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System for Environmental and Agricultural Modelling;
Linking European Science and Society

Regional typologies of ecological and biophysical context

G.W. Hazeu, B.S. Elbersen, C.A. van Diepen, M.J. Metzger.

Partners involved: Alterra, WUR

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Email: seamless.office@wur.nl
Internet: www.seamless-ip.org

Authors of this report and contact details

Name: Gerard Hazeu Partner acronym: Alterra
Address: P.O. Box 47, 6700 AA Wageningen, the Netherlands
E-mail: Gerard.hazeu@wur.nl

Name: Kees van Diepen Partner acronym: Alterra
Address: P.O. Box 47, 6700 AA Wageningen, the Netherlands
E-mail: Kees.vanDiepen@wur.nl

Name: Berien Elbersen Partner acronym: Alterra
Address: P.O. Box 47, 6700 AA Wageningen, the Netherlands
E-mail: Berien.Elbersen@wur.nl

Name: Marc Metzger Partner acronym: WUR
Address: P.O. Box 8080, 6700 DD Wageningen, the Netherlands
E-mail: Marc.Metzger@wur.nl

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General information

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Executive summary

The Agri-Environmental Zonation (AEnZ) is meant to be a core environmental framework within SEAMLESS. It will be used as a basis for:

1. upscaling of APES point information,
2. determining FSSIM runs (farm type bio-physical endowment combinations),
3. selection of sample regions,
4. collection of data (on current activities, alternative activities) in sample regions,
5. presentation of farm type information and modelling results.

The starting point for the creation of the AEnZ is to create classes that are relatively homogeneous from an agronomic perspective. This implies the involvement of soil, climate, latitude and altitude factors for the development of the typology.

Indirectly most of these factors have already been incorporated in the Environmental Stratification of Europe (Metzger et al., 2005). The suggested approach is therefore to build on this classification and include additional soil factors and factors that limit agricultural activities strongly such as altitude and slope. Furthermore, the resulting classification should give a good picture of the large variation in agronomic capacity of European farmland, but should also result in a 'manageable' number of agri-environmental classes per region.

The Environmental Stratification (Metzger et al., 2005) is the result of a principal component analysis (PCA) of 20 most relevant and available environmental variables (grouped under climate, geomorphology, oceanicity and northing) combined by means of an ISODATA clustering. The resulting 84 strata of the Environmental Stratification (EnS) are aggregated into 13 environmental zones (EnZ). The resulting Environmental Stratification is a vector dataset hierarchically built up with environmental zones and strata.

The original coverage of 13 environmental zones is extended, for the SEAMLESS project, along the coastline to fit with the SEAMLESS standard grid. The euclidian distance method has been used to fill the empty grid cells with an environmental code.

For the inclusion of soil factors in the agri-environmental zonation (AEnZ) several soil factors within different data sources were selected and tested using a PCA analysis. The results showed that more than 90% of the soil variation in Europe was explained by the topsoil organic carbon (Jones et al., 2005).

The topsoil organic carbon dataset is the result of a novel approach combining a rule-based system (pedo-transfer rules) with detailed thematic spatial data layers. The effects of land use, vegetation and temperature were taken into account in the calculations to estimate the organic carbon contents (Jones et al., 2005). All data was processed at a 1*1km grid spacing.

For the creation of the agri-environmental zonation (AenZ) the topsoil organic carbon content (%), which is a continuous variable, is grouped into six classes and gives a fair picture of the relative variation in agronomic capacity of soils within Europe.

For the inclusion of altitude factors and the delimitation of areas where agriculture is not possible or only possible under strong bio-physical constraints, an additional mask is developed: the ‘agri-mask’. For the definition of this agri-mask altitude (which ranges with latitude), slope, rooting depth, alkalinity and salinity information is combined. The agrimask consists of the following three classes:

- areas having no or relatively small constraints to agriculture
- areas where arable agriculture is not possible (mountainous areas above a certain altitude, depending on the latitude, and/or very steep slopes (>16%) and/or limited rooting depth (<20cm)),
- strongly naturally handicapped areas where agriculture is heavily constrained and restricted to extensive farming (areas with steep slopes (>8%) and/or high alkalinity (>15% exchangeable sodium) and/or salinity (>15dS/m),

Note that the agri-masks are environmental classes for potential land use, and do not describe actual land use. The suitable class 0 includes both agricultural areas and non-agricultural areas, such as forested areas.

To produce the final agri-environmental zonation the three above described classifications are integrated into one land typology. The resulting classification is hierarchical:

1. at first level: 13 environmental zones (EnZ),
2. at second level: 6 topsoil organic carbon classes (OCTOP), and
3. at third level: 3 agri-mask classes (AGRI-MASK) regarding constraints to agriculture.

Each agri-environmental land type is defined by its Environmental Zone, topsoil carbon class and agrimask class. The dataset is based on the 1*1km SEAMLESS standard grid. The zonation’s geographical coverage is EU25+ minus Turkey plus Russian enclave Kaliningrad and Serbia/Montenegro. The topsoil organic carbon dataset is adapted to the SEAMLESS spatial framework. This implies that the SEAMLESS grid cells for which organic carbon data are missing are marked as ‘no data’.

In order to create a dataset that can be used for the selection of sample regions for the project the agri-environmental zonation needs to be further specified per region. For this the first level of the agri-environmental zonation is combined with NUTS 2 level boundaries (v7). The result will be an administrative subdivision of the 13 environmental zones of Europe to which the second and third level agri-environmental zonations, the 6 topsoil organic carbon classes and the 3 agri-masks respectively are connected as attribute information. This subdivision and related attribute information can then be used for the selection of sample regions ensuring that the full agri-environmental variation of Europe is included in the selected sample regions of SEAMLESS.

Specific part

1 Introduction

1.1 Objective

The Agri-Environmental zonation (AEnZ) is a biophysical typology that has spatial land units as homogeneous as possible from an agronomic perspective. From this perspective soil and climate data are important.

