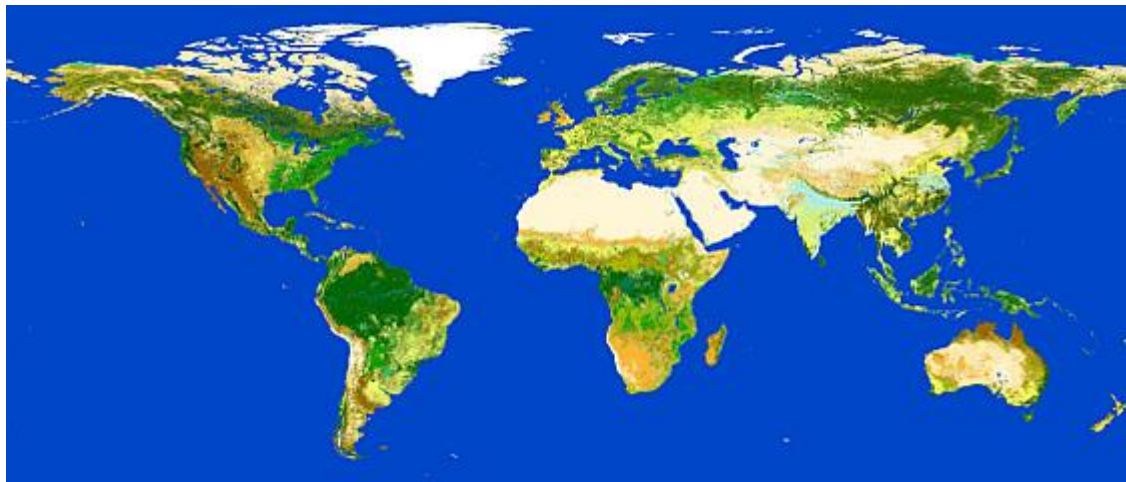- 60 Open (15-40%) broadleaved deciduous forest/woodland (>5m)
- 70 Closed (>40%) needle-leaved evergreen forest (>5m)
- 90 Open (15-40%) needle-leaved deciduous or evergreen forest (>5m)
- 100 Closed to open (>15%) mixed broadleaved and needleleaved forest
- 110 Mosaic forest or shrubland (50-70%) and grassland (20-50%)
- 120 Mosaic grassland (50-70%) and forest or shrubland (20-50%)
- 130 Closed to open (>15%) shrubland (<5m)
- 140 Closed to open (>15%) grassland
- 150 Sparse (<15%) vegetation
- 160 Closed (>40%) broadleaved forest regularly flooded, fresh water
- 170 Closed (>40%) broadleaved semi-deciduous and/or evergreen forest regularly flooded, saline water
- 180 Closed to open (>15%) grassland or shrubland or woody vgt on regularly flooded or waterlogged soil, fresh, brakish or saline water
- 190 Artificial surfaces and associated areas (Urban areas >50%)
- 200 Bare areas
- 210 Water bodies
- 220 Permanent Snow and Ice
- 230 no data

The global Globcover legend is compatible with the GLC2000 global land cover classification (http://www-tem.jrc.it/glc2000/legend.html) and the Land Cover Classification System (LCCS) developed by FAO (see Section 0). Grassland is mapped in mosaic/composite land cover classes 20, 30, 110 and 120 (+ 140).

3.3.2 GLC2000

The global land cover data for the year 2000 (GLC2000) project[24], coordinated by the European Joint Research Centre (JRC), provides consistent global land cover information for the year 2000. The GLC2000 project followed a bottom-up approach to map world's land cover. The global land cover map was derived by merging 18 regional products made by regional experts. Consistency between the regional products was derived by classifying SPOT4-Vegetation dataset (spatial resolution 1km) and applying the land cover classification system (LCCS) produced by the United Nations (UN) (Di Gregorio, 2005). After harmonization and merging the individual regional products one global GLC2000 product with a generalized legend was produced (Bartholomé and Belward, 2005). The GLC2000 database has 22 classes (see Table 8 and Figure 11).
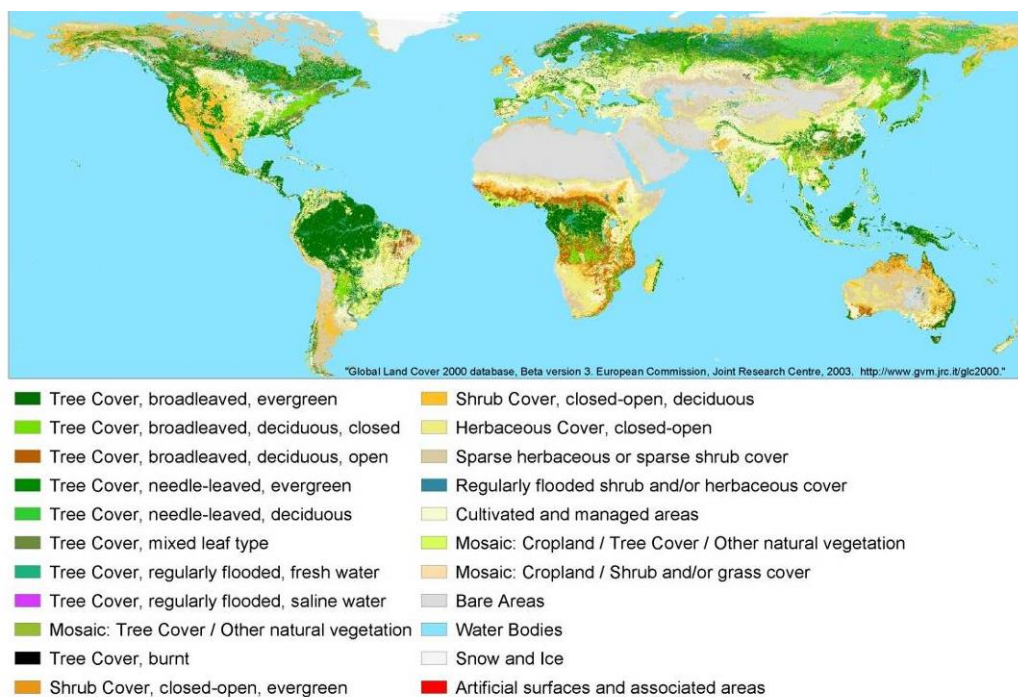
Figure 11.The Global Land Cover dataset for the year 2000 (GLC2000)

Table 8. GLC2000 legend aggregated from regional classes using LCCS

Nr.	GLC Global Class (according to LCCS terminology)
1	**Tree Cover, broadleaved, evergreen** *LCCS >15% tree cover, tree height >3m* (Examples of sub-classes at regional level: *closed > 40% tree cove; open 15-40% tree cover*)
2	**Tree Cover, broadleaved, deciduous, closed**
3	**Tree Cover, broadleaved, deciduous, open** *(open 15-40% tree cover)*
4	**Tree Cover, needle-leaved, evergreen**
5	**Tree Cover, needle-leaved, deciduous**
6	**Tree Cover, mixed leaf type**
7	**Tree Cover, regularly flooded, fresh water** (& brackish)
8	**Tree Cover, regularly flooded, saline water,** (daily variation of water level)
9	**Mosaic: Tree cover / Other natural vegetation**
10	**Tree Cover, burnt**
11	**Shrub Cover, closed-open, evergreen** (Examples of sub-classes at reg. level: (i) sparse tree layer)
12	**Shrub Cover, closed-open, deciduous** (Examples of sub-classes at reg. level: (i) sparse tree layer)
13	**Herbaceous Cover, closed-open** (Examples of sub-classes at regional level: (i) natural, (ii) pasture, (iii) sparse trees or shrubs)
14	**Sparse Herbaceous or sparse Shrub Cover**

15	**Regularly flooded Shrub and/or Herbaceous Cover**
16	**Cultivated and managed areas** (Examples of sub-classes at reg. level: (i) terrestrial; (ii) aquatic (=flooded during cultivation), and under terrestrial: (iii) tree crop & shrubs (perennial), (iv) herbaceous crops (annual), non-irrigated, (v) herbaceous crops (annual), irrigated)
17	**Mosaic: Cropland / Tree Cover / Other natural vegetation**
18	**Mosaic: Cropland / Shrub or Grass Cover**
19	**Bare Areas**
20	**Water Bodies** (natural & artificial)
21	**Snow and Ice** (natural & artificial)
22	**Artificial surfaces and associated areas**

3.3.3 CORINE land cover

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 (CLC). Up to now three maps have been produced (1990, 2000 and 2006) and the fourth (2012) is currently under development. Feranec et al. (2012) presents an overview of land cover and its change in Europe for the period 1990-2006 based on the CLC maps.

CLC 1990
The reference year for this database is 1990 (range 1986 – 1995) and its geographical extent covers 24 countries (most of the EU-27, except Sweden, Finland and United Kingdom) [25]. The land cover information is derived from high resolution satellite data (Landsat-TM) by computer assisted visual interpretation in combination with ancillary data. The minimum mapping unit is 25 ha and for line elements the minimum width is 100m. The scale of the land cover database is 1:100.000.

CLC 2000
The reference year for this database is 2000 (range 1999 - 2001) and its geographical extent covers all EU 27 and countries belonging to EFTA4 and EEA32 [26]. The land cover is derived from the Landsat-7 ETM single date satellite data. The basic parameters of CLC2000 are the same as those of CLC 1990 inventory (i.e. minimum mapping unit of 25 hectares, minimum width of linear elements: 100 metres and standard CLC nomenclature). This data set has been widely used for many environmental assessments and policy driven research questions, see e.g. Figure 12. Dominant landscape types in Europe based on CLC 2000Figure 12.

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[25] http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-clc1990-100-m-version-12-2009

[26] http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-raster-2
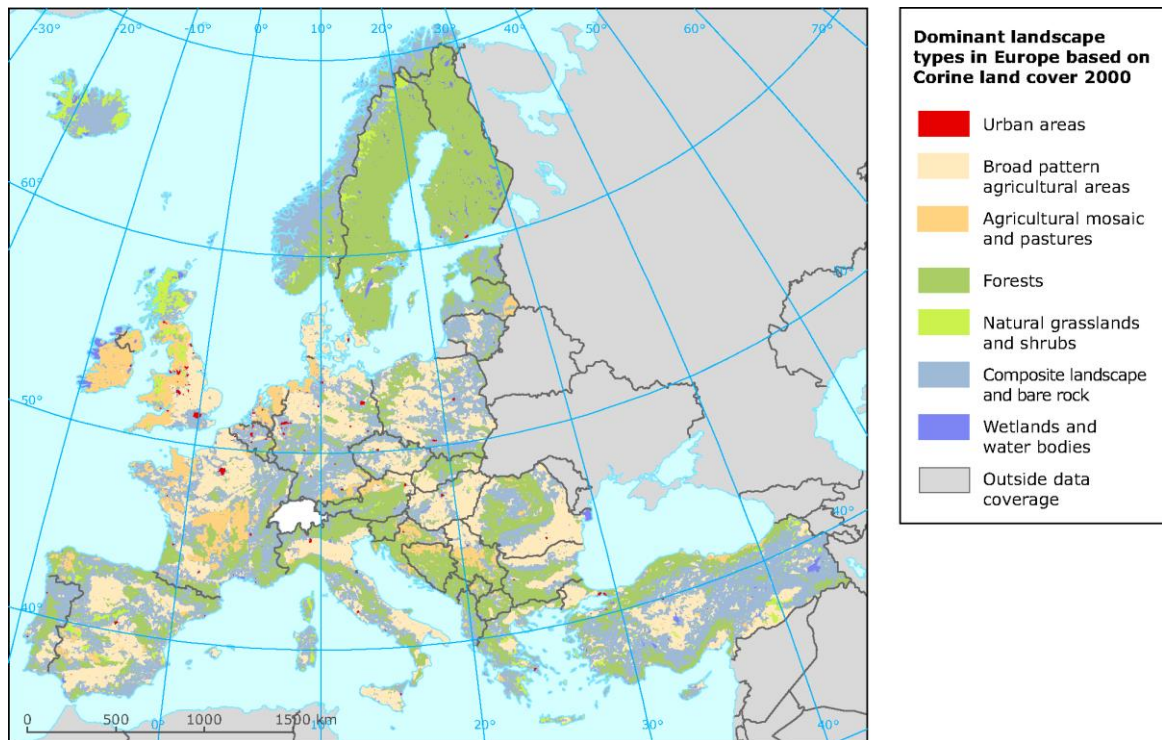
Figure 12. Dominant landscape types in Europe based on CLC 2000[27]

CLC 2006

The reference year for this database is 2006 (range 2005 - 2007) and its geographical extent covers all EU-27 countries, except Greece[28], and neighbouring countries and all EEA Member countries (38 countries in total, see Figure 13). The land cover is derived from the SPOT-4/5 and IRS P6 LISS III dual date satellite data. The basic parameters of CLC2006 are the same as those of previous CLC inventories (i.e. minimum mapping unit of 25 hectares, minimum width of linear elements: 100 metres and standard CLC nomenclature). More details can be found in Büttner et al. (2012). A comparison of the different parameters for the CLC 1990, 2000 and 2006 version is provided in Table 9.

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[27] http://www.eea.europa.eu/data-and-maps/figures/dominant-landscape-types-in-europe

[28] http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-2
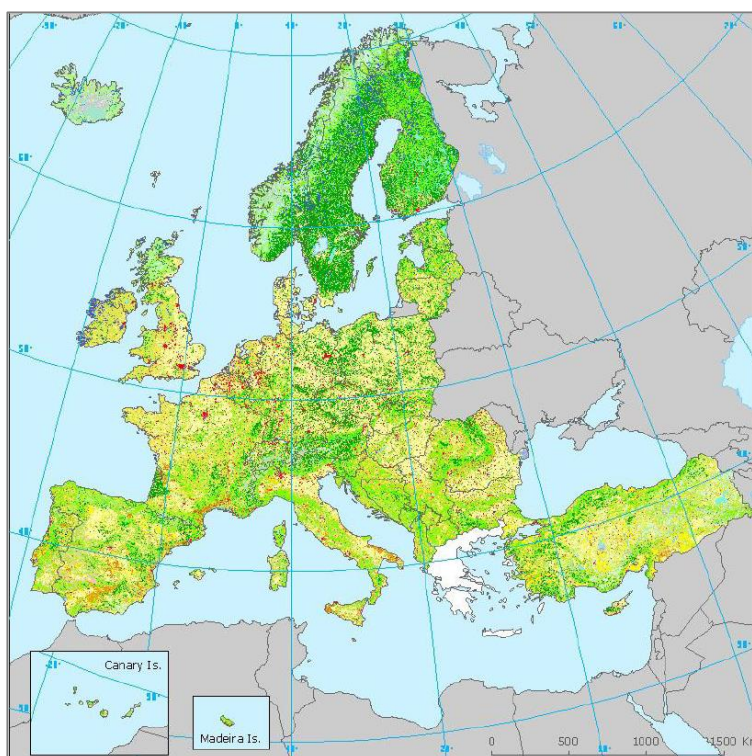
Figure 13. Corine Land Cover map 2006

Table 9. Evolution CORINE Land Cover projects (Büttner et al., 2012).

Parameter	CLC 1990	CLC 2000	CLC 2006
Main satellite data	Landsat-4&5 MSS/TM single date	Landsat-7 ETM single date	SPOT-4/5 and IRS P6 LISS lll dual date
Time consistency	1986-1998	2000 +/- 1 year	2006+/- 1 year
Geometric accuracy satellite images	≤ 50 m	≤ 25 m	≤ 25 m
CLC mapping min. mapping unit/width	25 ha/ 100m	25 ha/ 100m	25 ha/ 100m
Geometric accuracy CLC data	100 m	better than 100 m	better than 100 m
Thematic accuracy	≥ 85% (probably not achieved)	≥ 85% (achieved [6])	≥ 85% (not checked)
Change mapping	not implemented	boundary displacement min. 100 m; change area for existing polygons ≥ 5 ha; for isolated changes ≥ 25 ha	boundary displacement min.100 m; all changes > 5 ha are to be mapped
Production time	10 years	4 years	planned: 1.5 years realised: 3.0 years
Documentation	incomplete metadata	standard metadata	standard metadata
Access to the data	unclear dissemination policy	dissemination policy agreed from the start	free access for all kinds of users (CLC data)
Number of European countries involved	26	30	38

Used definitions and classification
The final CLC database consists of a geographical database describing land cover/use in 44 classes grouped into a three level hierarchical structure. The CORINE land cover nomenclature has 5 major categories at the first level, 15 land cover categories at the second level and 44 categories at the third level. More information is provided in Section 4.1.7 and in Annex 1 examples for the different pasture types are provided.

3.3.4   GIO HR grassland

GIO HR stands for GMES (Global Monitoring for Environment and Security) Initial Operations High Resolution. A high resolution data set of permanent grassland will be produced. The analysis will use the three reference years (2006, 2009, 2012) to detect the permanent presence of grassland. The discrimination of permanent grassland from other agricultural land areas such as arable land, bare soil, needs to take into account seasonal variations. A minimum of 3 (worst case), an average of 4-5 and up to maximum 8 seasonal images of AWiFS data (reference year 2012) will be used as additional information for the classification process. Resolution will be 20 m x 20 m, and statistical validation will be carried out on the 100 m x 100 m data. Required minimum accuracy is 80%.

Grassland is defined as ground covered by vegetation dominated by grasses and other herbaceous plants with dominantly agriculture use. Grassland includes the following landscape types:
-    Pastures, grassland used for grazing or hay production (CLC classes 2.3.1, but also appears in classes 2.1.1 to 2.4.4).
-    Cultivated or semi-natural grassland within forests, and grass covered surfaces with-in transitional woodland (appears in CLC classes 3.1.1-3.1.3, 3.2.4).
-    Natural grassland in any surrounding (CLC class 3.2.1).
-    Grassy areas with low (10%) fraction of scattered trees and shrubs.
-    Alpine meadows with low fraction of bare rock or gravel.

Land covers not to be considered as grassland:
-    Grassland in urban areas: parks, urban green in residential and industrial areas.
-    Grass surfaces in sport and recreation areas, incl. golf courses.
-    Clearcut areas, new forests.
-    Areas of shrubs: areas dominated by moors and heathland (Atlantic, CLC class 3.2.2) or sclerophyllous vegetation (Mediterranean, CLC class 3.2.3).
-    Surfaces covered exclusively by mosses and lichen (Subarctic).
-    Peatland (either in natural condition or in excavation, CLC class 4.1.2).

3.3.5   Geoland2 HR Grassland

Within the GMES initiative (Global Monitoring for Environment and Security) the Land Services provide cross-border harmonised geo-information at global to local scales in a time- and cost-effective manner. Building upon previous project, Geoland2 aims to organise a qualified production network, to build, validate and demonstrate operational processing lines and to set-up a user driven product quality assurance process. One of the core mapping services is EUROLAND which provides land cover, land use and land cover change data. EUROLAND addresses both the local and the continental component (i.e. high spatial resolution, wall-to-wall land cover parameters and land cover change).

The concept and product specifications are based on the latest consolidated user requirements (on a high common European level) for high resolution (HR) layers as presented in the project and service

specifications[29]. For the HR grassland layer, a multi-criteria approach is requested for characterisation. This approach would lead to a GL mask, which is being subdivided according to the following four criteria:

- Wetness,
- Intensity of use,
- Mixture with high vegetation elements, and
- Cover density (grass)

Based on feasibility criteria of the earth observation (EO) based approach, the developed overall concept will serve the following layers:

- A grass surface indicator (primary probability layer),
- A grass surface mask (secondary layer),
- An arable land mask (annual crops),

plus the following intensity layers (secondary layers), specified and described in detail below:

- Shrub and trees indicator (corresponding to "Mixture with high vegetation elements"),
- Grass density indicator (corresponding to "Cover density"), and
- Cutting indicator (addressing "Intensity of Use").

The maps will be at high resolution of 60 m x 60 m pixels, based on AWiFS data with a minimum mapping unit of 1 ha. Only the AWIFS data provide currently the necessary multi-temporal data coverage for an economic price – about 4 to 6 dates are necessary, depending on the significance in the vegetation season. The Geoland2 HR grassland layer has so far only been produced for three case study areas in Germany, Austria and Greece[30].

Definition of the Primary product - Grass Surface Indicator (EL-01a1)

The Grass surface indicator is a thematic map that shows continuous EO-defined probability (1-100%) of grass surface occurrence, typically aggregated to discrete percent classes. The map is produced by help of multi-temporal EO derived supporting data sets and other HR Layers, i.e. Soil sealing, Forest area map and Water map. The indicator provides information about the spatial extent of grass covered surfaces. The probability degrees derived for this layer reflect the level of resemblance of each pixel to the expected spectral-phenological behaviour of grass surfaces. E.g., extreme temporal variability of the spectral vegetation response may point to an arable area rather than grass surface, which can be expected to be more steadily vegetated throughout the year (in humid temperate climate). In this respect, geographically (climate, soils, elevation, etc.) induced variability of grassy surfaces throughout the year will be taken into account by means of an eco-region based stratification.