The main reasons to create an Agri-Environmental zonation (AEnZ) are to establish an environmental framework to be used in the SEAMLESS project. This framework will be used as a basis for :

1. upscaling of APES point information,
2. determining FSSIM runs (farm type bio-physical endowment combinations),
3. selection of sample regions,
4. collection of data (on current activities, alternative activities) in sample regions,
5. visualization of farm type information and modelling results.

Ad 1 and 2. The framework will be used as a modelling basis for APES (and FSSIM) to be able to interpolate/up-scale result to the bio-physical regions. In this way the APES output obtains a more general value than just point information. The up-scaled APES information can then be used as input in FSSIM.
Ad 3. The AEnZ will make it possible to select sample regions that represent the large variation in bio-physical circumstances in the EU countryside. By combining the AEnZ with NUTS2 boundaries it will provide a good basis for the selection of sample regions. At this moment it is expected that with the selection of 25-30 sample regions the large variation in the agri-environment within the EU can be well represented in SEAMLESS.
Ad 4. The AEnZ will be used as a basis for collecting information on current activities. This current activities information is input for modelling in APES and FSSIM and it is therefore logical to also collect this data according to the same sampling framework.
Ad.5. The AEnZ will be used to present the farm type information at the level of a bio-physical entity. This is necessary as it provides the possibility to model farming activities within the context of a relatively homogeneous environmental endowment. The combination of farm type and activity information together with information on the environmental (bio-physical) endowment enables the modelling of environmental impacts of farming. When farm information is only presented at the level of administrative regions the environmental endowment is often too diverse to use as modelling input.

It is also aimed at writing a paper about the creation of the AEnZ of Europe for a peer-reviewed journal. The main objective of this paper is to show that the AEnZ is scientifically and statistically robust and that it provides a good overview of the diversity in agri-environment in the EU.

1.2 Approach

Overall it is clear that we can distinguish zones in Europe where agricultural activities are very much limited by climatic, soil and/or other biophysical factors, while in other areas the natural factors provide good opportunities for a wide range of agricultural activities or specific types of agriculture. From this perspective we can roughly distinguish three main zones of agricultural potential, called agri-mask classes, numbered as agri-mask 0, 1 and 2:

0) Areas having no or relatively small constraints to agriculture. This zone incorporates the largest area and can be characterised by a wide number of soil and climate class combinations. Agricultural activities are very diverse in this zone ranging from intensive to extensive farming, arable, mixed, livestock farming, horticulture etc..
1) Areas where arable agriculture is not possible, such as mountainous areas above a certain altitude, depending on the latitude. These include all areas above the tree line which are only suited for extensive grazing in summer periods. In addition this zone includes areas with very steep slopes (>16%) and/or very shallow soils (rooting depth <20cm), irrespective of altitude.
2) Naturally handicapped areas where efficient agriculture is not possible. These areas have either steep slopes (>8 %) and/or a short growing season. They often coincide with areas that can be characterised as High Nature Value (HNV) farmland areas (Andersen, et al., 2004 and EEA-UNEP, 2004).

The subdivision of Europe into these three zones needs to be based on factors restricting agricultural production and should be applicable all over Europe.

Besides this relatively coarse division of Europe, a more detailed zonation is required into relatively homogeneous zones from an agronomic perspective with relatively similar agricultural potential. This implies that soil and climate factors are the main starting point for this further subdivision. Climate factors have been incorporated in the already published and generally accepted Environmental Stratification of Europe (EnS)(Metzger et al., 2005). However, this classification has been delimited on a cluster of climate factors but soil factors, which are very relevant from an agronomic perspective, have not been included. The suggested approach is therefore to build on the Environmental Stratification and further subdivide the classes according to soil factors and the three above described zones of agricultural potential. For this further subdivision a ‘manageable’ number of agri-environmental classes should be the result.

2 Methodology

Given the reasons for the creation of an AEnZ of Europe in SEAMLESS and the requirements of the SEAMLESS end-users the methodological approach starts from the following assumptions:

- It should provide a good overview of the agri-environmental diversity in Europe supporting the development of a framework for agri-environmental modelling that is applicable to the main agricultural production areas in Europe. It should therefore be based soil and climate factors that provide a good overview of the large variation in agronomic capacity within and between European regions.
- It should provide a statistically robust classification that can be used as a sampling and up-scaling basis for collection of farm information and (point) modelling.
- Europe wide data need to be used as the basis for the classification.
- It should not duplicate any existing environmental classifications but should build on these.

In the following sections first a description is given of available European soil and climate data and classifications that have been selected as the most suitable as input for the classification. This is then followed by a description of the methodological approach to create the classification.

2.1 Input data

For the selection of the input variables and data we build on the experience from former projects and the availability of data at the European scale, such as the European maps of soil and land use/land cover, the weather data in the MARS meteo data base, and the statistics from Eurostat's regional data bases.

All metadata of datasets used in the development of the agri-environmental zonation are described in the PD431.

2.1.1 Environmental Stratification (EnS)

The Environmental Stratification of Europe (EnS) consists of 84 strata, which have been aggregated into 13 Environmental Zones (EnZ) (Metzger et al., 2005). The stratification has a 1km2 resolution. The coverage of the EnS is the 'Greater European Window' bordered by 11^0W, 32^0E, 34^0N and 72^0N. The EnS has been constructed using tried and tested statistical procedures. It forms an appropriate stratification for stratified random sampling of ecological resources, the selection of sites for representative studies across the continent and for the provision of strata for modelling exercises and reporting at European scale.

The EnS is the result of a principal component analysis (PCA) of the following 20 most relevant and available environmental variables:

- climate (minimum and maximum temperature, precipitation and sunshine for January, April, July and October),

- geomorphology (altitude and slope),
- oceanity (annual temperature range divided by latitude), and
- northing (latitude).

The PCA was used to explain 88% the variation into three dimensions, which were subsequently clustered into 84 strata using an ISODATA clustering routine. The mean first principal component values of the classification variables were used to aggregate the strata into 13 Environmental Zones (EnZ) which provides a basis for a consistent nomenclature. The EnZ's are used as the climatic basis for the development of the Agri-Environmental Zonation (AEnZ).

2.1.2 GTOPO30

GTOPO30 is a global digital elevation model with a horizontal grid spacing of 30 arc seconds (approximately 1 kilometer). The global data set is covering the full extent of latitude from 90 degrees south to 90 degrees north, and the full extent of longitude from 180 degrees west to 180 degrees east. The horizontal grid spacing is 30-arc seconds (0.008333333333333 degrees), resulting in a DEM having dimensions of 21,600 rows and 43,200 columns. The horizontal coordinate system is decimal degrees of latitude and longitude referenced to WGS84. The vertical units represent elevation in meters above mean sea level. The elevation values range from -407 to 8,752 meters. In the DEM, ocean areas have been masked as "no data" and have been assigned a value of -9999. Lowland coastal areas have an elevation of at least 1 meter, so in the event that a user reassigns the ocean value from -9999 to 0 the land boundary portrayal will be maintained. Due to the nature of the raster structure of the DEM, small islands in the ocean less than approximately 1 square kilometer will not be represented. For more information see: http://edc.usgs.gov/products/elevation/gtopo30/gtopo30.html.

Adaptations made for use of the dataset in SEAMLESS:

- no data,
- elevations below zero are set at 1,
- pan European coverage.

2.1.3 European Soil Database (ESDBv2)

The European Soil Database (distribution version v2.0) consists of a number of databases of which the following two are used as input for the AEnZ:

- the Soil Geographical Database of Eurasia at scale 1:1,000.000 (SGDBE), which is a digitized European soil map and related attributes (version 4 beta),
- the Pedo Transfer Rules Database (PTRDB) version 2.0, which holds a number of pedotransfer rules which can be applied to the SGDBE ; the results of the application of the pedotransfer rules to the SGDBE are delivered as a table with new attributes related to the European soil map.

The Soil Geographical Database of Eurasia (SGDBE) at scale 1:1,000,000 is part of the European Soil Information System (EUSIS). It is the resulting product of a collaborative project involving all the European Union and neighbouring countries. It is a simplified representation of the diversity and spatial variability of the soil coverage. The methodology used to differentiate and name the main soil types is based on the terminology of the F.A.O. legend for the Soil Map of the World at scale 1:5,000,000, which is developed further into the World Reference Base for soil classification. This terminology has been refined and adapted to take account of the specificities of the landscapes in Europe. It is itself founded on the distinction of the main pedogenetic processes leading to soil differentiation: brunification, lessivage, podzolisation, hydromorphy, etc.

The database contains a list of Soil Typological Units (**STU**). Besides the soil names they represent, these units are described by variables (attributes) specifying the nature and properties of the soils: for example the texture, the water regime, the stoniness, etc. The geographical representation was chosen at a scale corresponding to the 1:1,000,000. At this scale, it is not feasible to delineate the STUs. Therefore they are grouped into Soil Mapping Units (**SMU**) to form soil associations and to illustrate the functioning of pedological systems within the landscapes. Each SMU corresponds to a part of the mapped territory and as such is represented by one or more polygons in a geometrical dataset.

Pedotransfer rules define how to infer values for an output attribute based on a set of values from a number of input attributes. Within the Soil Database, the input attributes are selected among the attributes in the STU table from the SGDBE. The whole set of pedotransfer rules constitute the PedoTransfer Rules Database (PTRDB).

Appendix 1 shows the attributes of the SGDBE and PTRDB databases. More information of both databases can be found on http://eusoils.jrc.it/ESDB_Archive/ESDBv2/fr_intro.htm.

2.1.4 Topsoil organic carbon (OCTOP)

The topsoil organic carbon dataset is the result of a novel approach combining a rule-based system (provided by pedo-transfer rules) with detailed thematic spatial data layers. The effects of land use, vegetation and temperature were taken into account in the calculations to estimate the organic carbon contents. Point data extrapolation was not suitable to generate the database as the number of samples for Europe is insufficient, data was insufficiently geo-referenced and the OC contents vary within soil units depending on vegetation and land management (Jones et al., 2005).

The geographical coverage of the database is Europe west of Russia, Byelorussia, Ukraine, Moldova and Turkey. For this region the organic carbon content in the topsoil, taken as 0-30cm deth, is quantified. All data was processed at a 1*1km grid spacing. This resolution is regarded as appropriate for planning effective soil protection measures at European level. The estimation or determination of the spatial distribution of organic carbon content of soils will have always an element of uncertainty.

The data sources used to compile the OCTOP database are:

- European Soil Database version 1.0 (ESDBv1) (Heineke et al., 1998),
- European Land Cover Data (combination of CORINE LC (EEA) and Eurasian land cover (USGS)) (Hiederer, 2001),
- Average Annual Accumulated Temperature (AAAT) from the Global Historical Climatology Network (GHCN).

2.2 Methods

The Agri-Environmental Zonation (AEnZ) fits in the SEAMLESS spatial framework (see PD432). The zonation will be the environmental framework for all activities within SEAMLESS. The Agri-Environmental Zonation (AEnZ) should have a spatial resolution of 1km*1km.

2.2.1 Inventory of user needs

After a project consultation with the end-users of the AEnZ in the SEAMLESS project it was clear that the typology should be based on the following factors:

- a selection of climate factors,
- a selection of soil factors,
- slope,
- altitude.

It was decided not to incorporate land cover and yield data as it is important to use only stable factors that are limiting crop choice and productivity and that do not change easily under influence of human interference. Land cover and yield data can then be used as attributes to the Agri-environmental zones to describe the differences between them. At the scale of sample regions it can be possible to make a correlation between the agri-environmental zones and the yield and land cover data.