Grass surfaces captured in this layer contain grassland and grassy surfaces of any use and management, e.g. pasture, cultivated meadows, lawn used for sports, etc., together with grass surfaces with shrub and trees present. The layer itself does now allow for distinguishing different habitats. According to the conceptual approach, the specification of grass surface layer is limited with regard to built-up areas and forest. The forest and build-up land cover classes have been excluded from the processing, even though there may be grass covered surfaces under the tree canopy or in between the trees (regarding low forest cover) or the buildings. On the other hand, the Grass surface indicator includes areas across a broad probability range, meaning that pure grassy surfaces and surfaces with partially "grassy behaviour" are contained in the layer.

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[29] http://www.gmes-geoland.info/project-documentation/product-service-specifications.html

[30] http://www.geoland2.eu/portal/service/ListService.do?serviceCategoryId=CA80C481

Nomenclature:

Grass Surface Indicator
- Covering areas with vegetation of full or partial grass-like phenological behaviour (site-specific) that does not belong to forests and built-up areas
- mapped in continuous probability percent (1-100%) that can be aggregated to discrete map and such suit different customer needs
- pixel-based product (60 m)
- Linear (e.g. roads) features are included if smaller than the defined MMU

Definition of the Secondary product - Grass Surface Mask (EL-01b1)

The grass Surface mask is derived as a binary layer from the Grass Surface probability map via thresholding the probability levels. The determination of the appropriate threshold is evolving during production and cannot be specified a prior. It can be defined that the layer covers areas where grass constitutes the dominant surface (>50%). The Grass Surface Mask is the spatial framework for the set of intensity layers for the further characterisation of grassy surfaces (Shrub and trees, Grass density, and Cutting indicator). That means, these indicators will be derived within the Grass Surface Mask only.

Nomenclature:

Grass Surface Indicator
- Grass area mask includes: grass dominant (>50%) surfaces, pastures, cultivated meadows, lawn used for sports, together with grass surfaces with shrub and trees present
- Pixel-based product (60 m), the grass area mask is mapped with 1 ha minimum area / 60 m width

Definition of the Secondary Grassland product - Grass Vegetation Density Indicator (EL-01b4)

The Grass Vegetation Density Indicator provides information on grass vegetation density, the maximum of Leaf Area Index – LAI (m^2/m^2) during vegetation period, within the Grass Surface mask.

The Grass Vegetation Density Indicator is derived from biophysical EO parameter LAI that differentiate vegetation according to their leaf area cover, the leaf density. On a regional scale, it allows separating areas of high(er) from low(er) grass vegetation density. In as much as intensely managed grass parcels have potentially higher vegetation productivity compared to less intensely managed or natural grass surfaces, this indicator is also related to the intensity of grass management. Local/regional environmental conditions play an important role for the indicator, hence regional contextual interpretation of the indicator is required.

Nomenclature:

Grass Vegetation Density Indicator
- Mapped in relative density values 0-100, which correspond to Leaf Area Index (m^2/m^2)
- Can be aggregated to discrete ranges and thus be customised
- pixel-based product (60 m)
- 1 ha minimum area / 60 m width is inherited in the indicator from the Grass Surface mask area
-

Definition of the Secondary Grassland product - Cutting Indicator (EL-01b5)

The Cutting Indicator provides information on grass cutting and/or grazing on a relative scale from 0 to 100% within the Grass Surface area mask. The values refer to the intensity and/or frequency of green vegetation biomass change during main vegetation period. The Cutting Indicator is derived from multi-

temporal EO parameters that show the biomass changes during the main vegetation period. The proper calculation of this indicator is highly sensitive to availability of frequent multi-temporal EO images, especially during the high vegetation period. This indicator aims at detecting presence of cutting, but also grazing that is not separated as different management. The separation of the two ways of agricultural uses and its combination is practically not possible. The cutting indicator is a partial indicator for the intensity of use of the grass covered areas.

Nomenclature:
Cutting Indicator
- Mapped in relative intensity values 0-100%
- Can be aggregated to discrete percent ranges and thus be customised
- pixel-based product (60 m)
- 1 ha minimum area / 60 m width is inherited in the indicator from the Grass Surface mask area

3.4   Analysis of possible sources of grassland data

This Chapter will analyse and compare the different sources of grassland data that are available at European level. Table 10 provides an overview of the characteristics of the main data sources that were discussed in the   previous   sections.   In

Table 11 we have assessed the grassland data sources for several criteria which determine the usefulness for data collection on grasslands to create a coherent European dataset that serves European policy needs. White indicates that the data source has a high potential when evaluated against the criterion, grey a moderate potential and black a low potential.

The following criteria were included: clear harmonized definitions, spatial coverage, spatial resolution, temporal coverage, temporal resolution, grassland productivity data and availability. The 'clear harmonized definitions' refer to the presence of clear and distinct definitions and / or classification for grasslands that are used in a harmonized manner within the EU countries. Spatial coverage refers to the number of EU countries that are included, while spatial resolution refers to the scale at which the data is collected (e.g. field or farm scale or national scale). Temporal coverage refers to the number of years for which the data is available, while temporal resolution refers to the frequency of data collection, e.g. every year or less frequent. Grassland productivity refers to the availability of productivity data in the data source and availability refers to accessibility (e.g. public available) as well as easiness to obtain the data (e.g. easy downloadable, completeness of data records).

Table 10. Summary of characteristics of grassland data sources

Name of data source	Type of data collection	Classification method	Clear harmonized definitions	Spatial coverage	Spatial resolution	Temporal coverage	Temporal resolution	Grassland productivity data
FSS	Sample every 2/3 years and full census every 10 years	Following the definitions in the EC regulation (1999) and updated Regulation 1200/2009	Yes	EU-27 + Norway, Switzerland, Croatia	FSS regions (Nuts 2/3)	For EU-27 from 2003-2007, 2010 census expected to be available in 2013. For EU-15 data go back to 1990	2/3 yearly	No
FADN	Stratified sample among farms	From an economic perspective in order to allocate both costs and returns to the classes	Yes, same as FSS	EU-27	FADN regions	1999 - 2003 (only EU-15) and 2004 - 2010 (EU-27)	Annual	Yes, indirectly via monetary outputs, but not always possible to relate directly to grassland
Eurostat crop statistics	National / regional statistics based on surveys	Following EC regulation 543/2009	Less clearly defined compared to FSS, although in practice might be the same	EU-27	National and for some items regional (NUTS1/2)	Starting from 1974 for some MS up to most recent year 2011	Annual	Some countries do report production data as well
LPIS	Farmers survey	Farmers judgement on temporal / permanent grassland	No, LPIS is not standardised and land cover codes very among different Member States	EU27 (only eligible area, many semi-natural grasslands are not considered yet as eligible for the CAP	Parcel size	1992 - 2012	Annual	could be derived
LUCAS	(point) field sampling	LUCAS land cover and land use nomenclatures	Yes, very good harmonized protocol for survey	samples in EU-27 countries	Selection of points (±25%) of 2 km grid	Some earlier pilot years, 2009, 2012	Every 3 year	No
EW-MFA	Statistics	Following Eurostat Crop Statistics	Same as Eurostat crop statistics	EU-27 (+ Norway, Switzerland, Croatia and Turkey)	National	1990-2010 (although before 2000 many gaps)	Annual	Yes

Name of data source	Type of data collection	Classification method	Clear harmonized definitions	Spatial coverage	Spatial resolution	Temporal coverage	Temporal resolution	Grassland productivity data
FAOSTAT	National statistics	Following FAOSTAT definitions	Yes, clear and elaborated definitions are used	Global	National	1961 - 2009	Annual	No
UNFCCC	Country specific, combination of statistics and RS	Country specific, combination of statistics and RS	No, although the IPCC guidelines provide default definitions, most MS use their own definition	Annex 1 countries, incl. EU member states, except Malta and Cyprus	National	1990-2010	Annual	No
OECD	National statistics	Following FAOSTAT	Same as FAOSTAT but less extensive	OECD countries	National	1990-2004	Annual	Yes
PASK study	Statistics	Statistics and description	No, although (an old) Eurostat definition is used, most data are based on national classifications	EU-27 (+ Turkey)	National	Trend till 2002, starting year differs per country	Single review of statistics in 2003	For some countries and some fodder crops
GlobCover	Satellite derived	Semi-automatic	No, satellite derived and based on land cover with several mixed classes	global	300 m grid cell	2009	Once	No
GLC2000	Satellite derived	Semi-automatic	No, satellite derived and based on land cover with several mixed classes	global	1 km grid cell	2000	Once	No
CORINE land cover	Satellite derived	Visual/semi-automatic	Good classification scheme, but some mixed classes and remains mainly satellite derived	EEA32+ for 2012, for previous years less countries, EU-27 MS were all included except for 1990 (Sweden and Finland missing)	100 m grid cell	1990, 2002, 2006, 2012	Several years	No
GIO HR grassland	Satellite derived	Semi-automatic	Same as CORINE land cover	EEA32+	20 m grid cell	2006-2012	Once	No
Geoland2 HR Grassland	Satellite derived	Semi-automatic	No, based on different earth observation techniques with sometimes gradual classes	In principal for EEA32+, currently only for some case study areas	60 m grid cell	2006	Once	No

Table 11. Assessment grassland data sources (white is good, grey medium and black bad performance on criteria)

Name of data source	Clear harmonized definitions	Spatial coverage	Spatial resolution	Temporal coverage	Temporal resolution	Grassland productivity data	Availability
FSS	white	white	grey	white	grey	black	white
FADN	white	white	grey	white	white	grey	white
Eurostat crop statistics	grey	white	grey	white	white	grey	white
LPIS	black	white	white	white	white	grey	black
LUCAS	white	white	grey	grey	grey	black	white
EW-MFA	grey	white	black	white	white	white	white
FAOSTAT	white	white	black	white	white	black	grey
UNFCCC	black	white	black	white	white	black	grey
OECD	grey	grey	black	grey	white	white	grey
PASK study	grey	white	black	grey	grey	grey	white
GlobCover	black	white	white	grey	black	black	white
GLC2000	black	white	white	black	black	black	white
Corine Land Cover	grey	grey	white	grey	grey	black	white
GIO HR grassland	grey	white	white	grey	black	black	grey
Geoland2 HR Grassland	black	grey	white	black	black	black	grey

The   assessment   as   presented   in

Table 11 shows that there is no data source that scores well on all criteria. In general the remote sensing based sources have a low score on criteria as clear and harmonized definitions, the temporal coverage and resolution and the lack of data on grassland productivity. The statistical sources perform lower on the spatial resolution and most also lack data on data on grassland productivity. FSS and FADN statistics score both well, only FSS is lacking the grassland productivity data and has not an annual frequency. LPIS data only score bad at the clear harmonized definitions and on the public availability aspect. However, both could be improved with Eurostat support, which would make this a very valuable data source. When detailed grassland locations are needed the Corine Land Cover map and related products are most useful, while LUCAS is more valuable for general and regional trends in grassland areas and use, as this is the grassland data source that is most harmonized among EU member states.

Besides the assessment of the grassland data sources, as presented in Table 10 and Table 11, we have also assessed the different data sources from a policy data demand perspective (Table 12). In Chapter 4.3.1 we have identified the different data needs on grassland for different EU policy areas. For these data needs we made an assessment whether the current available data sources provide the required data. However, this assessment does not consider the temporal and spatial dimension and resolution, see previous tables, at which the data is available. It is clear that almost all data sources have information on grassland areas, but for the other data needs the potential data sources are limited or not available at all. Many of the data sources also provide only the indirect information from which a specific data need can be derived. For example, grassland yields are often only indirect available (e.g. FADN provides it in financial terms) or from scattered or descriptive sources (e.g. Eurostat crop statistics and the PASK study).

Table 12. Overview of grassland data sources in relation to data needs from a policy perspective

Data needs	FSS	FADN	Eurostat crop statistics	LPIS	LUCAS	EW-MFA	FAOSTAT	UNFCCC	OECD	PASK study	GlobCover	GLC2000	Corine Land Cover	GIO HR grassland	Geoland2 HR Grassland
Grassland area	x	x	x	x	x		x	x	x	(x)	x	x	x	x	(x)
Grassland yield		(x)	(x)	(x)		(x)			x	(x)					
Biodiversity value					(x)					(x)			(x)		
Permanency	(x)	(x)	(x)	x	(x)		(x)	(x)					(x)	x	(x)
Status of grazing	(x)	(x)			(x)										x
Status of fertilization		(x)													
Status of tillage	(x)				(x)										
Status of cutting		(x)													x
Area non-grasslands which are grazed	(x)				(x)										
Amount of manure from grazing on non-grasslands															

4 Review on current definitions and classifications of grassland

4.1 Overview different definitions and classifications

The definition of land cover is fundamental, because in many existing classifications and legends it is confused with land use. Land cover is the observed (bio)physical cover on the earth's surface. Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it. Definition of land use in this way establishes a direct link between land cover and the actions of people in their environment. For example, "grassland" is a cover term, while "rangeland" or "tennis court" refer to the use of a grass cover (Di Gregorio, 2005). In general data sources derived by remote sensing refer to land cover, while statistical sources refer to land use.

An often cited definition is from White et al. (2000), who defined grasslands as terrestrial ecosystems dominated by herbaceous and shrub vegetation and maintained by fire, grazing, drought and/or freezing temperatures. This is a broad definition that encompass not only non-woody grasslands but also savannas, woodlands, shrublands, and tundra. The focus of their study was on global scale mapping of grasslands and a strong emphasis on (semi) natural grasslands. Below we present an overview of different definitions and classifications of grassland that focus more on the European and agricultural context.

4.1.1 International terminology for grazing lands and grazing animals

In 1991, Terminology for Grazing Lands and Grazing Animals was published with the objective of 'developing a consensus of clear definitions of terms used in the grazing of animals.' This first effort involved primarily organizations and agencies within the USA but included representation from New Zealand and Australia. In 2000, Terminology became the first project to be jointly supported by the International Grassland Congress (IGC) and the International Rangeland Congress (IRC). In 2010 this resulted in a completed revision of the terminology, which was published in 2011 in the journal of Grass and Forage Science (Allen et al. 2011).

It is intended that these terms enhance communication in education, science, industry and production and that they become the standard for use in publications. The most relevant terms related to grassland definitions are stated below, the complete list can be found in Allen et al. (2011).

Grazing land. Any vegetated land that is grazed or has the potential to be grazed by animals (domestic and wild). This term is all-inclusive and covers all kinds and types of land that can be grazed.

Pastureland. Land (and the vegetation growing on it) devoted to the production of introduced or indigenous forage for harvest by grazing, cutting, or both. Usually managed to arrest successional processes

Grassland. The term 'grassland' is synonymous with pastureland when referring to an imposed grazing-land ecosystem. The vegetation of grassland in this context is broadly interpreted to include grasses, legumes and other forbs, and at times woody species may be present.

Annual pastureland / grassland. Forage is established annually, usually with annual plants, and generally involves soil disturbance, removal of existing vegetation, and other cultivation practices.

Cultivated pastureland / grassland. Forage is established with domesticated introduced or indigenous species that may receive periodic cultural treatment such as renovation, fertilization or weed control.

Permanent pastureland / grassland. Land on which vegetation is composed of perennial or self-seeding annual forage species which may persist indefinitely. It may include either naturalized or cultivated forages.

Temporary pastureland / grassland. Land on which vegetation is composed of annual, biennial, or perennial forage species kept for a short period of time (usually only a few years).

> Note: Temporary pastureland / grassland can be regularly resown or can be integrated in a crop rotation (ley). It is usually composed of simple mixtures of grasses, grass / legume or legume species.

Ley. Temporary pastureland / grassland that is integrated in a crop rotation.

Naturalized pastureland / grassland. Forage species present are primarily introduced from other geographical regions that have become established and have persisted under the existing conditions of environment and management over a long time.

Semi-natural pastureland / grassland. Managed ecosystem dominated by indigenous or naturally occurring grasses and other herbaceous species (cf. Native grassland).

Meadow. A natural or semi-natural grassland often associated with the conservation of hay or silage.

> Note: A meadow may exist as a result of discontinuous features of hydrology, landscape position, or soil characteristics that differ from the surrounding landscape and vegetation. Descriptive terms include 'mountain meadow,' 'alpine meadow,' 'wet meadow,' and 'hay meadow.' 'Flower meadows' are kept for aesthetic interest and can also provide feeding or bedding.

Rangeland. Land on which the indigenous vegetation (climax or sub-climax) is predominantly grasses, grass-like plants, forbs or shrubs that are grazed or have the potential to be grazed, and which is used as a natural ecosystem for the production of grazing livestock and wildlife.

> Note: Rangelands may include natural grasslands, savannas, shrublands, many deserts, steppes, tundras, alpine communities and marshes.

Native or natural grassland. Natural ecosystem dominated by indigenous or naturally occurring grasses and other herbaceous species used mainly for grazing by livestock and wildlife.

> Note: There are many types of natural grasslands, with vegetation characteristics determined by climate and soil conditions, by grazing animals and by fire. Examples of local / regional variations follow. Geographical regions where examples may be found are provided in parentheses following the definition. This is not an all-inclusive list of grassland types or of locations in which they are found but provides some examples.

Marshland. Flat, wet, treeless wetland usually covered by shallow water and dominated by marsh grasses, rushes, sedges, other grass-like plants and forbs.

Shrubland. Land on which the vegetation is dominated by low-growing woody plants

Tundra. Land areas in arctic and alpine regions devoid of large trees, varying from bare ground to various types of vegetation consisting of grasses, sedges, forbs, dwarf shrubs and trees, mosses and lichens.

4.1.2 Common Agricultural Policy

The EU needed a clear and simple definition of permanent grassland in the framework of their subsidization policy. In 2004 the EU defined permanent grassland as: land used to grow grasses or other herbaceous forage naturally (self-seeded) or through cultivation (sown) and that is not included in the crop rotation of the holding for five years or longer (Commission Regulation EU No 796/2004). Before the EU definition, permanent grassland was defined in vague terms. It was an area with grass as a continuous crop for a relatively long to very long time, with or without resowing. Reheul et al. (2007) provide an overview of definitions used by several member states for permanent and temporary grassland, before the EU definition was set. This shows that definitions varied widely among countries, especially regarding the time of being part of the rotation.

Definition for post 2013 CAP
The definition of permanent pasture has been very much debated during the process of the CAP-reform. The EC proposed (COM(2011) 625) to define permanent pasture as: land used to grow grasses or other herbaceous forage naturally (self-seeded) or through cultivation (sown) and that has not been included in the crop rotation of the holding for five years or longer; it may include other species suitable for grazing provided that the grasses and other herbaceous forage remain predominant.

There is discussion to erase the term *herbaceous*, so e.g. heathlands can also be regarded as permanent grassland. There were also proposals to extent the period of exclusion from crop rotation to 8 years, but also even longer periods (10 or 15 years) have been mentioned[31]. In June 2013 the political agreement on the CAP reform was reached.

The definition for permanent grassland is still not officially published, but the following definition is currently proposed: "*Permanent grassland and permanent pasture means land used to grow grasses or other herbaceous forage naturally (self-seeded) or through cultivation (sown) and that has not been included in the crop rotation of the holding for five years or more; it may include other species such as shrubs and/or trees which can be grazed provided that the grasses and other herbaceous forage remain predominant; as well as, subject to a decision by Member States to include land which can be grazed and which forms part of established local practices where grasses and other herbaceous forage are traditionally not predominant in grazing areas*".

4.1.3 Farm Structure Survey

In 2009 the Commission defined the characteristics to be used for the Community farm structure surveys, which are specified in the Commission Regulation (EC) No 1200/2009. This also comprises the definitions of all land use categories, including grassland. The EUROSTAT crop statistics use the same definitions. In the Eurostat "Handbook on implementing the FSS and SAPM definitions" the latest updates are included and also new additional coding is used, this is the number code that is provided below in between brackets.

The classification of permanent grassland in FSS and SAPM is build up hierarchically. At the highest level there is one land use class F defined as:

F. **PERMANENT GRASSLANDS** (2.03) which is described as:

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[31] http://ec.europa.eu/agriculture/cap-post-2013/legal-proposals/concept-paper-on-greening_en.pdf

I. Land used permanently (for five years or more) to grow herbaceous forage crops, through cultivation (sown) or naturally (self-seeded) and that is not included in the crop rotation on the holding.

II. The land can be used for grazing or mowed for silage or hay.

This main Permanent grassland and meadow class is further sub-divided into 3 classes:

- F/1 **Pasture and meadow, excluding rough grazings** (2.03.01)

  I. Permanent pasture on good or medium quality soils. These areas can normally be used for intensive grazing.

  II. The following are excluded:

  — rough grazing, whether used intermittently or permanently (F/2),

  — pasture and meadow not in use (H/1).

- F/2 **Rough grazings** (2.03.02)

  I. Low yielding permanent pasture, usually on low quality soil, for example on hilly land and in high altitudes, usually unimproved by fertiliser, cultivation, reseeding or drainage. These areas can normally be used only for extensive grazing and cannot support a large density of animals and are normally not mowed.

  II. This can include stony ground, heath, moorland and 'deer forests' in Scotland.

  Rough grazing not in use is excluded (H/1)

- F/3 **Permanent grassland no longer used for production purposes and eligible for the payment of subsidies** (2.03.03)

  Areas of permanent grassland and meadows no longer used for production purposes, which, in line with Regulation (EC) No 1782/2003 (or, where applicable, the most recent legislation), are maintained in good agricultural and environmental condition and are eligible for the single payment.

In addition there are also land uses in the forage plant category which are relevant to provide a definition for and which include the temporary grassland category:

D/18   **Plants harvested green** (2.01.09):

I. All 'green' arable crops intended for animal feed, grown in rotation with other crops and occupying the same land for less than five years (annual or multiannual feed crops).

II. These 'green' (as opposite to those 'for dry grain') crops are normally used for allowing animals to graze or are harvested green, but can be also harvested dried, like dry hay. Generally the whole plant, except the roots, is harvested and used for fodder. Crops not used on the holdings but sold, either for direct use on other holdings or to industry, are included. Cereals, industrial plants and other arable land crops harvested and/or consumed green for fodder are included. Fodder roots and brassicas (D/12) are excluded.

D/18a **Temporary grass** (2.01.09.01)**:**

I. Grass plants for grazing, hay or silage included as a part of a normal crop rotation, lasting at least one crop year and less than five years, sown with grass or grass mixtures. The areas are broken up by ploughing or other tilling or the plants are destroyed by other means such as by herbicides before they are sown again.

II. Mixtures of predominantly grass plants and other forage crops (usually leguminous), grazed, harvested green or as dried hay are included here. Annual grass crops (lasting less than one crop year) are not included here.

4.1.4 FAOSTAT

In FAOSTAT under the land statistics (part of the Resource statistics), grassland categories are distinguished. The main distinction is between temporal and permanent grassland and also irrigated versus non-irrigated is distinguished and also the area under organic agriculture is indicated (Table 13). No further information on the definitions and classification is provided at the FAO website.

Table 13. Definitions for grassland according to FAOSTAT land statistics

Item Code	Item Name	Definition
6656	Perm. meadows & pastures - Cultivated	Permanent meadows and pastures is the land used permanently (five years or more) to grow herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing land).
6659	Perm. meadows & pastures - Nat. grown	Permanent meadows and pastures - Naturally grown is the land not being controlled under permanent meadows and pastures such as wild prairie or grazing land.
6657	Perm. meadows & pastures Cult. & irrig	Permanent meadows and pastures - Cultivated and irrigated, area of the "Cultivated Permanent meadows and pastures" which is actually irrigated in a given year.
6658	Perm. meadows & pastures Cult. non-irrig	Permanent meadows and pastures - Cultivated and non- irrigated, area of the "Cultivated Permanent meadows and pastures" which development relies on rainfed irrigation in a given year.
6655	Permanent meadows and pastures	Permanent meadows and pastures is the land used permanently (five years or more) to grow herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing land).
6682	Permanent meadows and pastures area certified organic	Part of the area of the "Permanent meadows and pastures" exclusively dedicated to organic agriculture and managed by applying organic agriculture methods. It is the portion of land area managed (cultivated) or wild harvested in accordance with specific organic standards or technical regulations and that has been inspected and approved by a certification body.
6683	Permanent meadows and pastures area in conversion to organic	Part of the area of the "Permanent meadows and pastures" which is going through the organic conversion process, usually two years period of conversion to organic land.
6681	Permanent meadows and pastures organic, total	Sum of areas under "Permanent meadows and pastures area certified organic" and "Permanent meadows and pastures area in conversion to organic".
6634	Temp. meadows & pastures irrigated	Temporary meadows and pastures irrigated, area of the "Temporary meadows and pastures" which is actually irrigated in a given year.
6635	Temp. meadows & pastures non-irrig.	Temporary meadows and pastures non- irrigated, area of the "Temporary meadows and pastures" which development relies on rainfed irrigation in a given year.
6633	Temporary meadows and pastures	Temporary meadows and pastures is the land temporarily cultivated with herbaceous forage crops for mowing or pasture. A period of less than five years is used to differentiate between temporary and permanent meadows.

4.1.5   UNFCCC

The IPCC good practice guidance provide default definitions of grassland. However, every country can use its own definition of grassland. According to the IPCC Good Practice Guidance for LULUCF (2003) the definition of grassland is: "Grassland includes rangelands and pasture land that is not considered as cropland. It also includes systems with vegetation that fall below the threshold used in the forest land category and are not expected to exceed, without human intervention, the threshold used in the forest land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastural systems, subdivided into managed and unmanaged consistent with national definitions".

A very similar definition is used in the IPCC 2006 guidelines: "Grassland includes rangelands and pasture land that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the Forest Land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastural systems, consistent with national definitions".

However, countries are allowed to use their own definition for the different land use categories to account for the local circumstances or to fit to available land use data sources. For example, in the Netherlands orchards are included under grassland, since the soil under orchards is always covered by grass. Also heatlands and peat moors are included under grasslands. Instead, in Spain the CORINE land cover map is used as the basis for reporting under LULUCF, and they include the following categories under grassland: 231 (Pastures), 321 (Natural grassland), but also 242 (Complex cultivation patterns), 243 (Land principally occupied by agriculture, with significant areas of natural vegetation) and 244 (Agro-forestry areas), see Section 4.1.7. For these last categories a higher level breakdown of the CLC codes is used to discriminate between grassland and cropland. This illustrates that there is now uniform approach at EU level to distinguish grasslands.

4.1.6   LUCAS

The relevant classes for grassland of the LUCAS nomenclature are in stated below. The full nomenclature can be found on the Eurostat website[32].

Grassland (E00)
Land predominantly covered by communities of grassland, grass like plants and shrubs. The density of tree-crown is less than 10% and the density of tree+shrub-crown is less than 20%. The following three subclasses are discerned: E10 Grassland with sparse trees, E20 Grassland without trees, E30 Spontaneous vegetation.

E10 Grassland with sparse trees: Land predominantly covered by communities of grassland, grass-like plants and forbs including sparsely occurring trees (the density of the tree crown is between 5 and 10% and the total density of the tree+shrub crown is between 5 and 20% of the area). Fruit trees in small groups or along an avenue on grassland are classified here as well.

This class includes:
   –   dry grasslands, dry edaphic meadows, steppes with gramineae and artemisia

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[32] http://epp.eurostat.ec.europa.eu/portal/page/portal/lucas/documents/Nomenclature_LUCAS2009_C_3.pdf

- plain and mountainous grassland
- wet grasslands
- alpine and subalpine grasslands
- saline grasslands
- arctic meadows
- temporarily unstocked areas within forests

Links with Land Use
- E10 - U111 Agriculture: Permanent pastures, rough grazings, alpages, meadows
- E10 - U112 Fallow and abandoned land
- E10 - U120 Clear cuts within previously existing forestsE10 ☐U210 Energy production
- E10 - U31x Associated areas of transport areas
- E10 - U340 Grassland attached to commerce, finance or business areas
- E10 - U350 Grassland attached to community service areas
- E10 - U36x Grassland for recreation: public gardens, golf courses and nature reserves
- E10 - U370 Grassland attached to residential areas
- E10 - U400 Natural grassland or grassland outside agricultural areas not utilized

E20 Grassland without trees: Land predominantly covered by communities of grassland, grass like plants and forbs without trees and shrubland (density of tree+shrub crown is less than 5%).

This class includes:
- dry grasslands, dry meadows and steppes
- plain and mountainous grassland
- wet grasslands
- alpine and subalpine grasslands
- saline grasslands
- arctic meadows
- temporarily unstocked areas within forests

Links with Land Use
- E20 - U111 Agriculture: Permanent pastures, rough grazings, alpages, meadows
- E20 - U112 Fallow and abandoned land
- E20 - U120 Clear cuts within previously existing forests
- E20 - U31x Associated areas of transport areas (e.g. aerodromes)
- E20 - U340 Grassland attached to commerce, finance or business areas
- E20 - U350 Grassland attached to community service areas
- E20 - U36x Grassland for recreation: public gardens, golf courses, sports fields and nature reserves
- E20 - U370 Grassland attached to residential areas
- E20 - U400 Natural grassland grassland outside agricultural not utilized

E30 Spontaneous vegetation: Mostly agricultural land which has not been cultivated this year or the years before. It has not been prepared for sowing any crop this year. This class can also be found on unused land, storage land etc.

Main case is agricultural land not providing a crop during the entire year or abandoned earlier agricultural surfaces. It is occupied by spontaneous vegetation in case of set-aside arable land, with some tall herbs or weeds. This class applies as well for former grassland or hedge margins which are currently not used anymore but covered by tall herbs fringes. There might be some bare land pockets or crop residues and spontaneous re-grown crops of the before management period. Only surfaces which have not been

deliberately sown and do not have any fodder crops like mixed cereals or are temporary grasslands classify for this land cover class.

This class includes:
– Set aside land within agricultural areas
– Unused artificial land

This class excludes:
– Other Legumes and mixtures for Fodder (B53)
– Mixed cereals (B54)
– Temporary grassland (B55)
– Grassland without tree/shrub cover (E20)
– Bare land (F00)

Links with Land Use
– E30 - U112 Spontaneous vegetation on fallow and abandoned land
– E30 - U120 Clear cuts within previously existing forests)
– E30 - U140 Mining and quarrying if in use
– E30 - U21x Energy and industrial production surfaces with spontaneous vegetation cover if still in use
– E30 - U31x Transport, storage, water and waste treatment etc surfaces with spontaneous vegetation cover if in use
– E30 - U400 Unused, spontaneously vegetated land

Class B50 is Fodder crops, this category includes Clovers (B51), Lucerne (B52), Other leguminous and mixtures for fodder (B53), mix of cereals (B54) and temporary grassland (B55).

B55 Temporary grassland: Land occupied by temporary and artificial pastures, occupying the ground for at least one crop year and less than five years, the seeds being either pure or mixed grass, on cropland areas. This can also be the case on fallow fields, when i.e. after some years graminaceous plants settle over spontaneously. If the soil is ploughed and /if the grass is sown the same year, the grassland is very likely a temporary one and not a permanent one.

This class includes:
temporary pastures (Italian ryegrass, other ryegrasses, cock's foot, fescues, timothy) on agricultural areas/cropland

This class excludes:
– permanent grassland (E)
– Mix of legumes with gramineous plants for fodder (B53)
– Mix of cereals for fodder (B54)

Links with Land Use
– B55 - U111 Agricultural production
– B55 - U113 Kitchen garden
– B55 - U361 Amenities, museum, leisure
– B55 - U364 Nature reserves

4.1.7 CLC classification

The final CLC database consists of a geographical database describing land cover/use in 44 classes grouped into a three level hierarchical structure (Table 14). The CORINE land cover nomenclature has 5 major categories at the first level, 15 land cover categories at the second level and 44 categories at the third level. In Bossard et al. (2000) an extensive description is given for each CORINE land cover class, including detailed descriptions with particularities, inclusions and exclusions, photo's, and visual interpretation characteristics. In Annex 1 examples for the different pasture types are provided.

Table 14. CORINE Land Cover nomenclature

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 or commercial units
		1.2.2. Road and rail networks and associated land
		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-agri-cultural vegetated areas	1.4.1. Green urban areas
		1.4.2. Sport 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 plantations
		2.2.3. Olive groves
	2.3. Pastures	**2.3.1. Pastures**
	2.4. Heterogeneous agricultural areas	2.4.1. Annual crops associated with permanent crops
		2.4.2. Complex cultivation patterns
		2.4.3. Land principally occupied by agriculture, with significant areas of natural vegetation
		2.4.4. Agro-forestry areas
3. FOREST AND SEMI-NATURAL AREAS	3.1. Forests	3.1.1. Broad-leaved forest
		3.1.2. Coniferous forest
		3.1.3. Mixed forest
	3.2. Scrub and/or herbaceous associations	**3.2.1. Natural grassland**
		3.2.2. Moors and heathland
		3.2.3. Sclerophyllous vegetation
		3.2.4. Transitional woodland-scrub
	3.3. Open spaces with little or no vegetation	3.3.1. Beaches, dunes, sands
		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.Marine 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

4.1.8   FAO-LCCS

The Land Cover Classification System (LCCS) is a comprehensive, standardized a priori classification system, designed to meet specific user requirements, and created for mapping exercises, independent of the scale or means used to map. The system can be used for any land cover classification initiative anywhere in the world, using a set of independent diagnostic criteria that allow correlation with existing classifications and legends. Land cover classes are defined by a combination of a set of independent diagnostic criteria – the so-called classifiers – that are hierarchically arranged to assure a high degree of geographical accuracy. Due to the heterogeneity of land cover, the same set of classifiers cannot be used to define all land cover types. The hierarchical structure of the classifiers may differ from one land cover type to another. Therefore, the classification has two main phases:

– an initial Dichotomous Phase, where eight major land cover types are distinguished, and
– a subsequent Modular-Hierarchical Phase, where the set of classifiers and their hierarchical arrangement are tailored to the major land cover type.

Further definition of the Land Cover Class can be achieved by adding attributes. Two types of attributes, which form separate levels in the classification, are distinguished:

– Environmental Attributes are attributes (e.g. climate, landform, altitude, soil, lithology and erosion) that influence land cover but are not inherent features of it, and which should not be mixed with "pure" land cover classifiers, and
– Specific Technical Attributes are associated with specific technical disciplines. Thus for (Semi)Natural Vegetation, the Floristic Aspect can be added; for Cultivated Areas, the Crop Type; and for Bare Soil, the Soil Type.

All Primarily Vegetated land cover classes are derived from a consistent physiognomic structural conceptual approach that combines the classifiers Life Form, Cover and Height (in (Semi-)Natural Vegetation) and Life Form (in Cultivated Areas) with Spatial Distribution. The Primarily Non-Vegetated classes have a similar approach, using classifiers that deal with surface aspects, distribution or density, and height or depth.

The LCCS is a highly flexible a priori land cover classification in which each land cover class is clearly and systematically defined, thus providing internal consistency. The system is truly hierarchical and applicable at a variety of scales. Re-arrangement of the classes based on regrouping of the classifiers used facilitates extensive use of the outputs by a wide variety of end-users. Accuracy assessment of the end product can be generated by class or by the individual classifiers forming the class. All land covers can be accommodated in this highly flexible system; the classification could therefore serve as a universally applicable reference base for land cover, thus contributing towards data harmonization and standardization (Di Gregorio 2005, Di Gregorio & Jansen 2005, Jansen 2010).

The LCCS first divides the landscape into areas that are primarily vegetated or non-vegetated. Each is then divided further according to whether it is terrestrial or aquatic or regularly flooded. Within the vegetated areas, areas that are cultivated or managed are separated from those that are semi-natural. Within the non-vegetated category, artificial surfaces and associated areas (primarily urban) are separated from bare areas and artificial and natural water bodies are distinguished.

Grasslands occur under "Cultivated and managed Terrestrial Areas" and "Natural and Semi-Natural Terrestrial vegetation". In the second modular-hierarchical phase a set of classifiers are tailored to the major land cover types. Classifiers describing grassland are Life forms (Herbaceous – Forbs or Graminoids), Cover and Height

Relevant definitions with regards to grasslands in the classification system are:

Herbaceous: Plants without persistent stem or shoots above ground and lacking definite firm structure are defined as herbaceous. There are two categories, depending on the physiognomy, namely Graminoids and Forbs.

Graminoids: Includes all herbaceous grasses and other narrow-leaved grass-like plants that are not grasses according to the taxonomic definition (Kuechler and Zonneveld, 1988). *Guidelines:* Graminoid vegetation is defined by the presence of more than 75% of Graminoids in the herbaceous coverage. There is no upper limit of height: the only condition is the physiognomy of the plant.

Cover: The cover can be considered as the proportion of a particular area of the ground, substrate or water surface covered by a layer of plants, considered at the greatest horizontal perimeter level of each plant in the layer. A distinction is made between closed (more than 60–70%), open (70–60% to 20–10%), closed to open (between 100 and 15%) and sparse (20–10% to 1%). As herbaceous plants are seasonal in character, it has to be noted that the cover of herbaceous vegetation is always considered at the time of its fullest development.

Height: The height of a certain layer is measured from the ground to the average top of the Life Form being assessed (Kuechler and Zonneveld, 1988). The fact that single plants of one synusia differ from the average height can be ignored, apart from the fact that they can form their own layer (e.g. the emergents of a rainforest that tower above the rest). Height sub-divisions are: >30 down to 3 m for Trees; 5 m to 0.3 m for Shrubs; and 3 m to 0.03 m for Herbaceous. Each class is further sub-divided.

4.1.9   EAGLE

The EAGLE group (EIONET Action Group on Land monitoring in Europe) was set up as a working group with members of EIONET NRCs on land cover. The group evolved as a response to the growing need to discuss solutions for a better integration of national mapping activities with European land monitoring initiatives (i.e. CORINE Land Cover) at technical level and independent from any political or industry preferences following the concept of a bottom-up approach.

The objective of the working group is to elaborate a future-oriented conceptual solution that will allow the "feeding" of a European land monitoring database from existing national sources, and to integrate the upcoming approach of object oriented data modelling in the field of land monitoring. The discussion embarked on how to describe the earth's surface in a conceptual way and how to store that descriptive information on land cover and land use in a data model. The main deliverables of the EAGLE working group are: i) EAGLE matrix: A tool for semantic comparison between the class definitions of different classification systems by decomposing them to land cover components, land use attributes and further landscape characteristics and ii) EAGLE data model: A UML model representation of the conceptual data model, visualized in the form of a graphical UML chart.

Although the work of the EAGLE group is still on-going, an example of the classification for grasslands is provided below:

1. Herbaceous Plants (Grasses and Forbs)
Annual, biennial or perennial plants that do not have a persistent woody stem above the ground (in botanical term: herb). In contrary to woody plants, which have stems above ground that remain alive during the dormant season and grow shoots the next year from the above-ground parts, shoots of herbaceous plant die down at the end of growing season, so they regenerate themselves from tissues left above or under the ground (e.g. bulbs, rhizomes, tubers, seeds).

1.1.1. Graminaceous (grass-like)

Grasses, or more technically graminoids, are monocotyledonous, usually herbaceous plants with narrow leaves growing from the base. They include the "true grasses", of the Poaceae (or Gramineae) family, as well as the sedges (Cyperaceae) and the rushes (Juncaceae). The true grasses include cereals, bamboo and the grasses of lawns (turf) and grassland. Sedges include many wild marsh and grassland plants, and some cultivated ones. Belonging here regardless of being wild-growing - forming natural grasslands or being component of other biomes (e.g. wetlands, forest, tundra) or cultivated – forming cropland (arable, meadow, pasture) or grass surfaces / lawn for sports / recreation.

1.1.1.1. Regular Graminaceous (grasses, cereals)

Annual or perennial graminaceous plants, naturally growing or cultivated, with potential height not exceeding 2 meter. This includes most grass species and cereals (e.g. wheat, barley, maize, rice), except reeds and bamboo.

4.1.10 DG Environment project Ecologically Valuable Grasslands

In a related project for DG Environment (Contract No. 07-0307/2012/633993/ETU/B1), which is currently executed by Alterra, data and definitions on ecologically valuable grasslands are analysed. The purpose of this study is to provide a synthesis of data available, and consider the need for improved data, on certain specific environmental issues (including ecologically valuable grasslands) linked to agriculture, so as to underpin the policy process in these areas. One of the guiding developments in this respect are new policies currently under discussion in the new CAP. These new policy developments are an important context for this study and will be discussed in the next chapter of this report.

This study also proposes several relevant definitions for grasslands (see Elbersen et al., in press).

Grassland is defined as all land which is in agricultural use and is not permanent crops or arable and thus:
1) Excludes grasslands in which there is no evidence of human intervention (e.g. through grazing, mowing) and cannot therefore be categorized as agricultural land.
2) Includes all uncultivated land with vegetation that is grazed and/or cut for fodder, including herbaceous and non-herbaceous species.

Ecologically Valuable Grassland (EVG) are a category of grasslands (including those with non-herbaceous species) that are notable, within the overall context of agricultural grasslands, for their ecological value. EVG have a spectrum of values depending on management but focus on biodiversity value and there is often a strong relation between high biodiversity value and other services. The EVG are semi-natural and natural grasslands that are not agriculturally-improved (e.g. through cultivation, reseeding, fertilisation, irrigation and drainage) of long standing and species–rich (taking account of all taxa not only higher plants).

4.2 Habitat classifications

There are many regional and national habitat classifications which will not be considered (Mucher et al., 2004). 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. Dengler et al. (2013) introduce a series of articles devoted to the classification of European grasslands that will appear as a Virtual Special Feature in the journal of Applied Vegetation Science. They want to (1) initiate the preparation and publication of international classifications for European grasslands and (2) stimulate the necessary methodological developments for producing such studies.