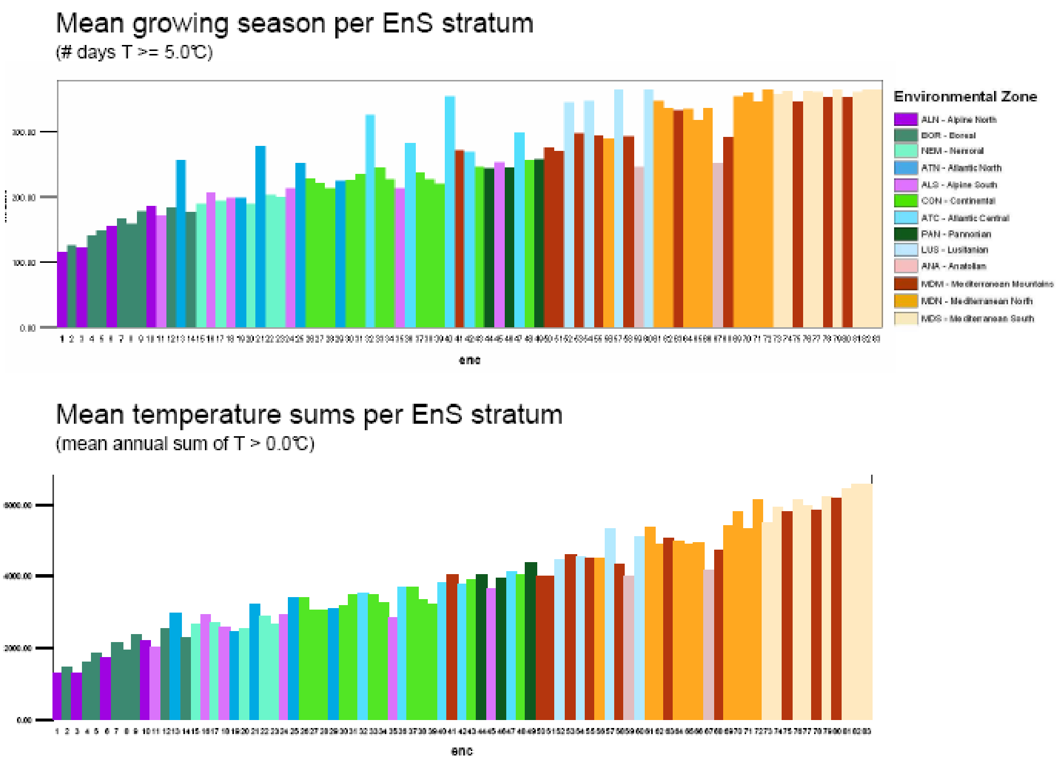
2.2.2 Inventory of other biophysical classifications

On basis of the inventarisation of user needs it was decided to explore the existing European typologies. The following typologies were taken into account:

1. Meeus landscape typology,
2. Potential Natural Vegetation (Bohn et al., 2000),
3. LANMAP2 (Landscape Map of Europe) (Mucher et al., 2003),
4. Environmental Stratification (EnS) (Metzger et al., 2005).

The first three typologies are determined by factors that are not sufficiently based on agricultural potentials. The zones/types are not homogeneous in terms of agronomic limitations and suitability and therefore do not provide a good overview of the agri-environmental diversity in Europe. And thirdly, the presented typologies do not provide a statistically robust classification that can be used as a sampling and up-scaling basis for collection of farm information and (point) modelling

The Environmental Stratification however is most suited as it is a statistically robust classification based on main climatic and geomorphological factors that are determinant for the agronomic variation in Europe. Furthermore, it is a published database in peer-reviewed journals (Metzger et al., 2005). The environmental strata show a clear variation in agronomic meaningful factors such as length of growing season and temperature sum as Figure 2.1 illustrates. However, it is also clear that while the climatic diversity of Europe is well represented by the Environmental Stratification, this is not the case for the diversity in soil factors which should therefore be added as a separate layer of information to create the AEnZ land types suitable for SEAMLESS purposes.



Source: Metzger et al., 2005.

Figure 2.1.Variation in key agroclimatic factors between the 84 environmental strata of the environmental stratification.

2.2.3 Environmental Stratification(EnS)

The Environmental Zones (EnZ) of the Environmental Stratification of Europe (EnS) are used in the development of the Agri-Environmental Zonation (AEnZ) of Europe. The following EnZ can be distinguished (see Metzger et al., 2005):

- class 1: Alpine North (ALN),
- class 2: Boreal (BOR),
- class 3: Nemoral (NEM),
- class 4: Atlantic North (ATN),
- class 5: Alpine South (ALS),
- class 6: Continental (CON),
- class 7: Atlantic Central (ATC),
- class 8: Pannonian (PAN),
- class 9: Lusitanian (LUS),

- class 10: Anatolian (ANA),
- class 11: Mediterranean Mountains (MDM),
- class 12: Mediterranean North (MDN),
- class 13: Mediterranean South (MDS).

This dataset has been prepared for the SEAMLESS spatial data framework.

- conversion of projection into the ETRS_1989_LAEA,
- vector to raster conversion (1*1km resolution),
- geographical coverage is more or less identical to SEAMLESS EU25+ geographical coverage (see PD432). The geographical coverage of the database is Europe west of Russia, Byelorussia, Ukraine, Moldova, Turkey. All Balkan countries and the Russian enclave Kaliningrad are taken into account. Furthermore, Turkey is cut off as it is only partly covered by the EnS. For this reason the EnZ class 10 Anatolian is not included in the present SEAMLESS data set of Agri-Environmental Zones.
- “empty” SEAMLESS grid cells are filled by Euclidean Distance routine.