 In Figure 14 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 & Deviliers-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://eunis.eea.europa.eu/habitats.jsp).
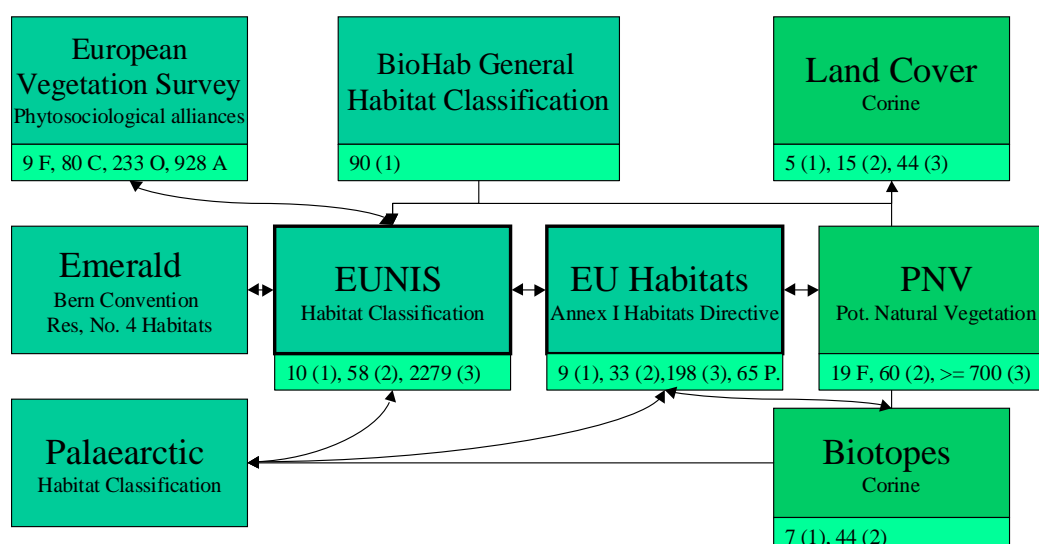

Figure 14. Relationships between various existing habitat classifications and related databases (figure is little outdated)

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.

4.2.1 Habitats Directive

The European Commission has published an Interpretation Manual of EU habitats in 1999 for the delineation of Natura 2000 sites (European Commission, 2007). 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.
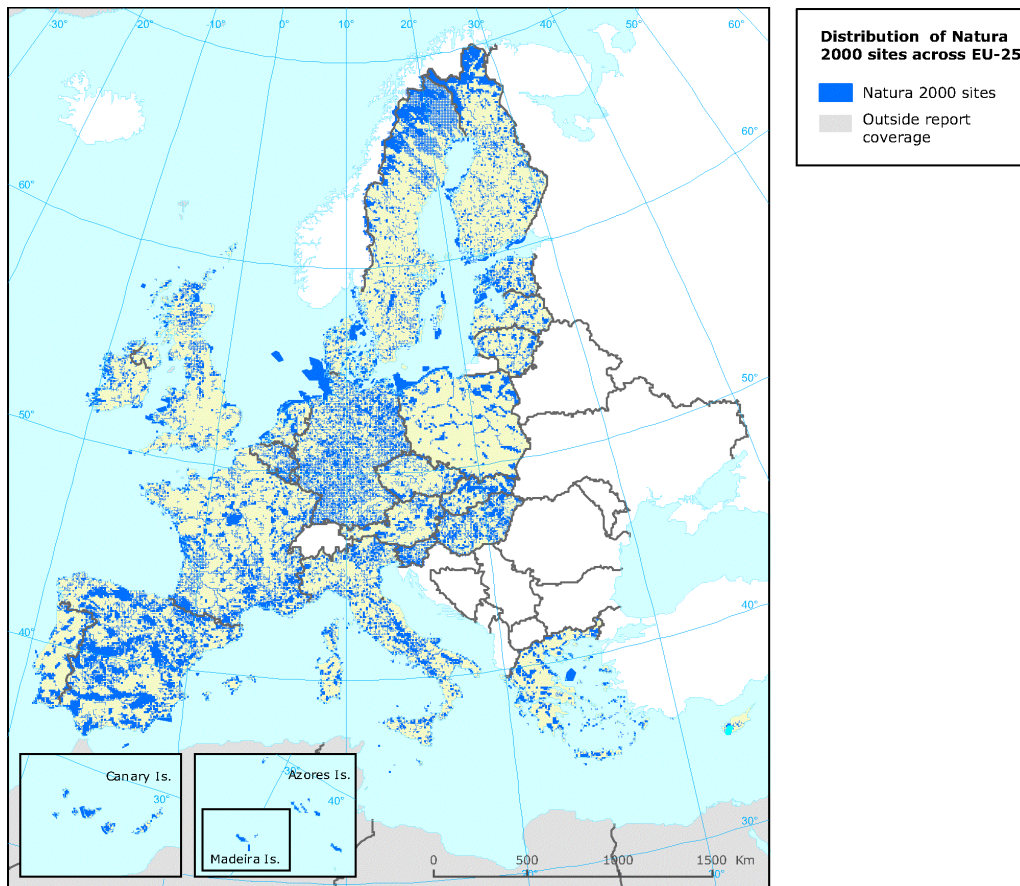
Figure 15. Distribution of Natura 2000 sites across EU-25 (Source: EEA, 2010)

Annex I lists today 231 European natural habitat types, including 71 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 2 since that was the only existing classification at European level. The habitat types for natural and semi-natural grassland formations are stated in

Table 15.

Soon a report will be published by the European Commission on guidance on how to integrate Natura 2000 conservation objectives into farming practices. This report also provides a table (called Annex A) that describes the key Annex I habitat types that are dependent on agriculture and the degree of dependency for each, as well as their distribution, total extent, proportion of habitat within Natura 2000 designated sites, and current conservation status.

Table 15. Habitat types for natural and semi-natural grassland formations

61. Natural grasslands
> 6110 * Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi
> 6120 * Xeric sand calcareous grasslands
> 6130 Calaminarian grasslands of the Violetalia calaminariae
> 6140 Siliceous Pyrenean Festuca eskia grasslands
> 6150 Siliceous alpine and boreal grasslands
> 6160 Oro-Iberian Festuca indigesta grasslands
> 6170 Alpine and subalpine calcareous grasslands
> 6180 Macaronesian mesophile grasslands
> 6190 Rupicolous pannonic grasslands

62. Semi-natural dry grasslands and scrubland facies
> 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)
> 6220 * Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea
> 6230 * Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)
> 6240 * Sub-Pannonic steppic grasslands
> 6250 * Pannonic loess steppic grasslands
> 6260 * Pannonic sand steppes
> 6270 * Fennoscandian lowland species-rich dry to mesic grasslands
> 6280 * Nordic alvar and precambrian calcareous flatrocks
> 62A0 Eastern sub-mediteranean dry grasslands (Scorzoneratalia villosae)
> 62B0 * Serpentinophilous grasslands of Cyprus
> 62C0 *Ponto-Sarmatic steppes
> 62D0 Oro-Moesian acidophilous grasslands

63. Sclerophillous grazed forests (dehesas)
> 6310 Dehesas with evergreen Quercus spp.

64. Semi-natural tall-herb humid meadows
> 6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)
> 6420 Mediterranean tall humid grasslands of the Molinio-Holoschoenion
> 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
> 6450 Northern boreal alluvial meadows
> 6460 *Peat grasslands of Troodos

65. Mesophile grasslands
> 6510 Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)
> 6520 Mountain hay meadows
6530 * Fennoscandian wooded meadows

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.

An example of a full description of an Annex I habitat type is given in the box below.

6120 * Xeric sand calcareous grasslands
PAL.CLASS.: 34.12

1) Dry, frequently open grasslands on more or less calciferous sand with a subcontinental centre of distribution (*Koelerion glaucae, Sileno conicae-Cerastion semidecandri, Sedo-Cerastion* p.).

2) Plants: *Allium schoenoprasum, Alyssum montanum* ssp. *gemelinii, Astragalus arenarius, Cardaminopsis arenosa, Carex ligerica, Carex praecox, Dianthus deltoides, Euphorbia seguieriana, Festuca psammophila, Gypsophila fastigiata, Helichrysum arenarium, Herniaria glabra, Koelerion glauca, Petrorhagia prolifera, Sedum reflexum, Silene chlorantha.*

3) Corresponding categories
German classification : "340403 ausdauernder Sandtrockenrasen mit geschlossener Narbe". Nordic classification: "5141 *Koeleria glauca*-typ".

4) This habitat type occurs in association with non coastal dune complexes.

5) Olsson, H. (1974). Studies on South Swedish sand vegetation. *Acta Phytogeogr. Suec.* 60:1-170.

4.2.2   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 231 Annex I habitats of the Habitats Directive and has a more scientific approach.

For the purposes of EUNIS, a 'habitat' is defined as: 'a place where plants or animals normally live, characterized primarily by its physical features (topography, plant or animal physiognomy, soil characteristics, climate, water quality etc.) and secondarily by the species of plants and animals that live there' (Davies and Moss, 2002). On their website it is stated (http://eunis.eea.europa.eu/habitats.jsp) 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. 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.
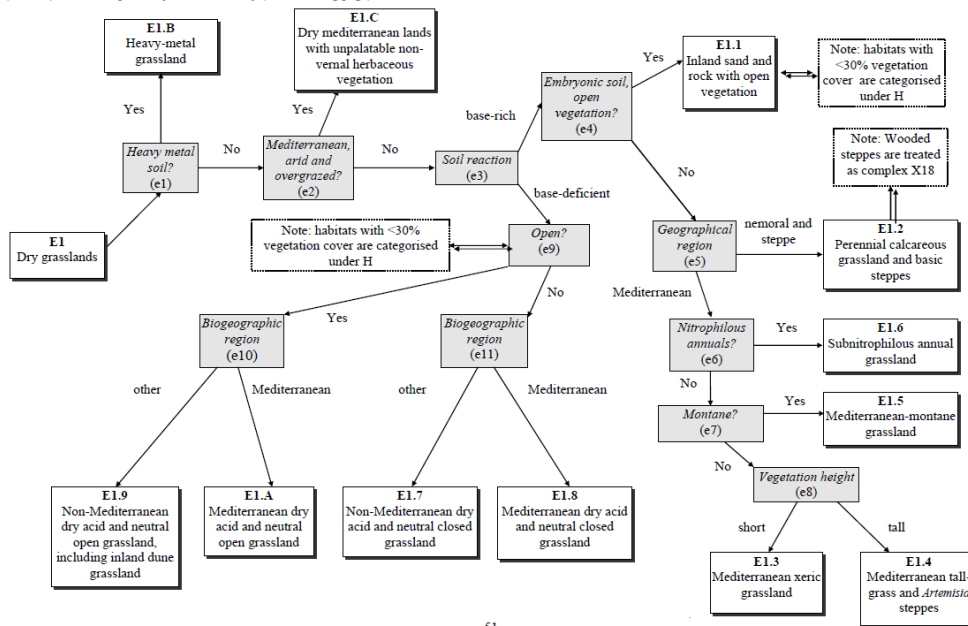
Table 16. EUNIS major habitats (first level)

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 (Table 16). 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.

Table 17. Second level EUNIS habitats related to grassland (Source: Hill et al., 2004)

EUNIS code	Level	EUNIS name	Description
E	1	Grasslands and lands dominated by forbs, mosses or lichens	Non-coastal land which is dry or only seasonally wet (with the water table at or above ground level for less than half of the year) with greater than 30% vegetation cover. The vegetation is dominated by grasses and other non-woody plants, including mosses, macrolichens, ferns, sedges and herbs. Includes semiarid steppes with scattered [Artemisia] scrub. Includes successional weedy vegetation and managed grasslands such as recreation fields and lawns. Excludes regularly tilled habitats (I1) dominated by cultivated herbaceous vegetation such as arable fields.
E1	2	Dry grasslands	Well-drained or dry lands dominated by grass or herbs, mostly not fertilized and with low productivity. Included are [Artemisia] steppes. Excluded are dry mediterranean lands with shrubs of other genera where the shrub cover exceeds 10%; these are listed as garrigue (F6).
E2	2	Mesic grasslands	Lowland and montane mesotrophic and eutrophic pastures and hay meadows of the boreal, nemoral, warm-temperate humid and mediterranean zones. They are generally more fertile than dry grasslands (E1), and include sports fields and agriculturally improved and reseeded pastures.
E3	2	Seasonally wet and wet grasslands	Unimproved or lightly improved wet meadows and tall herb communities of the boreal, nemoral, warm-temperate humid, steppic and mediterranean zones.
E4	2	Alpine and subalpine grasslands	Primary and secondary grass- or sedge- dominated formations of the alpine and subalpine levels of boreal, nemoral, mediterranean, warm-temperate humid and Anatolian mountains.
E5	2	Woodland fringes and clearings and tall forb stands	Stands of tall herbs or ferns, occuring on disused urban or agricultural land, by watercourses, at the edge of woods, or invading pastures. Stands of shorter herbs forming a distinct zone (seam) at the edge of woods.
E6	2	Inland salt steppes	Saline land with dominant salt-tolerant grasses and herbs. Excludes saline scrubland, listed under F6.8 xero-halophile scrubs.
E7	2	Sparsely wooded grasslands	Grasslands with a wooded overstorey that normally has less than 10% cover.

Figure 16. Example of EUNIS Habitat classification for dry grasslands to level 3

4.2.3 Phytosociological plant communities in Europe

Phytosociology is the science which attempts to describe the diversity of plant communities. 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 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. In Annex 2 all phytosociological alliances for grasslands are provided. 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.

4.3 Assessment of grassland definitions and classifications

In this Chapter we will make a first assessment of grassland definitions and classifications and their usefulness for EU policies. Grassland related data are relevant to several EU policies, including the Nitrates Directive, Common Agricultural Policy (CAP), climate policy, biodiversity policies and the Renewable Energy Directive (RED). Below we shortly describe these policies and the relevance of grassland data for these policies.

4.3.1 Policy-related data needs related to grasslands

Nitrates Directive
The main objectives of the Nitrates Directive are to reduce water pollution caused or induced by nitrates from agriculture, and to prevent further such pollution. Member states have to take actions in so-called nitrate vulnerable zones (NVZ), which have to be presented in an Action Programme. The area and production of grasslands is required for several aspects in the Nitrates Directive. For all crops, member states have to present nitrogen application standards (and in some member states also phosphorus application standards), which follow the principle of balanced nitrogen (or phosphorus) application. The yield and nitrogen uptake of the crops are important factors affecting the application standards.

Countries can apply for a derogation for application of manure above the standard of 170 kg N per year following the Nitrates Directive. One of the criteria of using more manure than this standard is the nitrogen uptake capacity and the length of growing season. Grasslands have a long growing-season and high nitrogen uptake capacity. This shows that there is a clear need by the Nitrates Directive for data on grassland area and production (for different grassland types and management).

Common Agricultural Policy
The Common Agricultural Policy (CAP) is the European Union legislation regulating agriculture and rural development. The 2003 reform of CAP introduced a major change in European agricultural policy and 'decoupled,' the direct link between farm payments and agricultural production. For the post-2013 CAP the EC proposed "greening measures" to further support innovation in and sustainability of farming by linking them to the system of direct payments (pillar one). Three measures have been proposed i.e. crop diversification, permanent grassland protection and ecological focus areas. The strength in these measures lies in the fact that they create a level playing field in the Union, because they are compulsory for almost all farmers. The greening measures go beyond cross-compliance obligations and raise the baseline, thereby increasing the environmental ambitions of the EU as a whole.

The 2003 CAP reform obliges Member States to ensure that their area of permanent pasture (the ratio compared to total agricultural land) does not reduce as a result of the reform. The monitoring is based on a ratio of permanent pasture compared to total agricultural land. If there is a significant decrease in the ratio, national authorities may impose measures to stop the decline (e.g. prior authorisation for ploughing; obligation to return arable land to pasture). Good information on the grassland and especially the status of permanency is obviously very important for correct payment of the CAP subsidies. In addition, there are some aspects under cross compliance related to grasslands, including the Nitrates Directive and Habitat Directive and some of the measures under the good agricultural and environmental condition (GAEC).

EU climate policy
Grasslands are an important stock of carbon and a source of nitrous oxide. Countries have to report the emissions to the United Nations Framework Convention on Climate Change (UNFCCC). Different methodologies are used to quantify greenhouse gas emissions. Emissions of N_2O are different for grasslands than for cropland, and some countries like the Netherlands use different emission factors for

grassland than for arable land (Velthof and Mosquera, 2011). For such an approach, the area and management of grassland is needed. As IPCC encourage countries to use country specific Tier 2 or 3 methodologies it may be expected that the need for data on area and use of grasslands will increase.

In addition the EU parliament recently approved a law to establish common rules for accounting for GHG emissions and removals of carbon from the atmosphere resulting from activities related to land use, land-use change and forestry (LULUCF). This decision represents a first step towards incorporating the forestry and agriculture sectors, the last major sectors without common EU-wide rules on GHG, into EU climate policy. One of the aspects is the mandatory accounting of grazing land management by the member states, for which more grassland related data would be needed. This includes data on soil type (especially grassland on peat soil), changes in land use, and information of grassland management (e.g. grazing and grassland renewal).

Biodiversity policies
The EU is committed to the protection of biodiversity, and to halting biodiversity loss within the EU by 2020. The EU has built up a network of 26000 protected areas in all the Member States and an area of more than 750.000 km^2, which is known as Natura 2000. The legal basis for Natura 2000 comes from the Birds Directive and the Habitats Directive, which form the backbone of the EU's internal biodiversity policy. The Habitats Directive (92/43/EEC) has focused on the requirement of Member States to establish a network of special areas of conservation (SACs) that, together with the special protection areas (SPAs) designated under the Birds Directive (79/409/EEC), make up the Natura 2000 network. The Habitats Directive requires continuous monitoring of the condition of species and habitats within each member state, with results being updated every six years. The Birds Directive (2009/147/EC) is aimed at the conservation of wild birds, which creates a comprehensive scheme of protection for all wild bird species naturally occurring in the European Union.

The EU biodiversity strategy to 2020 (COM(2011) 244) has defined six targets, of which Target 3 is to increase the contribution of agriculture and forestry to maintaining and enhancing biodiversity. It aims to maximise by 2020 the areas under agriculture across grasslands, arable land and permanent crops that are covered by biodiversity-related measures under the CAP so as to ensure the conservation of biodiversity. The strategy should bring a measurable improvement in the conservation status of species and habitats that depend on or are affected by agriculture and in the provision of ecosystem services as compared to the EU 2010 Baseline. The improvement is to be measured against the quantified enhancement targets for the conservation status of species and habitats of EU interest and the restoration of degraded ecosystems.

Renewable Energy Directive
In 2009 the Renewable Energy Directive (2009/28/EC) on the promotion of the use of energy from renewable sources was adopted. The Directive sets ambitious targets for all Member States, such that the EU will reach a 20 % share of energy from renewable sources by 2020 and a 10 % share of renewable energy specifically in the transport sector. It also establishes a sustainability scheme for biofuels and bioliquids: in order to be accounted in the national binding targets biofuels and bioliquids have to meet specified sustainability criteria set in article 17 of the Directive. One of the criteria is that no raw material should be obtained from land with high biodiversity value, which includes highly biodiverse grassland.

Highly biodiverse grassland is defined as i) natural, namely grassland that would remain grassland in the absence of human intervention and which maintains the natural species composition and ecological characteristics and processes; or ii) non-natural, namely grassland that would cease to be grassland in the absence of human intervention and which is species-rich and not degraded, unless evidence is provided that the harvesting of the raw material is necessary to preserve its grassland status. This definition has been the source of debate among experts, policy makers and environmental NGOs with uncertainty over its coverage and how the definitions could be operationalised. The European Commission is tasked with establishing

'criteria and geographic ranges to determine which grassland shall be covered (Bowyer, 2010). However, these have currently not yet been published by the Commission. Although the RED refers to the global level, also data on European grasslands is required to identify these areas of highly biodiverse grasslands.

In Table 18 we have identified the different data needs on grassland for the respective EU policies. The data needs included are grassland area, grassland yield, biodiversity value, permanency, status of grazing, status of fertilization, status of tillage, status of cutting, area of non-grasslands which are grazed and amount of manure from grazing on non-grasslands. For example, for the Nitrates Directive information on nutrient balances is very important, to calculate these data on grassland area, yield and fertilization (including mineral fertilizer, grazing and applied manure) is needed. For the Renewable Energy Directive the data need focusses on the identification of high biodiverse grasslands, which are not allowed to be converted to other land uses for bioenergy production. In this case the area and biodiversity value are most important.

Table 18. Data needs on grassland for different EU policies

Data needs	Nitrates Directive	Common Agricultural Policy	EU Climate policies	Biodiversity policies	Renewable Energy Directive
Grassland area	X	X	X		X
Grassland yield	X	(X)			
Biodiversity value		X		X	X
Permanency	(X)	X	X	X	(X)
Status of grazing		(X)		(X)	
Status of fertilization	X		X	X	
Status of tillage		X	X		
Status of cutting	(X)	(X)		(X)	
Area non-grasslands which are grazed	X	(X)			
Amount of manure from grazing on non-grasslands	X				

4.3.2   Assessment of existing grassland definitions and classifications for EU policies

For this assessment we included the grassland definitions and classifications as described in Chapter 4.1 and 4.2 with a few exceptions. The work of the European Grassland Federation, the DG Environment project on ecologically valuable grasslands and by the EAGLE working group is still on-going and no final definition or classification has yet been established. Therefore these three sources of grassland definitions and classifications have not been included in the assessment, but will be taken into account in Task 3. Also the EUNIS Habitat classification and the phytosociological plant communities in Europe are not further discussed here, since the focus of this project is mainly on grassland for agricultural uses and their production potential, while the very detailed habitat classifications have a very strong focus on biodiversity aspects.

International terminology for grazing lands and grazing animals
The benefit of the international terminology for grazing lands and grazing animals is that it is accepted by the global grassland research community. However, in several cases the definitions are not sufficiently elaborated to be used directly for policy purposes. For example in the definition of permanent and temporary grassland no time horizon is included in the definition for a clear distinction between these two categories. Furthermore, there is no data source behind these definitions, which would only make them useful for new grassland data inventories.

Common Agricultural Policy
The current definition of permanent grassland under the CAP is more clear compared to the one from the international terminology, since the temporal dimension is specified. However, the definition still leaves space for discussion, which is also shown by different interpretations of the definition by the EU member states, see Beaufoy et al. (2011). Moreover, the definition for the post 2013 CAP is still under discussion, and is probably broader compared to the current definition.

Farm Structure Survey
The grassland definitions from the farm structure survey are useful for agricultural purposes. It has a clear distinction between permanent and temporary grassland and also the rough grazing grasslands are distinguished. However, it does not address the biodiversity aspects of grassland, and also the intensity of grassland use is not very well expressed in these definitions. However, the benefit of this classification is that it is widely used in the data collection on grasslands for Eurostat (e.g. FSS, FADN and partly for the crop statistics).

FAOSTAT
The FAOSTAT classification for grasslands is rather extensive and distinguishes between permanent and temporary grassland. It also provides information regarding the intensity of use, i.e. whether it is cultivated or naturally grown and whether it is irrigated or under organic agriculture. However, the availability of data for the sub-categories is very limited in FAOSTAT (see Table 5).

UNFCCC
The general definition of grassland as stated in the IPCC good practice guidance for LULUCF (2003) is very broad and is a kind of remaining category, in which other land uses that are not cropland, forestland, wetland or settlement. In addition, many countries use their own definition of grassland for UNFCCC reporting. This definition is too broad and not consistent among member states for most EU policy purposes.

LUCAS
The LUCAS land use classification is well elaborated and includes a good split between temporary and permanent grassland. However, the subclasses of grassland (Grassland with sparse trees, Grassland without trees, and Spontaneous vegetation) are linked to land cover than land use and do not provide further detail about management, which is relevant for EU policies. The benefit of the LUCAS land use data is that these are collected in a harmonized way throughout the EU and it is actually observed data in the field.

CLC classification
The CLC classification has been developed for land cover data. The classification is well elaborated and frequently used in remote sensing studies. However, the classification does not provide much information about the grassland management. Pastures refer to permanent grassland (> 5 years not in rotation), but the temporary grasslands are not included as separate category. On the other hand natural grasslands are better distinguished compared to many agricultural related classifications.

FAO-LCCS
The Land Cover Classification System (LCCS) is mainly aimed at land cover related classifications, which means that land management is not included as criteria in the classification. Grasslands can be described in terms of life form, cover and height, which can be relevant for biodiversity purposes, but not directly for agricultural and environmental policies. The classification is often used in a global context, due to the involvement of FAO, but it is not frequently used in Europe.

Habitats Directive

The habitat classification of the Habitats Directive (Annex 1) provides a good classification for the natural and semi-natural grasslands in Europe. It distinguishes about 30 grassland habitats, which are reasonably well described. However, it is only focussed on the semi-natural and natural grasslands and does not include the more intensively used agricultural grasslands. In addition harmonisation and further improvement of the habitat definitions and descriptions is still continuing (see e.g. EC, 2013), which

In Table 19 we assessed the usefulness of the current grassland definitions and classifications for the different policy needs of the Nitrates Directive, EU Climate policies, Common Agricultural Policy, Habitat Directive and the Renewable Energy Directive. The table shows that there is indeed the need for better data on the issue of defining, classifying, collecting and disseminating data on European grassland areas, use and production.

For the Nitrates Directive none of the current grassland classifications and definitions really fits the policy needs, as there is no clear distinction in the intensity and management level of the grasslands. The same holds for the climate policies, for which also data on grassland management would be needed. For the CAP the definition of permanent grassland and the FSS statistics are currently sufficient, but with the renewal of the CAP probably new data needs on grassland will be added (e.g. grasslands within Natura 2000 areas). For biodiversity policies the corresponding classification is useful, however, the mapping of the habitats at EU level still requires harmonisation, and there is not yet an overall EU map with all habitats according to this classification. Finally for the Renewable Energy Directive a definition and corresponding mapping of highly biodiverse grassland is needed, but none of the current definitions would fit, or all grassland classified under the habitat Directive should be included.

Table 19. Assessment of usefulness of grassland classifications and definitions for different EU policies (white is high, grey medium and black low potential for use policy data needs)

Classification / definition	Nitrates Directive	Common Agricultural Policy	EU Climate policies	Biodiversity policies	Renewable Energy Directive
International terminology for grazing lands and grazing animals	grey	grey	grey	grey	grey
Common Agricultural Policy	grey	white	grey	black	black
Farm Structure Survey	grey	white	grey	black	black
FAOSTAT	grey	grey	grey	black	black
UNFCCC	grey	black	grey	black	black
LUCAS	grey	grey	grey	grey	grey
CLC classification	grey	grey	grey	grey	grey
FAO-LCCS	grey	grey	grey	grey	grey
Habitats Directive	black	black	black	white	grey

5 Conclusion and recommendations

Based on the presented sources of grassland information (Chapter 3) and the review of current definitions and classifications of grassland (Chapter 4) we come to the following conclusions and recommendations:

– Spatial coverage for most grassland sources is sufficient and cover the EU-27. Spatial resolution differs largely, many statistical sources only provide data at national level, whereas the remote sensing sources can provide data at 100 meter grid cell resolution.

– The current remote sensing sources for data on grassland areas, do not provide data on productivity. Other remote sensing sources might be used to derive productivity data, however, most of them are still in experimental stage or have high uncertainty, see Task 2 report.

– Most statistical sources have already established a long time series and provide data at annual time steps. The remote sensing sources are often products produced for a certain year, although for the Corine Land Cover maps several time steps are available and updates are on-going.

– Few sources have clear and harmonized grassland definitions. The statistical sources of FADN, FSS and FAOSTAT do have clear definitions for different grassland types, although it remains unclear whether member states provide all information according to these definitions. Although remote sensing sources have clear classification schemes, the usefulness is limited as the classification is focussed on land cover and not on land use (e.g. no distinction between permanent and temporary grassland).

– Many EU policies require data on grasslands. Harmonization of grassland definitions and classifications would reduce the amount of data that has to be collected and would improve the data quality. None of the current grassland definitions and classifications does achieve the data needs of the different EU policies.

Task 1 Report

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Annex 1   CLC Pastures definition

Class 2.3 Pastures

Lands, which are permanently used (at least 5 years) for fodder production. Includes natural or sown herbaceous species, unimproved or lightly improved meadows and grazed or mechanically harvested meadows. Regular agriculture impact influences the natural development of natural herbaceous species composition.

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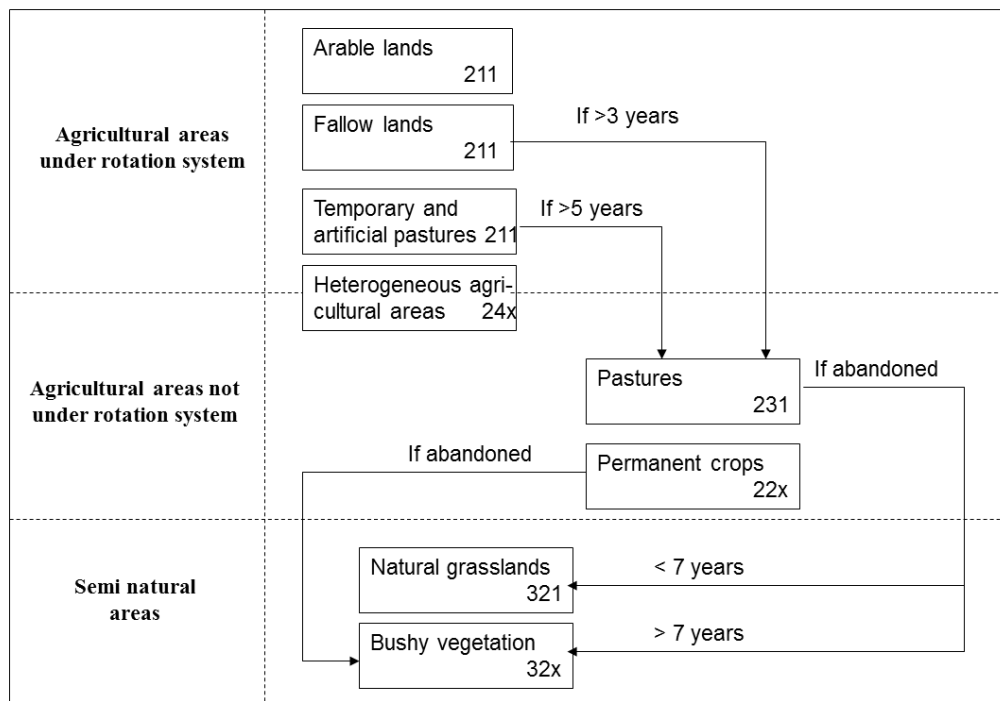
Extension:
Grazing used by cattle. Pastures can be described as extensively used grasslands with presence of farm structure such as: fences, shelters, enclosures, watering places, drinking trough, or regular agricultural works: mowing, drainage, hay making, agricultural practices, manuring.

This class includes:
- temporary and artificial pastures not under a rotation system which become permanent grasslands five years after ploughing. Significant number of natural vegetation species are present (as Taraxacum officinale, Ranunculus spp., Chrisanthemum leucantemum, Knautia arvensis, Achillea millefolium, Salvia spp., etc.);
- abandoned arable land not under a rotation system used as pastures (after 3 years);
- humid meadows with dominating grass cover. Sedges, rushes, thistles, nettles, cover less than 25 % of the parcel surface;
- pastures with scattered trees and shrubs.

This class excludes:
- military exercising grass fields (without grazing) (class 321);
- salt meadow located in intertidal flat areas (class 423);
- lawns inside sport and leisure facility areas (class 142);
- high-productive natural alpine meadows far from houses and/or crops (class 321);
- fodder crops (class 211);
- derelict grassland where semi-ligneous/ligneous vegetation cover at least 25 % of the parcel (class 322/324);
- strong humid meadows where hygrophyle plant species cover at least 25 % of the parcel (class 411);
- herbaceous grass cover composed of non-palatable and undesirable species for cattle as Molinia spp. and Brachypodium spp. (class 321).

Texture of grassland

Texture of scattered trees and shrubs (10-20% of surface)
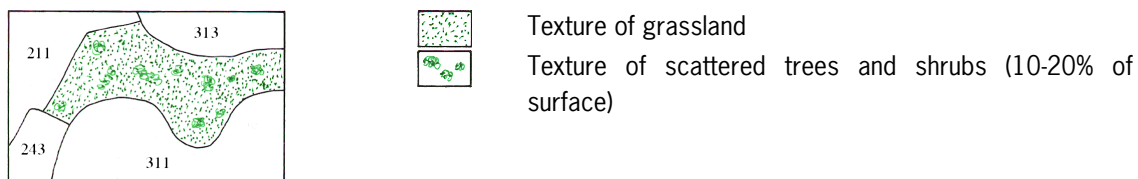
A generalised pattern of the class 231

Representative demonstration of the quoted class on example of grassland in Central part of Slovakia

Particularity of class 231: Pastures on abandoned land

Grassland developed by not using arable land for more than three years. Identification of the quoted grassland requires application of data obtained by field checking.

This class includes:
- areas of grassland representing succession of natural overgrowing of arable land by prevailingly herbaceous vegetation;
- areas of sporadically occurring shrubs.
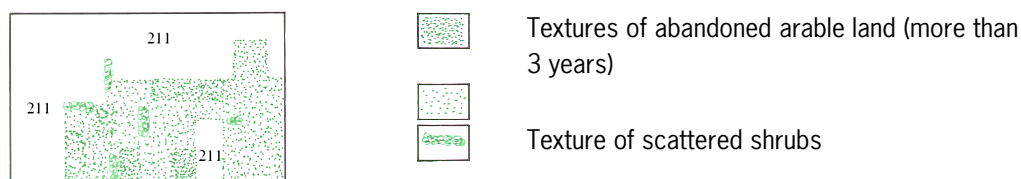
Textures of abandoned arable land (more than 3 years)

Texture of scattered shrubs

A generalised pattern of the particularity of class 231

Representative of the quoted class particularity on example of pasture on abandoned land in Latvia

Particularity of class 231: Wooded meadows

Meadows where dispersed trees and shrubs occupy up to 50% of surface of the area. These meadows are characterised by rich floristic composition.

This class includes:
- areas of grassland, partially covered by tree crowns;
- areas of scattered trees and shrubs.
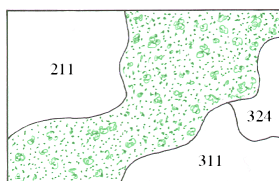
Texture of grassland

Texture of scattered trees and shrubs (40-50% of surface)

A generalised pattern of the particularity of class 231

Representative of the quoted class particularity on example of wooded meadow in Virtsu-Laelatu (Estonia)

321 Natural grassland

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 50 % 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.

This class includes:
- saline grasslands grown on temporary wet areas of saline soils;
- humid meadows where sedges, rushes, thistles, nettles cover more than 25 % of the parcel;
- natural grasslands with trees and shrubs if they do not cover more than 25 % of the surface to be considered;
- high-productive Alpine grasslands far from houses, crops and farming activities;
- herbaceous military training areas;
- grasslands which can be grazed, never sown and not otherwise managed by way of application of fertilizers, pesticides, drainage or reseeding except by burning;
- grasslands with a yearly productivity less than 1.500 units of fodder/ha;
- herbaceous grass covered composed of non-palatable gramineous species such as *Molinia spp.*and *Brachypodium spp.*;
- derelict natural grassland where ligneous vegetation cover less than 75 % of the area;
- grasslands found on calcareous soils with a high proportion of calcicole species of limestone, chalk Machair or Karst;
- grasslands dotted with bare rock areas which represent less than 25 % of the surface.

This class excludes:
- grey dunes (class 331);
- swampy grassland (class 411);
- fallow land (class 211).
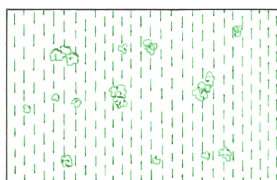
Texture of natural grassland

Texture of scattered trees and shrubs

A generalised pattern of the class 321

Representative demonstration of the quoted class of natural grassland in the Morava floodplain (Slovakia)
Generalisation:

At high altitude, class 321 might be present as altitude formation between heathlands (322) or class 31x and sparsely vegetated areas (333).
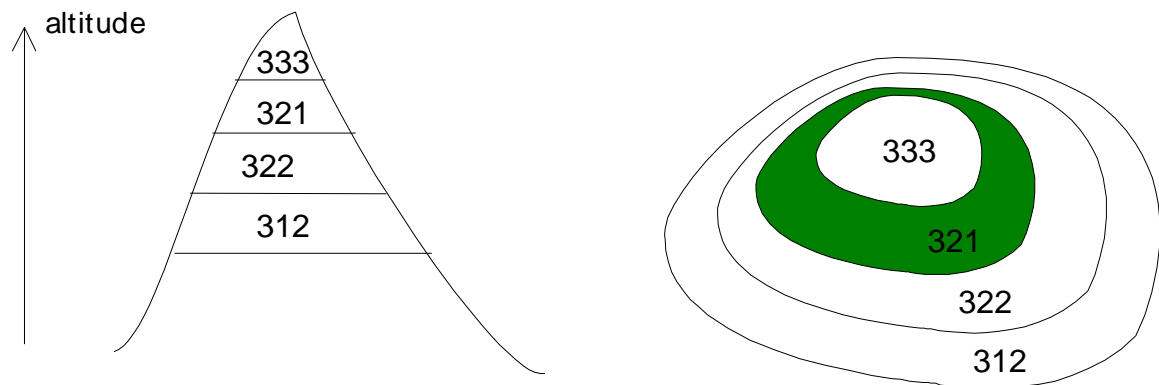
Particularity of class 321: Alpine meadows

Grass formations which occur in high mountains above the upper timberline. The most extensive areas of this particularity as far as the Phare countries are concerned, are in the mountains of the Alps, the Carpathian Arch, etc.

This class includes:
- natural grassland;
- rocky formations;
- dwarf pines.
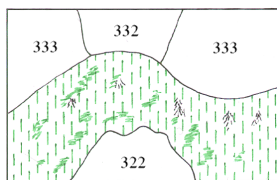
	Texture of natural grassland
	Texture of rocky formations
	Texture of dwarf pines

A generalised pattern of the particularity of class 321
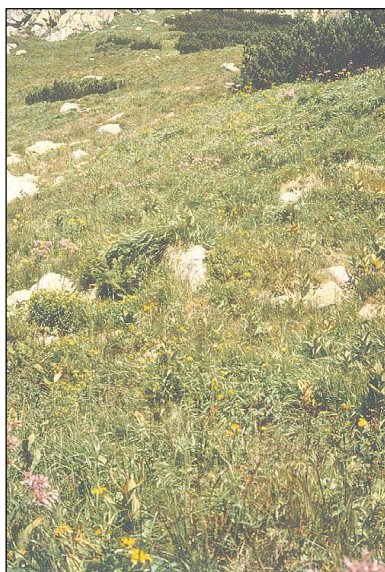
Representative of the quoted class particularity on example of alpine meadow in the High Tatras (Slovakia)

Particularity of class 321: Grass formations of inundated alluvial plains and coastal plains, lowlands

Human influence is very low with regard to natural conditions – of grass formations - extreme soil humidity and seasonal inundated.

This class includes:
- natural grassland;
- water bodies;
- shrub formations and scattered trees.
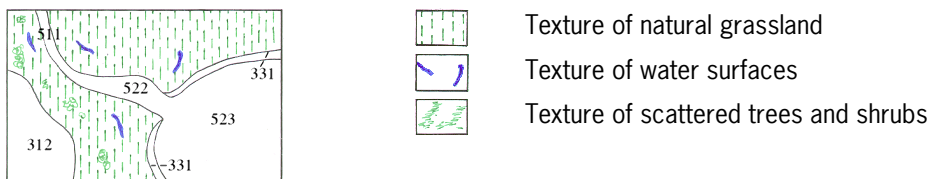
Texture of natural grassland

Texture of water surfaces

Texture of scattered trees and shrubs

A generalised pattern of the particularity of class 321

Representative of the quoted class particularity on examples of lower coastal grassland and upper coastal grassland (Rumpo and Vaemla, Estonia)

Annex 2 Phytosociological alliances for grasslands

G TEMPERATE GRASSLANDS, HEATHS AND FRINGE VEGETATION

26   **MOLINIO-ARRHENATHERETEA**

Anthropogenic pastures and meadows on deeper, more or less fertile soils in lowland regions

26A   ALTHAEETALIA OFFICINALIS

Meadows in the steppe and semi-desert zones of east Europe on moderately saline flooded soils

26A01   **Althaeion officinalis**

Meadows of the Lower Volga valley and surrounding limans on moderately saline flooded soils

26A02   **Euphorbion palustris**

Meadows in the steppe part of the Ural river valley on moderately saline flooded soils

26B   ARRHENATHERETALIA

Pastures and meadows on well-drained relatively fertile mineral soils

26B01   **Arrhenatherion**

Meadows of well-drained, relatively fertile mineral soils at lower altitudes *E2.1*

Permanent mesotrophic pastures and aftermath-grazed meadows E2.2 Coarse permanent grassland and tall herbs, usually mown but little grazed

E3.4 Moist or wet eutrophic and mesotrophic grassland

26B02   **Cynosurion cristati**

Pastures of relatively well-drained, fertile mineral soils at lower altitudes in central and western Europe

E2.1 Permanent mesotrophic pastures and aftermath-grazed meadows E2.2 Coarse permanent grassland and tall herbs, usually mown but little grazed

E2. 6 Agriculturally-improved, re-seeded and heavily fertilized grassland, including sports fields and grass lawns

E3.4 Moist or wet eutrophic and mesotrophic grassland

26B03   **Gaudinio fragilis-Cynosurion cristati**

Thermo-atlantic and supramediterranean mesic meadows of France and Spain

E2.2 Coarse permanent grassland and tall herbs, usually mown but little grazed

26B04   **Pancicion serbicae**

Thermophilous montane meadows of the central Balkans

26B05   **Phyteumo-Trisetion**

Meadows of less fertile mineral soils in central Europe with influence of Atlantic climate

E2.2 Coarse permanent grassland and tall herbs, usually mown but little grazed

E2.3 Mountain hay meadows

26C   CIRSIETALIA VALLIS-DEMONIS

Montane meadows in Sicily and Calabria

26C01   **Plantaginion cupanii**

Montane mesic meadows in Sicily and Calabria

E2.2 Coarse permanent grassland and tall herbs, usually mown but little grazed

26D   GALIETALIA VERI

Dry steppic herb-rich meadows of Ukraine and southern Russia

26D01   **Artemision ponticae**

Steppe meadows of the lower reaches of the Don river floodplain

E2.5 Meadows of the steppe zone

26D02 **Polygonion krascheninnikovii**

Meadows of tall herbs on fertile mineral soils of the forest and montane zones of the South Ural