2.2.4 Selection of soil variables

The following soil variables were selected as important from an agronomic perspective:

- Topsoil organic carbon (OCTOP)(continuous variable),
- Available water holding capacity (AWHC) (continuous variable, PTRDB),
- Rooting depth (classes, SGDBE),
- Depth of gleyed horizon (classes, PTRDB),
- Topsoil textural classes (classes, SGDBE),
- Topsoil Cation Exchange Capacity (classes, PTRDB).

Principal Components Analysis (PCA) was used to screen the selected variables. PCA is an effective multivariate technique to reduce the variation of many variables into a limited number of dimensions. The eigenvectors of the principal components explain how much of each component is explained by each variable. In this way it is possible to detect which variables are most important for explaining the variation in agronomic soil properties (i.e. the complete set). Other variables in the complete set will be correlated, or show less regional spatial variation.

The following three principal component analyses were performed:

- Only European Soil Bureau (ESB) data (SGDBE and PTRDB data),
- Only continuous variables,
- Combination of all of variables.

A principal component analysis is most effective on one type of variables. A mixture of continuous variables and classes is problematic. Furthermore, a restriction in using the ESB data is that geographical (country) borders have large influences on the class (value) of certain soil variables. The interpretation of certain soil variables differs between countries resulting in a heterogeneous database. Therefore, the ESB data are difficult to use for the determination of the most important soil factor that explains the most variation in agronomic potential of soils within Europe.

The PCA on only the continuous data revealed that all variation is explained by the topsoil organic carbon content. Disadvantage is the relatively small, but balanced dataset (OCTOP and AWHC).

The PCA on all variables revealed that 95% of the variation is explained by the OCTOP.

The overall conclusion of the PCA analysis was to use the Topsoil Organic Carbon content as variable to differentiate between soils in Europe.

2.2.5 Topsoil organic carbon

The organic carbon content is taken from published Topsoil Organic Carbon content database (OCTOP) (Jones et al., 2005). The OCTOP is a continuous variable which has been grouped into the following 6 classes (in %):

- class 1: 0.1-1.23,
- class 2: 1.23-2.46,
- class 3: 2.46-3.94,
- class 4: 3.94-5.66,
- class 5: 5.66-8.86,
- class 6: 8.86-63.0,
- class 9: no data or 0.

The class limits of the 6 classes are established in such a way that each class is covering a European land surface area of approximately the same extent. This was achieved by using the quintiles option in ArcGIS for distribution over six subclasses. Note that in the statistics the "no data" class is dealt with as a seventh class.

The Topsoil Organic Carbon content database (OCTOP) has been pre-processed to fit in the SEAMLESS spatial data framework:

- conversion of projection into the ETRS_1989_LAEA,
- vector to raster conversion (1*1km resolution),
- geographical coverage is more or less identical to SEAMLESS EU25+ geographical coverage (see PD432). The geographical coverage is only slightly different as all Balkan countries and Russian enclave Kaliningrad are taken into account. Turkey is cut off as it is not covered by OCTOP database,
- "empty" SEAMLESS grid cells are presented as no data with the code 9.

2.2.6 AGRI_MASK

The agri-mask was created by combining several datasets. Datasets used in the creation of the agri-mask were the CLC2000, GTOPO30 and ESDBv2 database. The databases were processed to a 1*1km grid and ETRS_1989_LAEA projection.

The altitude – latitude relation above which no arable agriculture is possible has been derived from the highest points in mountainous areas all over Europe where agriculture (non irrigated arable land and pastures) was found according to the CLC2000 database. On basis of those points a relation was established between altitude and latitude (see Figure 2.2). This relation was applied to GTOPO30 dataset to select all grid cells above this agriculture line.

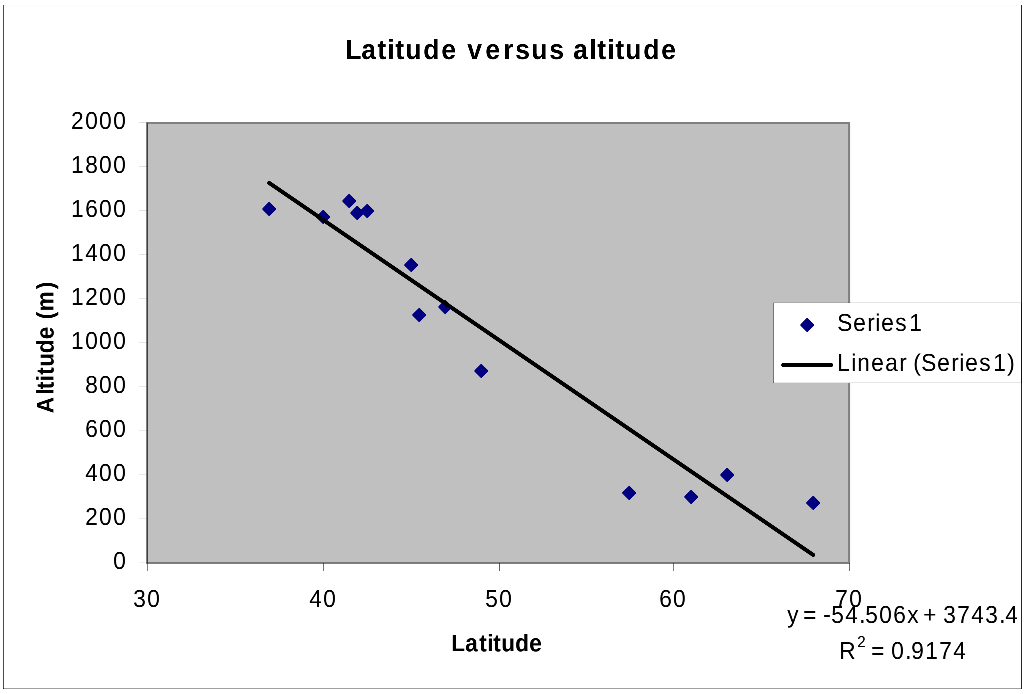


Figure 2.2. The line above which no arable agriculture is possible as a function of altitude and latitude .

The slope variable was calculated from the GTOPO30 database. Two databases were created with the European land surface area with slopes above 8 and 16%. Also a database was generated with a rooting depth of <20 cm. Also for alkalinity (>15% exchangeable sodium) and salinity (> 15dS/m) such a database was created. Rooting depth, alkalinity and salinity were taken from the European Soil Database (ESDBv2 and SINFO study). The mentioned limits are based on expert knowledge.

An agri-mask database was created by combining those separate grid databases resulting in the following three classes:

- class 0: areas with no or relatively small constraints to agriculture,
- class 1: areas where no arable agriculture is possible (mountainous areas above a certain altitude, depending on the latitude, and/or very steep slopes (>16%) and/or limited rooting depth (<20cm)),
- class 2: strongly naturally handicapped areas where agriculture, if practiced, is heavily constrained and restricted to extensive farming (areas with steep slopes (>8%) and/or high alkalinity and/or salinity (>15dS/m)).

2.2.7 Integration of data layers

The different data layers are integrated into one database which meets the requirements of the SEAMLESS spatial framework concerning projection and 1*1km grid resolution. The following 3 datasets were combined into an agri-environmental land type:

- 12 Environmental Zones (class 10 Anatolian does not occur in the mapped area),
- Topsoil Organic Carbon (6 classes, plus one no data class),
- Agri-mask (3 classes).

The maximum number of possible combinations of the three data layers is 12 x 7 x 3 is 252, representing 216 agri-environmental land types, and 36 units for which the carbon data are lacking. The actual map overlay resulted in 238 different agri-environmental units. In the following chapter these land types are described systematically. The AEnZ is presented hierarchically in which 3 levels can be distinguished. At the first level the AEnZ consists of the 12 Environmental zones mainly based on climatic factors. These 12 zones can than be further subdivided at the second level of the hierarchy in the 6 Organic Carbon classes (plus one no data class) and these can than be further subdivided at the third level by the three AGRI_MASK classes. In summary, an agri-environmental land type is defined by its Environmental zone (EnZ), plus topsoil organic carbon class (OCTOP) plus agrimask class (AGRI-MASK).

3 Results

3.1 Description of AEnZ

3.1.1 Characteristics and definition

The Agri-Environmental Zonation of Europe (AEnZ) database has a geographical coverage of EU25+ which is Europe west of Russia, Byelorussia, Ukraine, Moldova and Turkey. The spatial resolution of the database is 1*1km. In the attribute table the following attributes can be found; ID, ENZ (environmental zone), OCTOP_CL (topsoil organic carbon) and AGRI_MASK (agrimask). The database contains in total 238 different agri-environmental land types indicated by the ID. The ID of a land type can look like the following examples:

1. 1210 = Mediterranean North environmental zone (EnZ class = 12), 1.23 – 2.46% topsoil organic carbon content (OCTOP class = 1) and no or relatively small constraints to agriculture (AGRI_MASK class = 0)
2. 391 = Nemoral environmental zone (EnZ class = 3), no data for topsoil organic carbon (OCTOP class = 9) and agricultural restriction related to mountainous areas (AGRI_MASK class = 1)
3. 542 = Alpine South environmental zone (EnZ class = 5), 3.94 – 5.66% topsoil organic carbon content (OCTOP class = 4) and agricultural restriction related to strongly naturally handicapped areas (AGRI_MASK class = 2)

From those 238 different types 76 land types belong to the mountainous areas (AGRI_MASK class 1) where no arable agriculture is possible. Eighty land types are strongly handicapped by the natural conditions (AGRI_MASK class 2). The remaining 82 land types belong to the AGRI_MASK class 0 that indicates that there are no or only small constraints to agriculture. From those 82 types 12 relate to environmental zones for which information on the organic carbon content was not available (OCTOP class = 9). The number of 70 agri-environmental land types in agrimask class 0 is only slightly less than the maximum of 72 possible types (12*6).

The following table (Table 3.1) gives an overview of agri-environmental land types that do not exist in the European area (west of Russia, Byelorussia, Ukraine, Moldova and Turkey). The entire Anatolian EnZ does not exist in the extent of Europe used in SEAMLESS. In the AGRI_MASK class 0, the AEnZ land types Nemoral EnZ with OCTOP class 1 (AEnZ 310) and Mediterranean South (MDS) EnZ with OCTOP class 6 (AEnZ 1360) do not exist in the European area. In the Nemoral EnZ and the land type MDS EnZ combined with OCTOP class 6, the AGRI_MASK class 1 does not exist. The land types 212, 312, 352 and 1362 are EnZ/OCTOP combinations for AGRI_MASK class 2 that do not exist.

Table 3.1. AEnZ land types that do not exist in the European extent of the typology.

Environmental Zone (EnZ)	OCTOP	AGRI_MASK	AEnZ land type	Description
1. Alpine North (ALN)			-	
2. Boreal (BOR)	1	2	212	combined class EnZ 2, OCTOP 1 and AGR_MASK 2 is missing
3. Nemoral (NEM)	1	0, 1, 2	310, 311, 312	entire OCTOP class 1 is missing
	2-9	1	321, 331, 341, 351,361, 391	entire AGRI_MASK class 1 is missing
	5	2	352	combined class EnZ 3, OCTOP 5 and AGR_MASK 2 is missing
4. Atlantic North (ATN)			-	
5. Alpine South (ALS)			-	
6. Continental (CON)			-	
7. Atlantic Central (ATC)			-	
8. Pannonian (PAN)			-	
9. Lusitanian (LUS)			-	
10. Anatolian (ANA)	1-9	0, 1, 2	all	entire EnZ is missing
11. Mediterranean Mountains (MDM)			-	
12. Mediterranean North (MDN)			-	
13. Mediterranean South (MDS)	6	0, 1, 2	1360, 1361, 1362	entire OCTOP class 6 is missing