E2.5 Meadows of the steppe zone 26D03

Seselion libanotis

Steppe meadows of the lower reaches of Ural river floodplain

E2.5 Meadows of the steppe zone 26D04

Trifolion montani

Dry meadows of forest-steppe and steppe in east Europe and Siberia

E2.5 Meadows of the steppe zone

26E Holoschoenetalia

Humid meadows and reed communities in the Mediterranean region 26E01

Dactylorhizo-Juncion striati

Calabro-Sicilian humid meadows of high altitudes

E1.4 Mediterranean tall-grass and [Artemisia] steppes 26E02

Deschampsion mediae

Humid pastures on loamy soils

E3.2 Mediterranean short humid grassland

26E03 **Gaudinio fragilis-Hordeion bulbosi**

Humid meadows on sandy soils along the Mediterranean coast 26E04

Molinio-Holoschoenion

Reed communities on humid and seasonally sub-saline soils on ancient dune systems

C3.3 Water-fringing beds of tall canes

C3.4 Species-poor beds of low-growing water-fringing or amphibious vegetation

D5.2 Beds of large sedges normally without free-standing water E3.1

Mediterranean tall humid grassland

26E05 **Sieglingion decumbentis**

Wet meadows on edges of mountain water courses in Corsica

26F Molinietalia

Meadowsand pastures of moister soils, often peaty

26F01 **Alopecurion pratensis**

Meadows of fresh nutrient-rich soils dominated by graminoids, in floodplains of large rivers in central and eastern Europe

E2.1 Permanent mesotrophic pastures and aftermath-grazed meadows E2.2

Coarse permanent grassland and tall herbs, usually mown but little grazed

E3.3 Sub-mediterranean humid meadows

E3.4 Moist or wet eutrophic and mesotrophic grassland 26F02

Calthion palustris

Wet meadows and pastures of fertile, often manured soils of western and central Europe

D5.2 Beds of large sedges normally without free-standing water

E2.1 Permanent mesotrophic pastures and aftermath-grazed meadows E3.4

Moist or wet eutrophic and mesotrophic grassland

E5.5 Subalpine moist or wet tall-herb and fern habitats

26F03 **Carici distichae-Oenanthion fistulosae**

Submediterranean-atlantic wet meadows of broad valleys of western Europe 26F04

Cnidion venosi

Floodplain alluvial meadows of sub-continental regions of central Europe *E3.4 Moist or wet eutrophic and mesotrophic grassland*

26F05 **Deschampsion cespitosae**

Oligohaline moist tussocky meadows of southeast Europe *E3.4 Moist or wet eutrophic and mesotrophic grassland* 26F06 **Fiipendulion**

Tall-herb vegetation, seldom mown or grazed, on moist fertile mineral soils and peats

D5.2 Beds of large sedges normally without free-standing water E3.4 Moist or wet eutrophic and mesotrophic grassland

E5.4 Moist or wet tall-herb and fern fringes and meadows E5.5 Subalpine moist or wet tall-herb and fern habitats

26F07 **Juncion acutiflori**

Meadows and pastures of moist peaty mineral soils with flushing or impeded drainage

E3.4 Moist or wet eutrophic and mesotrophic grassland E3.5 Moist or wet oligotrophic grassland

26F08 **Junco-Molinion**

Meadows of moist but fresh soils in western Europe, usually unmanured *E3.5 Moist or wet oligotrophic grassland*

26F09 **Lythro-Euphorbion**

Meadows of moist soils in the river valleys of the semi-desert zone of European Russia

E3.4 Moist or wet eutrophic and mesotrophic grassland E5.4 Moist or wet tall-herb and fern fringes and meadows 26F10 **Molinion caeruleae**

Wet unmanured low-altitude meadows of central Europe *E3.4 Moist or wet eutrophic and mesotrophic grassland E3.5 Moist or wet oligotrophic grassland*

26F1 1 **Trifolion squamosi**

Slightly saline inundated herb-rich meadows of hind-dune habitats *A2. 6 Coastal saltmarshes and saline reedbeds*

26F 12 **Veronico longifoliae-Lysimachion vulgaris**

Central European sub-continental unmown tall-forb meadows on alluvia of large rivers

E5.4 Moist or wet tall-herb and fern fringes and meadows

26G PASPALO-HELEOCHLOETALIA

Periodically flooded grasslands of muddy alluvia in the Mediterranean region 26G01

Paspalo-Agrostidion semiverticillati

Grassy carpets on muddy soils in the western Mediterranean region

E1.4 Mediterranean tall-grass and [Artemisia] steppes

E5.4 Moist or wet tall-herb and fern fringes and meadows 26G02

Trifolio fragiferi-Cynodontion

Slightly saline flooded disturbed grasslands of the Mediterranean region

26H PLANTAGINI-PRUNELLETALIA

Weedy grasslands on trampled soils of shaded habitats

26H01 **Plantagini-Prunellion**

Weedy grasslands on trampled soils of shaded habitats

E3.4 Moist or wet eutrophic and mesotrophic grassland

26I POO ALPINAE-TRISETETALIA

High-altitude mesic hay meadows of the Alps

26I01 **Poion alpinae**

Cattle pastures of heavy fertile soils in subalpine belt of the Alps and Carpathians

E2.1 Permanent mesotrophic pastures and aftermath-grazed meadows E4.5 Alpine and subalpine enriched grassland

26I02 **Poion supinae**

Grasslands of heavily-trampled and overgrazed pastures at higher altitudes in temperate mountains of Europe

26I03 **Triseto-Polygonion bistortae**

Meadows of well-drained, relatively fertile mineral soils in low-input agricultural
systems of montane regions

E2.2 Coarse permanent grassland and tall herbs, usually mown but little grazed
E2.3 Mountain hay meadows
E4.5 Alpine and subalpine enriched grassland

26J   POTENTILLO-POLYGONETALIA

Temporarily flooded disturbed grasslands of temperate Europe

26J01   **Alopecurion utriculati**

Oligohaline mediterranean-subatlantic meadows of western Europe

26J02   **Potentillion anserinae**

Low herb communities of variable habitats with wet-dry, or brackish-fresh conditions

B1.4 Coastal stable dune grassland (grey dunes)
B1.8 Moist and wet dune slacks
C1.6 Temporary lakes, ponds and pools (wet phase)
D6. 1 Inland saltmarshes
E2.1 Permanent mesotrophic pastures and aftermath-grazed meadows
*E2. 6 Agriculturally-improved, re-seeded and heavily fertilized grassland, including sports
fields and grass lawns*
E3.4 Moist or wet eutrophic and mesotrophic grassland
E.6.2 Continental inland saline grass and herb-dominated habitats
*H5.3 Clay, silt, sand and gravel habitats with very sparse or no
vegetation*

26K   TRIFOLIO-HORDEETALIA

Amphiadriatic meadows of endorhoeic basins (polj es) and similar periodicallyflooded habitats

26K01   **Molinio-Hordeion secalini**

Dalmatian riverine and floodplain damp meadows *E3.3 Sub-
mediterranean humid meadows* 26K02   **Ranunculion velutini**

Apennine damp meadows of karstic plains *E3.3 Sub-
mediterranean humid meadows* 26K03   **Trifolion pallidi**

Riverine and damp meadows of the northern Dinarides *E3.3 Sub-
mediterranean humid meadows*

26K04   **Trifolion resupinati**

Oligohaline flooded meadows in central and southern Balkans and northern Greece

E3.3 Sub-mediterranean humid meadows

27   **STIPO GIGANTEAE-AGROSTIETEA CASTELLANAE**

Mediterranean-Iberoatlantic meso- to supra-mediterranean perennial grasslands

27A   AGROSTIETALIA CASTELLANAE

Iberian perennial pastures of meso- and supra-mediterranean belts

27A01   **Agrostio castellanae-Stipion giganteae**

Pastures on humic brown soils in the mediterranean zone of Iberia

E1.A Mediterranean dry acid and neutral open grassland

27A02   **Agrostion castellanae**

Iberian meso- to supra-mediterranean perennial grasslands

E2.4 Iberian summer pastures (vallicares)

27A03   **Festucion elegantis**

Pastures on humic brown soils in humid Mediterranean mountains in Iberia *E1.8
Mediterranean dry acid and neutral closed grassland*

27B   FESTUCETALIA JUBATAE

Supra-mediterranean open grasslands of the Azores and Madeira 27B01

Deschampsio maderensis-Parafestucion albidae

Supra-mediterranean open grasslands of Madeira

28   **FESTUCO-BROMETEA**

Steppes, rocky steppes and sandy grasslands of the sub-continental temperate and subboreal regions

28A **ASTRAGALO-POTENTILLETALIA**

Dry steppic grasslands of the submontane and montane belt of the south-central Balkans

28A01 **Armerio-Potentillion**

Dry steppic grasslands over siliceous bedrock in the montane belt of Macedonia

28A02 **Koelerio-Festucion dalmaticae**

Dry steppic grasslands over dolomite and ultramafic rock in Serbia 28A03

Saturejo-Thymion

Dry steppic grasslands over ultramafic rocks of Macedonia and south Serbia

28B **BRACHYPODIETALIA PHOENICOIDIS**

West and central Mediterranean dry perennial meadows and abandoned fields 28B01

Brachypodion phoenicoidis

West and central Mediterranean dry perennial meadows and abandoned fields *E1.2*

Perennial calcareous grassland and basic steppes

E5. 1 Over-grazed arid Mediterranean garrigues (ermes)

28C **BROMETALIA ERECTI**

Meso-xerophilous grasslands on deep calcareous soils

28C01 **Artemisio albae-Dichanthion ischaemi**

Meso-xerophilous, calcareous grasslands

28C02 **Bromion erecti**

Meso-xerophytic swards in sub-oceanic regions of western Europe *B1.4*

Coastal stable dune grassland (grey dunes)

E1.2 Perennial calcareous grassland and basic steppes

28C03 **Cirsio-Brachypodion pinnati**

Meso-xerophytic swards in sub-continental regions of central and eastern Europe

E1.2 Perennial calcareous grassland and basic steppes 28C04

Cytiso-Bromion caprini

Submediterranean subarid grasslands of mid-altitudes in Calabria *F7.4*

Hedgehog-heaths

28C05 **Danthonio-Brachypodion**

Meso-xerophilous grasslands of the southern and eastern Carpathians *E1.2*

Perennial calcareous grassland and basic steppes

28C06 **Festuco-Bromion**

Meso-xerophytic swards of submediterranean regions of Provence and the Ligurian Alps

28C07 **Gentianello amarellae-Avenulion pratensis**

Meso-xerophytic swards of north-west Europe

28C08 **Phleo ambigui-Bromion erecti**

Meso-xerophytic submontane-montane swards of the northern and central Apennines

E1.5 Mediterraneo-montane grassland

28C09 **Potentillo montanae-Brachypodion rupestris**

Steppic grasslands of northern Spain and the Pyrenees

E1.2 Perennial calcareous grassland and basic steppes 28C10

Teucrio pyrenaici-Bromion erecti

Calcareous chamaephyte-rich dry pastures in the Cantabrian area *F7.4*

Hedgehog-heaths

28D **BROMOPSIETALIA CAPPADOCICAE**

Steppes and dwarf semi-shrubby communities of Crimean mountains 28D01

Adonido vernalis-Stipion tirsae

Crimean steppes and dwarf-shrub communities of low altitudes 28D02

Carici humilis-Androsacion tauricae

Crimean steppes and dwarf-shrub communities of higher altitudes 28D03

Veronico multifidae-Stipion ponticae

Communities of foothills in the eastern part of south Crimean coast and northern Crimean mountains

28E   FESTUCETALIA VAGINATAE

European Continental steppes and dry meadows on sandy soils 28E01

Bromion tectorum

Pioneer vegetation among Pannonian steppe grasslands on acid sands *E1.2*

Perennial calcareous grassland and basic steppes

E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland

28E02   **Cynodonto-Teucrion polii**

Communities of older quartz sands and shell detritus on dunes with primitive soils in the Azov region

E1.2 Perennial calcareous grassland and basic steppes 28E03

Festucion beckeri

Communities of Ukrainian sandy steppes

B1.4 Coastal stable dune grassland (grey dunes)

E1.2 Perennial calcareous grassland and basic steppes E3.4 Moist or wet eutrophic and mesotrophic grassland 28E04   **Festucion vaginatae**

Communities of Pannonian sandy steppes

E1.2 Perennial calcareous grassland and basic steppes

E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland

E3.4 Moist or wet eutrophic and mesotrophic grassland 28E05

Scabiosion ucranicae

Sand steppes of plains around the western seaboard of the Black Sea

B1.4 Coastal stable dune grassland (grey dunes)

E1.2 Perennial calcareous grassland and basic steppes

28E06   **Verbascion pinnatifidii**

Communities of young quartz sands and shell detritus behind avadunes in the Azov region

B1.3 Shifting coastal dunes

E1.2 Perennial calcareous grassland and basic steppes

28F   FESTUCETALIA VALESIACAE

Sub-continental to continental closed fescue pastures and swards 28F01

Agropyrion pectinati

Xerophilous steppes on slightly saline soils described from the middle Volga region

E1.2 Perennial calcareous grassland and basic steppes 28F02

Artemisio tauricae-Festucion

Xerothermic communities on volcanic substrates in the Crimea 28F03

Danthonio-Stipion tirsae

Circum-Pannonian steppic grasslands on deep soils with fluctuating yearly moisture regime

E1.2 Perennial calcareous grassland and basic steppes 28F04

Diplachnion

Periodically arid swards on clayey soils in continental valleys of the eastern Alps

E1.2 Perennial calcareous grassland and basic steppes 28F05

Festucion valesiacae

Sub-continental closed fescue pastures and swards of central Europe

E1.2 Perennial calcareous grassland and basic steppes

E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland

28F06   **Helianthemo-Globularion**

Sub-boreal and boreal steppes of rendzinas on hard limestone (alvars)

E1.1 Open thermophile pioneer vegetation of sandy or detritic ground E1.2 Perennial calcareous grassland and basic steppes

28F07 **Stipion lessingianae**

Steppes of deep soils in Moldova, Dobrudga and southern Ukraine *E1.2*

Perennial calcareous grassland and basic steppes 28F08 **Stipo-Poion carniolicae**

Very arid swards of continental valleys in the western Alps *E1.2*

Perennial calcareous grassland and basic steppes 28F09 **Stipo-Poion xerophilae**

Very arid swards of continental valleys in the central and eastern Alps *E1.2*

Perennial calcareous grassland and basic steppes

28F 10 **Thymo comosi-Festucion sulcatae**

Steppic dry grasslands of Transsylvania

28G HALACSYETALIA SENDTNERI

Steppic vegetation on ultramafic soils in the Balkans

28G01 **Centaureo-Bromion fibrosi**

Rocky steppic grasslands over ultramafic bedrocks in Serbia and Albania 28G02

Polygonion albanicae

Rocky steppic grasslands over ultramafic bedrocks in central Bosnia 28G03

Potentillion visianii

Rocky steppic grasslands over ultramafic bedrocks in eastern Bosnia

28H HELICTOTRICHO-STIPETALIA

Continental temperate grasslands of the steppe and semi-desert zones of the south Urals region and northern Kazakhstan

28H01 **Centaurion sumensis**

Xerophilous steppe communities of stony substrates in the Middle Volga region

E1.2 Perennial calcareous grassland and basic steppes 28H02

Helictotricho desertori-Stipion rubentis

Continental steppes of North Kazakhstan and the South Ural

E1.2 Perennial calcareous grassland and basic steppes 28H03

Lathyro pallescentis-Helictotrichion schelliani

Xero-mesophilous steppes in the South Ural region 28H04

Orostachyion spinosae

Floristically impoverished dry steppe communities of stony substrates

E1.2 Perennial calcareous grassland and basic steppes 28H05

Scorzonero austriacae-Koelerion sclerophyllae

Xerophilous steppes of calcareous soils in the South Ural region

E1.2 Perennial calcareous grassland and basic steppes 28H06

Tanaceto-Stipion lessingianae

Steppes of west Kazakhstan and adjacent parts of Russia

28I KOELERIO-PHLEETALIA PHLEOIDIS

Silicicolous rocky steppic grasslands of western and central Europe 28I01

Chrysopogono-Danthonion

Steppic swards of lime-poor sandy soils in Serbia

E1.2 Perennial calcareous grassland and basic steppes 28I02

Koelerio-Phleion phleoidis

Steppic rocky grasslands and swards of lime-poor sandy soils in central and Western Europe

E1.2 Perennial calcareous grassland and basic steppes

E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland

F4.2 Dry heaths

28J   Poo-Agrostietalia vinealis

Mesoxerophilous acidophilous alluvial sandy grasslands of Ukraine 28J01

Agrostio-Avenulion schellianae

Steppic acidophilous swards in eastern Europe

28J02   **Agrostion vinealis**

Xero-mesophilous meadows on leached chernozem-like soils *E2.5*

Meadows of the steppe zone

28K   Scorzonero-Chrysopogonetalia

Calcareous karstic grasslands of the Illyric-Dinaric region 28K01

Centaureion dichroanthae

Illyrian-Praealpic steppic pastures on shallow calcareous soils 28K02

Chrysopogoni-Saturejon

Illyrian-Dinaric steppic pastures on shallow calcareous soils

E1.2 Perennial calcareous grassland and basic steppes F2.2

Evergreen alpine and subalpine heath and scrub

28K03   **Chrysopogono-Koelerion splendentis**

I   Ilyrian-Dinaric open steppic grasslands on calcareous substrates

28K04   **Scorzonerion villosae**

Illyrian-Dinaric dry pastures on deep, partly decalcified terra rossa and argillaceous flysch sediments of the Illyric and Dinaric regions

28L   Seslerietalia rigidae

Dealpine, closed, blue-grass dominated grasslands of the Alps, Hercynicum and Carpathians

28L01   **Diantho lumnitzeri-Seslerion albicantis**

Dealpine grasslands on limestone and dolomite in south-east central Europe *E1.1 Open thermophile pioneer vegetation of sandy or detritic ground E1.2 Perennial calcareous grassland and basic steppes*

28L02   **Seslerio-Xerobromion**

Dealpine calcareous grasslands of the northern fringes of the Alps and of Hercynicum

E1.2 Perennial calcareous grassland and basic steppes 28L03

Seslerion rigidae

East Carpathian dealpine closed calcareous grasslands

E1.2 Perennial calcareous grassland and basic steppes

E4.4 Calciphilous alpine and subalpine grassland

28M   Stipo pulcherrimae-Festucetalia pallentis

Open xerophilous rocky grasslands of sunny aspects of central and southeast Europe 28M01

Alyssion bertolonii

Steppic vegetation on ultramafic soils in the northern Apennines and Tuscany *E1.2 Perennial calcareous grassland and basic steppes*

28M02   **Alysso saxatilis-Festucion pallentis**

Open grasslands on mineral-rich siliceous rocks in the eastern Hercynicum *E1.2 Perennial calcareous grassland and basic steppes*

28M03   **Asplenio septentrionali-Festucion pallentis**

Open grasslands on shallow silicicolous soils in southwestern Europe *E1.2 Perennial calcareous grassland and basic steppes*

28M04   **Avenulo adsurgentis-Festucion pallentis**

Serpentine steppe vegetation of the eastern Alps

E1.2 Perennial calcareous grassland and basic steppes 28M05

Bromo pannonici-Festucion pallentis

Open xerophilous rocky calcareous grasslands of sunny aspects on northern fringes of the Pannonian Basin

E1.1 Open thermophile pioneer vegetation of sandy or detritic ground E1.2 Perennial calcareous grassland and basic steppes

28M06   **Chrysopogono-Festucion dalmaticae**

Open xerophilous rocky calcareous grasslands of sunny aspects on southern and southeastern fringes of the Pannonian Basin

E1.2 Perennial calcareous grassland and basic steppes 28M07

Helianthemo cani-Festucion pallentis

Rocky steppic grasslands on calcareous substrata of the Hercynicum

E1.2 Perennial calcareous grassland and basic steppes

28M08   **Pimpinello-Thymion zygoidi**

Semi-evergeen phrygana-like vegetation of the east Balkan steppes *E1.2*

Perennial calcareous grassland and basic steppes 28M09   **Xerobromion**

Xerophilous open swards in south-west central Europe

E1.2 Perennial calcareous grassland and basic steppes

28N   THYMO CRETACEI-HYSSOPETALIA CRETACEI

Xerothermic grasslands on chalky outcrops in south-west European Russia and Ukraine

28N01   **Artemisio hololeucae-Hyssopion cretacei**

Communities of the south-western central Russian uplands

28N02   **Centaureo carbonatae-Koelerion talievii**

Grassy communities of the south-western central Russian uplands

28N03   **Euphorbio cretophilae-Thymion cretacei**

Communities of the lower reaches of the North Donetz river valley

28N04   **Galio campanulatae-Poion versicoloris**

Communities of calcareous soils on very steep rocky slopes of the Ukraine *E1.2*

Perennial calcareous grassland and basic steppes

29   KOELERIO-CORYNEPHORETEA

Pioneer vegetation on primitive soils and rocky outcrops in regions with mild winter climate

29A   ALYSSO-SEDETALIA

Temperate pioneer grasslands and therophyte swards on calcareous immature soils 29A01

Alysso alyssoidis-Sedion albi

Thermophilous stonecrop communities of weathered calcareous rocks

E1.1 Open thermophile pioneer vegetation of sandy or detritic ground E1.2 Perennial calcareous grassland and basic steppes

29A02   **Sedion micrantho-sediformis**

Communities of calcareous outcrops in thermo-mesomediterranean southwestern Iberia