3.1.2 Description of Environmental zones

The description of the 12 Environmental Zones (EnZ) (Metzger et al., 2005) is based on the following variables:

- mean altitude (m),
- mean slopes (degrees),
- length of growing season (days),
- sum of active temperatures (+ 10^0C),
- mean annual precipitation (mm),
- land cover (%) grouped as urban, forest, agricultural land use, arable (rainfed, irrigated), grassland and High Nature Value (HNV) farmland,
- most important intensity systems as % UAA (high, medium, low input),
- most important land use systems in EU 15 as % UAA (cropping cereals, fallow land, mixed crops and specialist crops; grazing livestock permanent grass and temporary grass; permanent crops and mixed livestock).
- most important agricultural crops in EU10 as % UAA,
- most important environmental pressure (erosion, soil compaction, eutrophication, pesticide pollution, water abstraction, fire risk and land abandonment).

The list of characteristics of those environmental zones can be found in Appendix 2.

The description of the combination of environmental zones and OCTOP classes is a refinement of the above mentioned descriptions.

3.2 Statistics of AEnZ

This chapter describes the statistics of Agri-Environmental land types in various ways:

- The area extent of the various land types and its distribution over environmental zones, agrimasks and carbon classes.
- The distribution of land cover over the Agri-Environmental land types.
- The distribution of the biophysical variables over the Agri-Environmental land types.

The description of the Agri-environmental types in terms of land cover (section 3.2.4) and biophysical variables (section 3.2.5.) is restricted to the Agrimask class 0.

3.2.1 The area extent of the various Agri-Environmental land types

An overview of land shares per environmental zone (EnZ), OCTOP class and Agrimask class is presented in Table 3.2. Relatively large environmental zones are Continental (EnZ 6), Boreal (EnZ 2) and Atlantic Central (EnZ 7) with shares above 10%. (See also Figure 3.1) The four largest zones (zones EnZ 6, EnZ 2, EnZ 7, and EnZ 12) occupy 52 percent of the total European area. The remaining eight zones occupy 48 percent, each of them covering 5.5 to 7 percent, except for the smallest zone EnZ 9 which covers only 4 percent.

The OCTOP classes share more or less equal portions of land in Europe (13-16%), with the exception of OCTOP class 2 with 20.7 % and class 9 with 5.1%. The last figure indicates that 5.1.% of the European continent is missing OCTOP data.

Three quarters of Europe are falling under Agrimask 0 indicating no or relatively small constraints to agriculture.

Table 3.2. Share of land for all three AEnZ variables (EnZ, OCTOP and AGRI_MASK) for entire Europe (%).

Environmental Zone (EnZ)	%	OCTOP	%	AGRI_MASK class	%
1. Alpine North (ALN)	6.9	1. 0.1 - 1.23	14.1	0. areas with no or relatively small constraints	75.8
2. Boreal (BOR)	13.1	2. 1.23 - 2.46	20.7	1. areas where no arable agriculture is possible	17.2
3. Nemoral (NEM)	5.7	3. 2.46 - 3.94	16.0	2. areas that are strongly handicapped for agriculture	7.1
4. Atlantic North (ATN)	6.2	4. 3.94 - 5.66	15.9		
5. Alpine South (ALS)	5.7	5. 5.66 - 8.86	14.6		
6. Continental (CON)	19.4	6. 8.86 - 63.0	13.6		
7. Atlantic Central (ATC)	10.2	9. no data	5.1		
8. Pannonian (PAN)	7.1				
9. Lusitanian (LUS)	3.9				
10. Anatolian (ANA)					
11. Mediterranean Mountains (MDM)	5.5				
12. Mediterranean North (MDN)	9.4			Total surface 5069459 km2	
13. Mediterranean South (MDS)	7.0				

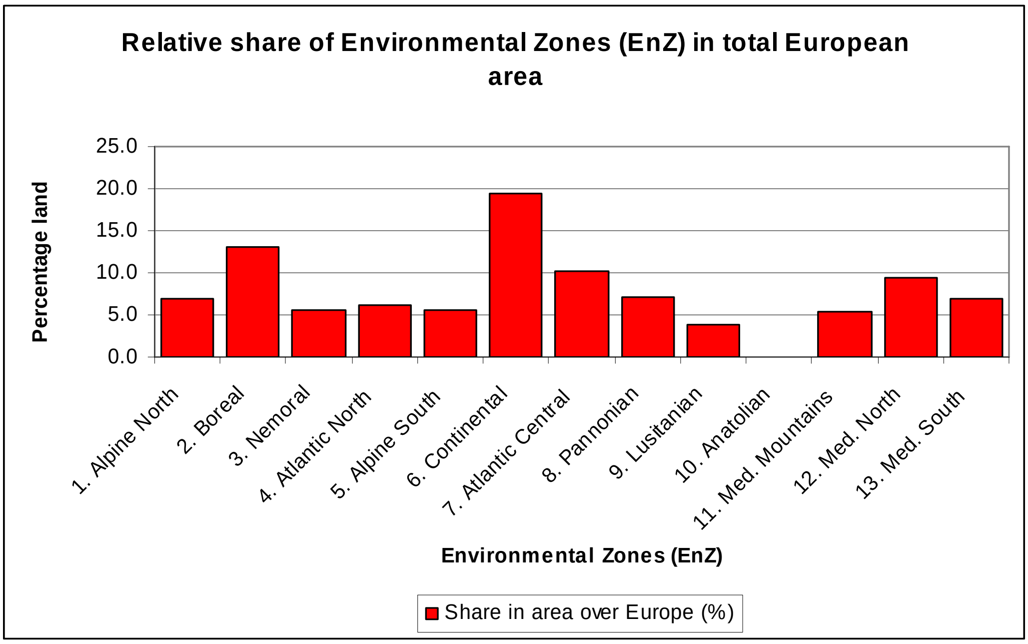


Figure 3.1. Relative share in total European area of the environmental zones.