29A03   **Sedo-Cerastion**

More or less closed swards on base rich, rather nutrient poor river dunes *E1.1*

Open thermophile pioneer vegetation of sandy or detritic ground E1.2 Perennial calcareous grassland and basic steppes

E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland

29B   ARTEMISIO-KOELERIETALIA

Bryophyte-rich grasslands on dry, calcareous soils in coastal dunes 29B01

Koelerion arenariae

Ephemeral vegetation of bare but stable calcareous sands

B1.4 Coastal stable dune grassland (grey dunes)

E1.1 Open thermophile pioneer vegetation of sandy or detritic ground E1.2 Perennial calcareous grassland and basic steppes

E1. 7 Non-Mediterranean dry acid and neutral closed grassland E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland

29B02   **Polygalo-Koelerion**

More or less closed (but not dense) swards on calcareous sands

E1. 7 Non-Mediterranean dry acid and neutral closed grassland

29C   CORYNEPHORETALIA CANESCENTIS

Open swards on sand of sub-atlantic regions of western and central Europe 29C01

Armerion girardii

Mediterranean sub-montane grasslands on dolomite sand in southern France *E1.3*
Mediterranean xeric grassland

29C02   **Corynephorion canescentis**

Colonising vegetation of mobile acid sands on coastal and inland dunes *B1.4*
Coastal stable dune grassland (grey dunes)
E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland

29C03   **Thero-Airion**

Ephemeral vegetation of bare but stable acid sands or siliceous rocky outcrops
B1.4 Coastal stable dune grassland (grey dunes)
E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland

29D   FESTUCO-SEDETALIA

Dry grasslands on neutral sandy soils

29D01   **Koelerion glaucae**

Grasslands of stable neutral sandy soils in central and northeastern Europe *E1.1 Open thermophile pioneer vegetation of sandy or detritic ground E1.2 Perennial calcareous grassland and basic steppes*
E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland

29D02   **Plantagini-Festucion ovinae**

Closed swards of neutral to acidic, drought-prone soils
B1.4 Coastal stable dune grassland (grey dunes)
B1.9 Machair
E1.2 Perennial calcareous grassland and basic steppes
E1. 7 Non-Mediterranean dry acid and neutral closed grassland E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland
E1.B Heavy-metal grassland

29E   SEDO-POETALIA GLAUCAE

Scandinavian pioneer vegetation on fine-grained and loam-rich shallow raw soils and rocky outcrops

29E01   **Veronico-Poion glaucae**

Scandinavian pioneer vegetation on fine-grained and loam-rich shallow raw soils and rocky outcrops
H2 Screes
H2. 1 Boreal siliceous screes

29F   SEDO-SCLERANTHETALIA

Pioneer grasslands and herb communities on immature soils over base-poor rocks 29F01

Hyperico perforati-Scleranthion perennis

Open grasslands on shallow soils on siliceous rocks in central Europe
B1.4 Coastal stable dune grassland (grey dunes)
E1.1 Open thermophile pioneer vegetation of sandy or detritic ground E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland

29F02   **Sedion anglici**

Stonecrop communities of shallow soils in the Atlantic zone
E1.1 Open thermophile pioneer vegetation of sandy or detritic ground 29F03

Sedion pyrenaici

Stonecrop communities of siliceous rocks in the Pyrenees and western Iberia
H3. 6 Weathered rock and outcrop habitats

29F04   **Sedo albi-Veronicion dillenii**

Therophyte and geophyte vegetation on stable siliceous rubble

E1.1 Open thermophile pioneer vegetation of sandy or detritic ground 29F05

Sedo-Scleranthion biennis

Stonecrop communities of sunny slopes in the alpic valleys

E1.1 Open thermophile pioneer vegetation of sandy or detritic ground H3. 6

Weathered rock and outcrop habitats

30   CALLUNO-ULICETEA

Dwarf-shrub and mat-grass heaths on acidic soils from the planare to montane belts

30A   NARDETALIA STRICTAE

Mat-grass swards on nutrient-poor soils at mid-altitudes

30A01   **Agrostion curtisii**

Mesophytic oligotrophic low-altitude grasslands of thermo-atlantic regions of France

E1. 7 Non-Mediterranean dry acid and neutral closed grassland 30A02

Carici macrostylae-Nardion strictae

Cantabrian species-rich mat-grass pastures

30A03   **Equiseto-Galion borealis**

Slightly chionophilous grasslands on base-rich, deep soils of Iceland and Greenland

30A04   **Juncion squarrosi**

Heath-rush vegetation on peaty soils

B1.4 Coastal stable dune grassland (grey dunes)

E3.5 Moist or wet oligotrophic grassland

30A05   **Nardo-Agrostion tenuis**

Species-rich mat-grass pastures of central European mountains *E4.3 Acid*

alpine and subalpine grassland

30A06   **Potentillion calabri**

Calabrian (Sila) high-altitude species-rich mat-grass pastures *E1.8*

Mediterranean dry acid and neutral closed grassland E4.3 Acid alpine

and subalpine grassland

30A07   **Potentillo-Polygonion vivipari**

Slightly chionophilous heavily grazed pastures on base-rich soils of Scandinavia

E4. 1 Snow-patch grassland

30A08   **Violion caninae**

Unfertilised mat-grass pastures at lower altitudes

B1.4 Coastal stable dune grassland (grey dunes)

E1. 7 Non-Mediterranean dry acid and neutral closed grassland F4.2 Dry

heaths

30B   ULICETALIA MINORIS

Gorse and ericoid heaths of winter-mild western Europe and Morocco

30B01   **Daboecion cantabricae**

Heathlands over ferric-humic podsols of northern Iberia

F4.1 Wet heaths F4.2 Dry

heaths

30B02   **Dactylido maritimae-Ulicion maritimi**

Gorse heaths of Atlantic coast sea-cliffs

F4.2 Dry heaths

30B03   **Ericion cinereae**

Bell-heather communities on dry to fresh soils in sub-atlantic regions

B1.5 Coastal dune heaths

F4.2 Dry heaths

30B04   **Ericion umbellatae**

Mediterranean-Ibero-Atlantic heaths of central-western and southwest Iberia and northwest Morocco

B1.5 Coastal dune heaths

F4.2 Dry heaths F5.2 Maquis
F5.5 Thermo-Mediterranean shrub habitats

30B05   **Genistion micrantho-anglicae**

Hygrophilous heaths of Mediterranean and Ibero-Atlantic distribution on gley, humus-rich soils

F4.1 Wet heaths F4.2 Dry heaths F5.5 Thermo-Mediterranean shrub habitats

30B06   **Stauracanthion boivinii**

Southern Iberian and Moroccan silicicolous brezal
F5.2 Maquis
F5.5 Thermo-Mediterranean shrub habitats

30B07   **Ulici-Ericion ciliaris**

Gorse-Dorset heath communities of damper soils in the Atlantic region
F4.1 Wet heaths
F4.2 Dry heaths

30B08   **Ulicion minoris**

Gorse heaths of the Atlantic region
B1.5 Coastal dune heaths
F4.1 Wet heaths
F4.2 Dry heaths

30C   Vaccinio-Genistetalia

Heaths of temperate central and northwestern Europe

30C01   **Empetrion nigri**

Coastal dune heathlands of northwestern and northern Europe
B1.5 Coastal dune heaths

30C02   **Genistion pilosae**

Greenweed heathlands in the lowland and montane zone of northwestern and central Europe
B1.5 Coastal dune heaths
E1.9 Dry, open perennial and annual siliceous grassland, including inland dune grassland
F2.2 Evergreen alpine and subalpine heath and scrub
F4.2 Dry heaths

30C03   **Genisto-Vaccinion**

Bilberry heaths of moist soils in the montane to subalpine belts of western Europe
B1.5 Coastal dune heaths
F2.2 Evergreen alpine and subalpine heath and scrub
F4.2 Dry heaths

31   Trifolio-Geranietea sanguinei

Thermophilous woodland fringe vegetation

31A   Melampyro-Holcetalia

Herbaceous vegetation of woodland margins and rides on impoverished acid sands

31A01   **Linarion triornithophorae**

Acidophilous fringe vegetation of northern Spain
E5.2 Thermophile woodland fringes

31A02   **Melampyrion pratensis**

Woodland margin and ride vegetation in drier situations
E5.2 Thermophile woodland fringes 31A03

Origanion virentis

Species-rich fringe vegetation of the mesomediterranean belt of Cantabria
E5.2 Thermophile woodland fringes

31A04   **Potentillo erectae-Holcion mollis**

Woodland margin and ride vegetation on damp soils of the western part of central Europe

> *E5.2 Thermophile woodland fringes*
>
> *E5.3 [Pteridium aquilinum] fields*

31A05   **Ranunculo cortusifolii-Geranion canariensis**

Herb-rich fringe of Canary laurel forests

31B   ORIGANETALIA VULGARIS

Herbaceous vegetation of woodland margins and rides on calcareous soils

31B01   **Dictamno-Ferulagion galbaniferae**

Species-rich fringes of Illyrian forests

> *E5.2 Thermophile woodland fringes* 31B02

Galio littoralis-Geranion sanguinei

Fringe vegetation of dune thickets of the Atlantic coast

> *B1.4 Coastal stable dune grassland (grey dunes)*
>
> *E5.2 Thermophile woodland fringes* 31B03

Geranion sanguinei

Drought-tolerant communities in sunny woodland edges on calcareous soils

> *B1.4 Coastal stable dune grassland (grey dunes)*
>
> *E5.2 Thermophile woodland fringes* 31B04

Trifolion medii

Fringe communities of central European mesophilous forests

> *E5.2 Thermophile woodland fringes*

H DRY GRASSLANDS AND SEMI-DESERTS

32   HELIANTHEMETEA GUTTATI

Mediterranean terrestrial plant communities dominated by annual low-grown herbs and grasses

32A   HELIANTHEMETALIA GUTTATI

Mediterranean and submediterranean ephemeral communities on acid soils in fire prone habitats

32A01   **Helianthemion guttati**

Early flowering communities on sandy soils

> *B1.4 Coastal stable dune grassland (grey dunes)*
>
> *E1.8 Mediterranean dry acid and neutral closed grassland*
>
> *H6. 3 Fumaroles, solfataras and mofettes*

32A02   **Molinerion laevis**

Late flowering communities on sandy soils

32A03   **Scabioso-Trifolion dalmatici**

Silicicolous therophyte swards of submediterranean character in southeast Serbia

32A04   **Sedion pedicellato-andegavensis**

Communities of succulent annuals on fine gravel over silicate rocks

32A05   **Trifolion cherleri**

Silicicolous therophyte swards of submediterranean character in Macedonia and northern Greece

32B   MALCOLMIETALIA

Mediterranean ephemeral vegetation of coastal sand dunes and beaches 32B01

Anthyllido hamosae-Malcolmion lacerae

Communities of coastal sandy habitats not exposed to saline influence

> *B1.4 Coastal stable dune grassland (grey dunes)*

32B02   **Corynephoro-Malcolmion patulae**

Ephemeral therophyte communities of inland sandy substrates of interior western Iberia

E1.8 Mediterranean dry acid and neutral closed grassland

E1.A Mediterranean dry acid and neutral open grassland

32B03   **Linarion pedunculatae**

Coastal dunes exposed to saline influence

B1.4 Coastal stable dune grassland (grey dunes)

32B04   **Alkanno-Maresion nanae**

Ephemeral therophyte communities of coastal and inland sandy areas of the Ibero-Levantine area

32B05   **Maresion nanae**

Ephemeral therophyte communities of semi-mobile coastal dunes of the central and eastern Mediterranean

32B06   **Medicagini-Triplachnion nitentis**

Short-lived communities of sandy and gravelly beaches of the eastern Aegean and southern Anatolia

32B07   **Ononidion tournefortii**

Therophyte communities of deep coastal sandy soils of the Canary Islands

32C   POETALIA BULBOSAE

Mediterranean and sub-mediterranean pastures heavily grazed, trampled and manured by sheep

32C01   **Plantaginion serrariae**

Heavily grazed pastures

32C02   **Poo bulbosae-Astragalion sesamei**

Heavily grazed pastures on calcareous soils in central and eastern Iberia 32C03

Trifolio subterranei-Periballion

Heavily grazed pastures on siliceous soils in central and western Iberia 32C04

Vulpio ciliatae-Crepidion neglectae

Therophyte swards of disturbed habitats rich in calcareous rubble in the central Mediterranean

32D   STIPO-BUPLEURETALIA SEMICOMPOSITI

Subhalophilous therophyte swards of the most arid regions of the Mediterranean with influence of eremian elements

32D01   **Asterisco-Velezion rigidae**

Subhalophilous therophyte swards of the continental regions of the Iberian Peninsula

32D02   **Dauco-Catananchion luteae**

Subhalophilous therophyte swards on loamy-clayey soils of Sicily and southern Calabria

E1.3 Mediterranean xeric grassland

32D03   **Plantagini-Catapodion marini**

Subhalophilous therophyte swards of the Tyrrhenian region

E1.3 Mediterranean xeric grassland

32E   TRACHYNIETALIA DISTACHYAE

Mediterranean ephemeral communities and pastures on basic soils

32E01   **Trachynion distachyae**

Ephemeral therophyte communities and pastures on base-rich soils *E1.3 Mediterranean xeric grassland*

32E02   **Laguro-Vulpion fasciculatae**

Subnitrophilous therophytic grasslands of disturbed coastal dunes of Corsica 32E03

Omphalodion commutatae

Mediterranean ephemeral communities and pastures on magnesitic soils

E1.3 Mediterranean xeric grassland 32E04

Sedo-Ctenopsion gypsophilae

Mediterranean ephemeral communities and pastures on gypsum substrates

E1.3 Mediterranean xeric grassland 32E05

Stipion retortae

Mediterranean ephemeral communities and pastures on calcareous soils or chalk loam

E1.3 Mediterranean xeric grassland 32E06

Vulpio-Lotion

Mediterranean therophyte communities on terra rosa and calcareous soils in the Illyric-Dinaric coastal region

E1.8 Mediterranean dry acid and neutral closed grassland

32E07 **Vulpion ligusticae**

Ephemeral communities on base-rich soils of the Tyrrhenian region

32E08 **Xeranthemion annui**

Annual-rich vegetation of abandoned fields in Macedonia

33 THERO-BRACHYPODIETEA RAMOSI

Mediterranean pseudo-steppes and related perennial grasslands

33A CYMBOPOGONI-BRACHYPODIETALIA

East Mediterranean pseudosteppes dominated by tufted perennial grasses 33A01

Cymbopogoni-Brachypodion ramosi

Pseudosteppes on limestone in coastal areas of the Balkan Peninsula *E1.3 Mediterranean xeric grassland*

33B HYPARRHENIETALIA HIRTAE

Tall tufted grasslands of the west and central Mediterranean 33B01

Hyparrhenion hirtae

Iberian and Sicilian tall tufted grasslands on exposed rocky slopes

E1.4 Mediterranean tall-grass and [Artemisia] steppes

F6.2 Eastern garrigues

33C THERO-BRACHYPODIETALIA

Mediterranean perennial grasslands (pseudosteppes)

33C01 **Agropyro pectinati-Lygeion**

Spanish and South Italian dense grasslands on continental clayey basins *E1.4 Mediterranean tall-grass and [Artemisia] steppes*

33C02 **Avenulo-Ampelodesmion mauritanici**

Thermomediterranean perennial tussocky grasslands dominated by Ampelodesmos mauritanicus of Calabria and Sicily

33C03 **Diantho humilis-Velezion rigidae**

Pseudosteppic communities of montane regions of the Crimea

E1.3 Mediterranean xeric grassland

33C04 **Festucion scariosae**

Spanish dense Festuca grasslands on basic substrates mainly in mediterraneanmontane zone

E1.4 Mediterranean tall-grass and [Artemisia] steppes

33C05 **Moricandio-Lygeion sparti**

Perennial, calcareous grasslands of mediterranean Italy

E1.3 Mediterranean xeric grassland

33C06 **Stipion parviflorae**

Calcareous sub-nitrophilous dry to semi-arid grasslands of the Ibero-Levantine area

33C07 **Stipion tenacissimae**

South Spanish dense Stipa grasslands on limestone or chalk in the mediterranean-arid belt

E1.4 Mediterranean tall-grass and [Artemisia] steppes

33C08 **Thero-Brachypodion**

Mediterranean garrigues and pseudosteppes on calcareous substrates

E1.3 Mediterranean xeric grassland F6. 1
Western garrigues

33C09   **Triseto velutini-Brachypodion boissieri**

Mediterranean perennial grasslands of Spain

34   PEGANO HARMALAE-SALSOLETEA VERMICULATAE

Thermomediterranean and Macaronesian halo-nitrophilous semidesert scrub

34A   CHENOLETALIA TOMENTOSAE

Macaronesian halo-nitrophilous semidesert scrub 34A01

Chenoleion tomentosae

Macaronesian halo-nitrophilous semidesert scrub *F6.8 Xero-halophile scrubs*

34B   FORSSKAOLEO ANGUSTIFOLIAE-RUMICETALIA LUNARIAE

Macaronesian halo-nitrophilous scrub

34B01   **Argyranthemo suculenti-Calendulion maderensis**

Madeiran halo-nitrophilous coastal scrub 34B02

Artemisio thusculae-Rumicion lunariae

Canarian halo-nitrophilous dwarf shrubs in moist or semi-arid climates

34B03   **Launaeo arborescentis-Schizogynion sericeae**

Canarian halo-nitrophilous scrub in sub-desertic climates

F8. 1 Canarian xerophytic habitats

34B04   **Traganion moquinii**

Canarian halo-nitrophilous coastal dune scrub in sub-desertic climates

B1.3 Shifting coastal dunes

B1.4 Coastal stable dune grassland (grey dunes)

34C   HELICHRYSO STOECHADIS-SANTOLINETALIA SQUARROSAE

Iberian sub-nitrophilous chamaephyte communities on degraded brown or red soils 34C01

Artemisio glutinosae-Santolinion rosmarinifoliae

Iberian sub-nitrophilous chamaephyte communities on acid soils

34C02   **Santolinion pectinato-canescentis**

IBERIAN SUB-NITROPHILOUS CHAMAEPHYTE COMMUNITIES ON BASIC SOILS

34D   NICOTIANO GLAUCAE-RICINETALIA COMMUNIS

Tall scrub, rich in tropical neophytes, of the thermomediterranean zone 34D01

Nicotiano glaucae-Ricinion communis

Tall scrub, rich in tropical neophytes, of the thermomediterranean zone

34E   SALSOLO VERMICULATAE-PEGANETALIA HARMALAE

Western Mediterranean halo-nitrophilous shrub communities in sub-desertic climates

34E01   **Artemision arborescentis**

Subnitrophilous coastal scrub of the central and eastern Mediterranean 34E02

Carthamo arborescentis-Salsolion oppositifoliae

Thermomediterranean halo-nitrophilous scrub in semi-arid to arid southeastern Spain

34E03   **Haloxylo tamariscifolii-Atriplicion glaucae**

Western Mediterranean halo-nitrophilous shrub on disturbed loamy soils 34E04

Lycio europaei-Ipomoeion purpureae

Halo-nitrophilous shrub communities

34E05   **Medicagini citrinae-Lavaterion arboreae**

Mediterranean halo-nitrophilous communities on coastal cliffs covered by guano

34E06   **Salsolo vermiculatae-Peganion harmalae**

Mediterranean inland sub-desertic halo-nitrophilous scrub on clayey soils

35   ARTEMISIETEA LERCHIANAE

Aralo-Caspian sub-halophilous semideserts

35A   ARTEMISIETALIA LERCHIANAE

Caspian desert vegetation of stabilised loamy soils

35A01 **Anabasion aphyllae**

Intensively grazed Caspian desert vegetation on loamy soils 35A02

Artemision lerchianae

Moderately grazed Caspian desert vegetation on loamy soil

35B Artemisietalia tschernievianae

Caspian desert vegetation of sandy soils

35B01 **Euphorbion seguieranae**

Caspian desert vegetation of stabilized sandy dunes

35B02 **Tamariceto-Salsolion australis**

Caspian desert vegetationon mobile wind-modelled barkhans and raised sand dune

I OROMEDITERRANEAN GRASSLANDS AND SCRUB

36 **Festucetea indigestae**

Oromediterranean Iberian xerophilous siliceous Festuca indigesta grasslands

36A Festucetalia indigestae

Oromediterranean Iberian xerophilous siliceous Festuca indigesta grasslands

36A01 **Minuartio-Festucion curvifoliae**

Alpine grasslands of the central Iberian mountains *E4.3 Acid alpine and subalpine grassland* 36A02 **Ptilotrichion purpurei**

Chamaephyte-rich crioro-mediterranean grasslands of the Sierra Nevada

E4.3 Acid alpine and subalpine grassland 36A03

Teesdaliopsio-Luzulion caespitosae

Alpine and subalpine grasslands of the Cantabrian mountains

E4.3 Acid alpine and subalpine grassland

36B Jasiono sessiliflorae-Koelerietalia crassipedis

Pastures in the Mediterranean zone of Iberia

36B01 **Armerion eriophyllae**

Pastures on serpentine in the Mediterranean zone of Iberia 36B02

Hieracio castellani-Plantaginion radicatae

Pastures with cushion chamaephytes in northern Iberia

E1.A Mediterranean dry acid and neutral open grassland E4.3 Acid alpine and subalpine grassland

37 **Festuco hystricis-Ononidetea striatae**

Dry, basiphilous pastures and scrub of hemicryptophytes and chamaephytes of humid to sub-humid, oro- to meso-mediterranean belts of southwest Europe

37A Festuco hystricis-Poetalia ligulatae

Subalpine and upper mountain zone dwarf shrub on soils with traces of cryoturbation

37A01 **Festucion burnatii**

High mountain pastures of the Cantabrian mountains *E1.5 Mediterraneo-montane grassland*

37A02 **Minuartio-Poion ligulatae**

Oromediterranean pastures of central Iberia

E1.5 Mediterraneo-montane grassland

37A03 **Plantagini discoloris-Thymion mastigophori**

Supra- and oromediterranean montane pastures of central and northern Spain

E1.5 Mediterraneo-montane grassland

37B Ononidetalia striatae

Calcareous pastures and low scrub of the colline to subalpine belts of southwestern Europe

37B01 **Echinospartion horridi**

Communities of thorny cushions on basic substrates in the central Pyrenees

F7.4 Hedgehog-heaths

37B02   **Euphorbion ligusticae**

        Ultramafic Ligurian garrigue

37B03   **Festucion scopariae**

          Upper-montane and subalpine dry pastures on basic substrates in the Pyrenees

E4.4 Calciphilous alpine and subalpine grassland

37B04   **Festucion spadiceae**

        Subalpine, thermophilous swards of Festuca spadicea in southern France and northern Iberia

E4.3 Acid alpine and subalpine grassland 37B05

       Genistion lobelii

        Low shrub vegetation of wind exposed limestone rocks *E1.5*

         Mediterraneo-montane grassland

         F7.4 Hedgehog-heaths

37B06   **Genistion occidentalis**

        Low shrubs on basic substrates in the Cantabrian Mountains and West Pyrenees

         F7.4 Hedgehog-heaths

37B07   **Lavandulo angustifoliae-Genistion cinereae**

        Supra- and oromediterranean garrigue of southern France

37B08   **Ononidion cristatae**

        Steppic grasslands of the upper montane belt in the southwestern Alps

37B09   **Ononidion striatae**

        Pastures on rendzina soils in sub-mediterranean hills *E1.5*

         Mediterraneo-montane grassland

         F6. 6 Supra-Mediterranean garrigues

37B10   **Seslerion elegantissimae**

        Supramediterranean calcareous Sesleria swards of southern France

         E1.5 Mediterraneo-montane grassland

38   CARICI CARYOPHYLLEAE-GENISTETEA SALZMANNII

       Cyrno-Sardean supramediterranean and oromediterranean siliceous phrygana

38A   CARICI CARYOPHYLLEAE-GENISTETALIA SALZMANNII

       Cyrno-Sardean oromediterranean siliceous phrygana

38A01   **Anthyllion hermanniae**

        Low scrub on exposed and windy crests on siliceous rocks

         F6. 1 Western garrigues

         F7.2 Central Mediterranean spiny heaths

         F7.4 Hedgehog-heaths

38A02   **Festuco-Armerion sardoae**

        Vegetation of cushion-like chamaephytes in windy habitats *F7.4*

         Hedgehog-heaths

38B   TEUCRIO-SANTOLINETALIA

       Secondary montane garrigue on siliceous and calcareous substrata of Sardinia 38B01

       Armerio sardoae-Genistion salzmannii

        Siliceous secondary montane garrigues of Sardinia

38B02   **Polygalo-Seslerion insularis**

        Calcareous secondary montane garrigues of Sardinia

39   SAGINETEA PILIFERAE

       Cyrno-Sardean oromediterranean siliceous grasslands

39A   SAGINETALIA PILIFERAE

       Cyrno-Sardean oromediterranean siliceous grasslands 39A01

       Plantaginion insularis

Cyrno-Sardean oromediterranean siliceous grasslands in snow-carrying depressions (pozzines)

E4.3 Acid alpine and subalpine grassland

39A02 **Sedo-Phleion brachystachyi**

Cyrno-Sardean oromediterranean siliceous grasslands of cold north aspects *E4.3 Acid alpine and subalpine grassland*

39A03 **Sesamoido-Poion violaceae**

Cyrno-Sardean oromediterranean siliceous grasslands of warm south aspects *E4.3 Acid alpine and subalpine grassland*

40 **RUMICI-ASTRAGALETEA SICULI**

Sicilian oromediterranean cushion scrub

40A RUMICI-ASTRAGALETALIA SICULI

Sicilian oromediterranean cushion scrub 40A01

Rumici-Astragalion siculi

Sicilian oromediterranean cushion scrub

F7.4 Hedgehog-heaths

H6. 1 Sparsely vegetated volcanic mountain summits, lava and ash fields

41 **DAPHNO-FESTUCETEA**

Greek and Aegean oromediterranean calciphilous grasslands and phrygana

41A DAPHNO-FESTUCETALIA

Greek and Aegean oromediterranean calciphilous grasslands and phrygana

41A01 **Astragalo angustifolii-Seslerion coerulantis**

Thorny cushion vegetation in step-shaped scarps on limestone

F7.4 Hedgehog-heaths

41A02 **Eryngio multifidi-Bromion fibrosi**

Discontinuous herb layer, zonal on limestone in the alpine belt

F7.4 Hedgehog-heaths

41A03 **Stipo pulcherrimae-Morinion persicae**

Secondary discontinuous carpet vegetation on limestone after cutting

F7.4 Hedgehog-heaths

41B SATUREJO-SCUTELLARIETALIA

Cretan oro-mediterranean calciphilous rocky grasslands and screes 41B01

Campanulion jacquinii

Rupicolous communities of high altitude in the Cretan mountains *F7.4 Hedgehog-heaths*

41B02 **Scutellarion hirtae**

Vegetation of calcareous and dolomitic screes of high mountains of Crete

41B03 **Verbascion spinosi**

Communities of calcareous and dolomitic slopes of the high mountains of western Crete

F5. 1 Arborescent matorral

F7.3 East Mediterranean phrygana

F7.4 Hedgehog-heaths

J MONTANE TALL-HERB, GRASSLAND, FELL-FIELD AND SNOWBED VEGETATION

42 **MULGEDIO-ACONITETEA**

Scrub and tall-herb vegetation at high altitudes, moistened and fertilised by percolating water

42A ADENOSTYLETALIA ALLIARIAE

Tall-herb and scrub communities on fertile soils at high altitudes of temperate and boreal Europe

42A01   **Adenostylion alliariae**

Tall-herb communities of central European mountains *E4. 1 Snow-patch grassland*

E5.5 Subalpine moist or wet tall-herb and fern habitats F2.1 Snow-patch dwarf willow scrub

F2.3 Subalpine deciduous scrub

42A02   **Adenostylion pyrenaicae**

Tall-herb communities of the Pyrenees and northern Spain *E5.5 Subalpine moist or wet tall-herb and fern habitats* 42A03   **Alnion viridis**

Subalpine green alder scrub of the Alps and Balkans *F2.3 Subalpine deciduous scrub*

42A04   **Cirsion appendiculati**

Tall-herb communities of eastern and central Balkans

E5.5 Subalpine moist or wet tall-herb and fern habitats 42A05

Cirsion flavispinae

Tall-herb communities of the Sierra Nevada

E5.5 Subalpine moist or wet tall-herb and fern habitats 42A06

Dryopterido-Athyrion

Fern-rich communities of the Carpathians and Hercynicum *E5.5 Subalpine moist or wet tall-herb and fern habitats* 42A07   **Petasition doerfleri**

Tall-herb hygrophilous communities of the subalpine belt of the Dinarides 42A08

Salicion helveticae

Silicicolous willow krummholz in subalpine belt of the Alps *F2.3 Subalpine deciduous scrub*

42A09   **Salicion pentandrae**

Calciphilous willow krummholz in subalpine belt of the Alps *F2.3 Subalpine deciduous scrub*

42A10   **Salicion silesiacae**

Tall herb-rich willow scrubs of the western Carpathians and Hercynicum *F2.3 Subalpine deciduous scrub*

42A11   **Violion cornutae**

Tall herb communities of the Pyrenees

42B   ADENOSTYLETALIA BRIQUETII

Tall-herb communities of nutrient-rich moist soils at high altitudes in Corsica 42B01

Cymbalarion hepaticifoliae

Shaded, mesophilous communities of oromediterranean belts in Corsica *F2.2 Evergreen alpine and subalpine heath and scrub*

F2.3 Subalpine deciduous scrub

42B02   **Doronicion corsici**

Tall-herb communities in the supramediterranean belt in Corsica *C2.1 Springs, spring brooks and geysers*

E5.5 Subalpine moist or wet tall-herb and fern habitats

42C   CALAMAGROSTIETALIA VILLOSAE

Tall-herb and fern communities of acidic and more impoverished soils 42C01

Calamagrostion arundinaceae

Tall-grass species-rich communities on dry soils of the upper montane and subalpine belts of western and central Europe

E5.5 Subalpine moist or wet tall-herb and fern habitats F2.3 Subalpine deciduous scrub

42C02   **Calamagrostion villosae**

Tall-herb and fern communities of acidic and more impoverished soils *E5.5*

Subalpine moist or wet tall-herb and fern habitats

F2.3 Subalpine deciduous scrub

42C03   **Festucion carpaticae**

Tall grass, chionophilous communities of upper montane and subalpine belts of the Carpathians

E5.5 Subalpine moist or wet tall-herb and fern habitats 42C04

Poo chaixii-Deschampsion caespitosae

High-altitude species-poor grasslands on moist soils of Hercynicum

E5.5 Subalpine moist or wet tall-herb and fern habitats

42D   RUMICETALIA ALPINI

Subalpine nitrophilous ruderal communities of Europe and the Caucasus 42D01

Rumicion alpini

Nitrophilous ruderal communities of the subalpine belt

E5.5 Subalpine moist or wet tall-herb and fern habitats

43   SALICETEA HERBACEAE

Vegetation of long-lasting snow-beds and slopes irrigated by melt waters

43A   SALICETALIA HERBACEAE

Vegetation of long-lasting snow-beds and slopes irrigated by melt waters

43A01   **Luzulion nivalis**

Herb-rich snow beds on lime-rich soils in the upper alpine belt of Scandinavia *E4. 1 Snow-patch grassland*

43A02   Mucizonion sedoidis

Cryo-oromediterranean and alpine silicicolous snow-bed communities of Iberia *E4. 1 Snow-patch grassland*

43A03   **Ranunculion crenati**

Herbaceous communities with long snow cover on limestone in Crna Gora 43A04

Salicion herbaceae

Dwarf-willow and moss dominated communities of snow-beds on lime-poor soils and rocks

E4. 1 Snow-patch grassland

F2.1 Snow-patch dwarf willow scrub

H2. 1 Boreal siliceous screes

H2. 3 Temperate-montane acid siliceous screes

43A05   **Saxifrago-Ranunculion nivalis**

Herb-rich snow-bed communities with solifluction in Arctic and oro-Arctic boreal mountains

E4. 1 Snow-patch grassland

F2.1 Snow-patch dwarf willow scrub

H2. 1 Boreal siliceous screes

44   ELYNO-SESLERIETEA

Alpine and subalpine calcareous grasslands

44A   ASTRAGALETALIA SEMPERVIRENTIS

Calcareous grasslands of montane to alpine belts of the northern Apennines and southwestern Alps

44A01   **Avenion montanae**

Calcareous grasslands on rocky slopes

E4.4 Calciphilous alpine and subalpine grassland 44A02

Avenion sempervirentis

Supramediterranean calcareous xerophilous open grasslands of the Alpes Maritimes and Ligurian Alps

E4.4 Calciphilous alpine and subalpine grassland 44A03

Ononidion cenisiae

Calcareous grasslands in the Apennines and southwestern Alps

E4.4 Calciphilous alpine and subalpine grassland

44B CREPIDETALIA DINARICAE

Montane to alpine calciphilous grasslands grasslands of the central Balkans 44B01

Campanulion albanicae

Calcareous grasslands of the subalpine belt of the Bjelasica Mountains

44B02 **Campanulion linifoliae**

Subalpine secondary grasslands on slightly acid soils in Montenegro

E4.4 Calciphilous alpine and subalpine grassland 44B03

Festucion xanthinae

Secondary subalpine grasslands on slightly acid soils in east Serbia 44B04

Oxytropidion urumovii

Mediterranean altimontane grasslands on volcanic rocks in Montenegro

E4.4 Calciphilous alpine and subalpine grassland

44C ONOBRYCHIDO-SESLERIETALIA

Balkan montane and submediterranean altimontane calciphilous grasslands 44C01

Edraiantho-Seslerion

Alpine tussock grasslands of central Balkan mountains (Macedonia)

E4.4 Calciphilous alpine and subalpine grassland

44D SESLERIETALIA ALBICANTIS

Alpine and subalpine calcareous grasslands

44D01 **Armerion cantabricae**

Subalpine and alpine calciphilous grasslands in the Cantabrian mountains

E4.4 Calciphilous alpine and subalpine grassland 44D02

Calamagrostion variae

Calcareous meso-hygrophilous tall-grass montane to subalpine grasslands in the Carpathians

44D03 **Caricion austroalpinae**

Montane limestone grasslands at the southern margin of the Eastern Alps

E4.4 Calciphilous alpine and subalpine grassland 44D04

Caricion ferrugineae

Alpine and subalpine calcareous sedge swards on steep, seasonally wet slopes of the Alps

E4.4 Calciphilous alpine and subalpine grassland

44D05 **Caricion firmae**

Calcareous open sedge swards on terraced slopes in the alpine belt of the Alps and Carpathians

E4.4 Calciphilous alpine and subalpine grassland F2.2

Evergreen alpine and subalpine heath and scrub 44D06 **Laserpitio-Ranunculion thorae**

Alpine and subalpine calcareous grasslands

E4.4 Calciphilous alpine and subalpine grassland 44D07

Primulion intricatae

Alpine calcareous grasslands of the Pyrenees

E4.4 Calciphilous alpine and subalpine grassland 44D08

Seslerion albicantis

Alpine and subalpine calcareous blue-grass swards

E4.4 Calciphilous alpine and subalpine grassland 44D09

Seslerion bielzii

Chionophilous calcareous alpine grasslands of the eastern and southern Carpathians

E4.4 Calciphilous alpine and subalpine grassland E5.5

Subalpine moist or wet tall-herb and fern habitats 44D10   **Seslerion tatrae**

Chionophilous calcareous alpine grasslands of the western Carpathians

E4.4 Calciphilous alpine and suba lpine grassland

44E   SESLERIETALIA TENUIFOLIAE

Subalpine and alpine tussock grasslands in wind-exposed habitats of the northwestern Dinarides

44E01   **Festucion pungentis**

Terraced subalpine grasslands on steep slopes in the Dinarides

E4.4 Calciphilous alpine and subalpine grassland 44E02

Festuco-Knaution longifoliae

Subalpine grasslands of eastern Serbia

E4.4 Calciphilous alpine and subalpine grassland 44E03

Seslerio-Festucion xanthinae

Secondary montane grasslands on limestone, derived from beech and pine woodlands

E4.4 Calciphilous alpine and subalpine grassland 44E04

Seslerion apenninae

Subalpine and alpine tussock grasslands in wind-exposed habitats in the central and southern Apennines

44E05   **Seslerion nitidae**

Secondary calcareous grasslands of exposed sunny slopes in Macedonia

E4.4 Calciphilous alpine and subalpine grassland 44E06

Seslerion tenuifoliae

Subalpine and alpine tussock grasslands in wind-exposed habitats in the Dinarides

E4.4 Calciphilous alpine and subalpine grassland

45   CARICI RUPESTRIS-KOBRESIETEA BELLARDII

Subalpine and alpine grasslands and dwarf-shrub heaths, tundra and fjell vegetation

45A   KOBRESIO-DRYADETALIA

Grassy and dwarf-shrub fjell vegetation of Scandinavia, Iceland and Arctic islands 45A01

Caricion nardinae

Chionophobous grassy and dwarf-shrub heaths on well-drained soils

E4.4 Calciphilous alpine and subalpine grassland

F2.2 Evergreen alpine and subalpine heath and scrub

45B   OXYTROPIDO-ELYNETALIA

Grassy alpine tundra of high mountains in central Europe and the Balkans

45B01   **Oxytropido-Elynion**

Kobresia carpets in windy places in the alpine belt

E4.4 Calciphilous alpine and subalpine grassland

F2.2 Evergreen alpine and subalpine heath and scrub

46   JUNCETEA TRIFIDI

Pastures, rush-heaths and fjell-field on lime-poor soils above the forest belt in alpine and subalpine zones

46A   CARICETALIA CURVULAE

Swards on lime-poor impoverished humic soils in the alpine and subalpine zones 46A01

Achilleo-Arnicion

Montane mat-grass communities in the Balkans *E4.3 Acid alpine and subalpine grassland* 46A02   Androsacion ciliatae

Central Pyrenees neutral to siliceous scree communities

46A03   **Anemonastro sibiricae-Festucion ovinae**

Moderately chionophilous alpine grasslands of the Urals and south Siberian mountains

46A04   **Caricion curvulae**

Alpine acid swards of the Alps and eastern and southern Carpathians

E4.3 Acid alpine and subalpine grassland

E4.4 Calciphilous alpine and subalpine grassland 46A05

Deschampsio-Anthoxanthion

Grass and herb communities on slopes irrigated by frigid melt-waters in Scandinavia

E4. 1 Snow-patch grassland

E4.3 Acid alpine and subalpine grassland F2.1 Snow-patch dwarf willow scrub 46A06 **Festucion eskiae**

Subalpine and alpine grasslands of the Pyrenees *E4.3 Acid alpine and subalpine grassland 46A07* **Festucion supinae**

Chionophilous grasslands of the humid-perhumid Pyrenees *E4.3 Acid alpine and subalpine grassland*

46A08 **Juncion trifidi**

Rush-heaths of Scandinavia, the Alps and the western Carpathians

E4.2 Moss and lichen dominated mountain summits, ridges and exposed slop es

E4.3 Acid alpine and subalpine grassland 46A09

Nardo-Caricion rigidae

Moderately chionophilous mat-grass communities of Scandinavia and Riesengebirge

D4.1 Rich fens, including eutrophic tall-herb fens and calcareous flushes and soaks

E4.3 Acid alpine and subalpine grassland

46B FESTUCETALIA SPADICEAE

Species-rich grasslands on deep mesotrophic acid soils in the mountains of the Alpic orogeny

46B01 **Agrostion schraderanae**

Open grassy swards of ground disturbed by avalanches in the eastern Alps

E4.3 Acid alpine and subalpine grassland 46B02

Festucion macrantherae

Grasslands on deep, decalcified soils of high altitudes of the central and southern Apennines

46B03 **Festucion pictae**

Tall-herb communities in humid depressions and gullies of the alpine belt of the Carpathians

H2. 3 Temperate-montane acid siliceous screes 46B04

Festucion variae

Dense grassy swards on steep, exposed and sunny slopes extending into the alpine belt

E4.3 Acid alpine and subalpine grassland 46B05

Nardion strictae

Dense chionophilous grassy swards of the subalpine and alpine belts of the Alps, Carpathians and northern Apennines *E4.3 Acid alpine and subalpine grassland*

E4.5 Alpine and subalpine enriched grassland

46C FESTUCETALIA VERSICOLORIS

Tussocky grasslands on steep, terraced slopes in the subalpine belt of east Hercynicum and the Carpathians

46C01 **Agrostion alpinae**

Tussocky grasslands on steep, terraced slopes in the subalpine belt of east Hercynicum

E4.4 Calciphilous alpine and subalpine grassland

46D SESLERIETALIA COMOSAE

Alpine and subalpine swards on acid soils in the Balkans 46D01

Jasionion orbiculatae

Swards on relatively acidic soils of sheltered habitats *E4.3 Acid alpine and subalpine grassland 46D02* **Poion violaceae**

Swards on strongly acidic soils of sheltered habitats *E4.3 Acid alpine and subalpine grassland* 46D03 **Potentillo ternatae-Nardion**

Mat-grass swards of the alpine belt in the mountains of the eastern Balkans *E1.8 Mediterranean dry acid and neutral closed grassland* *E4.3 Acid alpine and subalpine grassland* 46D04

Seslerion comosae

Alpine swards in windy habitats in the eastern and central Balkans *E4.3 Acid alpine and subalpine grassland*

46E TRIFOLIETALIA PARNASSII

Oromediterranean chionophilous mat-grass swards in the mountains of central Greece

46E01 **Trifolion parnassii**

Acidophilous oromediterranean grasslands of central Greece *E4.3 Acid alpine and subalpine grassland*

46F UDO-NARDETALIA

Mat-grass swards of the Sierra Nevada and northern Atlas 46F01

Campanulo herminii-Nardion strictae

Species-rich mat-grass swards of southern Iberian mountains *E1.8 Mediterranean dry acid and neutral closed grassland* *E4.3 Acid alpine and subalpine grassland* 46F02

Plantaginion thalackeri

Mat-grass swards of the Sierra Nevada. *E4.3 Acid alpine and subalpine grassland.*

This classification is described in Rodwell et al. (2002).