3.2.2 Distribution of different Agri-mask classes over the Agri-Environmental types

In this section 3.2.2 the distribution of the different Agrimask classes over the Environmental Zones and OCTOP classes is presented.

Three quarters of Europe (75.8%) is falling in the class with no or relatively small constraints (AGRI_MASK class 0). The environmental zones Nemoral (EnZ 3), Atlantic Central (EnZ 7) and Pannonian (EnZ 8) have more than 90% of their land falling in Agrimask 0. The 17% of European land which is unsuitable for arable agriculture are not equally distributed over Europe. The Alpine North environmental zone (EnZ 1) is the region with the largest share of land where arable agriculture is not possible (almost 90%) (AGRI_MASK class 1). Other environmental zones with large proportions of land falling in Agrimask class 1 are the Boreal (EnZ 2), Alpine South (EnZ 5) and the Mediterranean Mountains (EnZ 11) (see Table 3.3). Environmental zones with a share of more than 10% of land falling in AGRI_MASK class 2 are situated in southern Europe (Alpine South, Lusitanian (EnZ 9) and all Mediterranean environmental zones (EnZ 11, 12 and 13)).

Concerning the distribution of agrimasks over the OCTOP classes, the lower C classes (1,2 3 and 4) are overrepresented in the Agrimask class 0 (as compared to the overall European average share of 75.8 percent)), and the higher C classes (5 and 6) are underrepresented.. (Table 3.4). For agrimask 1 the situation is reversed. The OCTOP class 5 and 6 (high organic carbon content) have relatively high shares of land falling in AGRI_MASK class 1 (28.6 and 30.4%). The shares for the other OCTOP classes are below 15%. The share of land for AGRI_MASK class 2 is for all OCTOP classes between 4.2 and 8.4%, but a clear pattern of deviation from the average share of 7.1 percent of the European area can not be seen.

In Appendix 3 the area distribution over the combined EnZ and OCTOP classes is presented. The share of land over the different AGRI_MASK classes per OCTOP class within the environmental zones generally reflect the mean values per EnZ as presented in Table 3.2. Most important differences (>15% deviation from the EnZ mean) are the following:

- OCTOP class 1 and 2 for the Boreal zone (AGRI_MASK class 1)
- OCTOP class 1 for the Alpine South zone (AGRI_MASK class 0)
- OCTOP class 5 and 6 for the Lusitanian zone (AGRI_MASK class 2)
- OCTOP class 5 and 6 for the Mediterranean Mountains (AGRI_MASK class 1)
- OCTOP class 4 for the Mediterranean North (AGRI_MASK classes 1 and 2)
- OCTOP class 3, 4 and 5 for the Mediterranean South (AGRI_MASK classes 1 and 2)

N.B.

1. OCTOP class 9 (missing value) is not taken into account in this analysis

2. Between brackets the AGRI_MASK class which has a higher share (>15%) than the mean value for the EnZ.

Table 3.3. Share of area occupied by different Agrimask classes over the Environmental zones (%).

	AGRI_MASK class*		
Environmental Zone (EnZ)	0	1	2
1. Alpine North (ALN)	8.2	89.9	1.8
2. Boreal (BOR)	59.3	39.8	0.8
3. Nemoral (NEM)	100.0	0.0	0.0
4. Atlantic North (ATN)	88.7	3.9	7.3
5. Alpine South (ALS)	32.1	51.3	16.5
6. Continental (CON)	89.4	3.8	6.8
7. Atlantic Central (ATC)	98.7	0.1	1.2
8. Pannonian (PAN)	94.6	0.4	5.0
9. Lusitanian (LUS)	84.7	3.3	12.0
10. Anatolian (ANA)			
11. Mediterranean Mountains (MDM)	55.0	21.2	23.8
12. Mediterranean North (MDN)	84.3	4.1	11.6
13. Mediterranean South (MDS)	86.2	2.9	10.9

* 0. areas with no or relatively small constraints
1. areas where no arable agriculture is possible
2. areas that are strongly handicapped for agriculture

Table 3.4. Share of area occupied by different Agrimasks over the OCTOP classes (%).

	AGRI_MASK class*		
OCTOP	0	1	2
1. 0.1 - 1.23	87.6	4.3	8.1
2. 1.23 - 2.46	78.4	14.5	7.1
3. 2.46 - 3.94	81.9	10.8	7.2
4. 3.94 - 5.66	78.2	13.8	8.0
5. 5.66 - 8.86	63.0	28.6	8.4
6. 8.86 - 63.0	65.4	30.4	4.2
9. no data	70.0	26.1	3.9

* 0. areas with no or relatively small constraints
1. areas where no arable agriculture is possible
2. areas that are strongly handicapped for agriculture

3.2.3 Distribution of Carbon classes over the Agri-Environmental types for the different Agri-mask classes

While the Figure 3.1 shows the area extent of the Agro-Environmental zones, Figure 3.2 shows the breakdown of area extent of the seven Carbon classes (including no-data class) within each zone. These data are for the entire European area covered. When looking at the relative distribution of the Organic Carbon (OC) classes over the environmental zones (Figure 3.2) it becomes clear that practically all 6 OC classes occur through all environmental zones. Nemoral (OCTOP class 1) and Mediterreanean South (OCTOP class 6) do not occur in the typology.

It shows also that in the northernmost zones (1 through 5) the peak of the topsoil organic content is in OCTOP class 6, for the middle zones (EnZ 6, 7) the peak is at class 4, in the southernmost Mediterranean zones (EnZ 11, 12, 13) the peak is at class 2, or even 1, and for the intergrades EnZ 8 and 9 the peak is at OCTOP class 3. So there is a clear geographical pattern in overall soil carbon content.

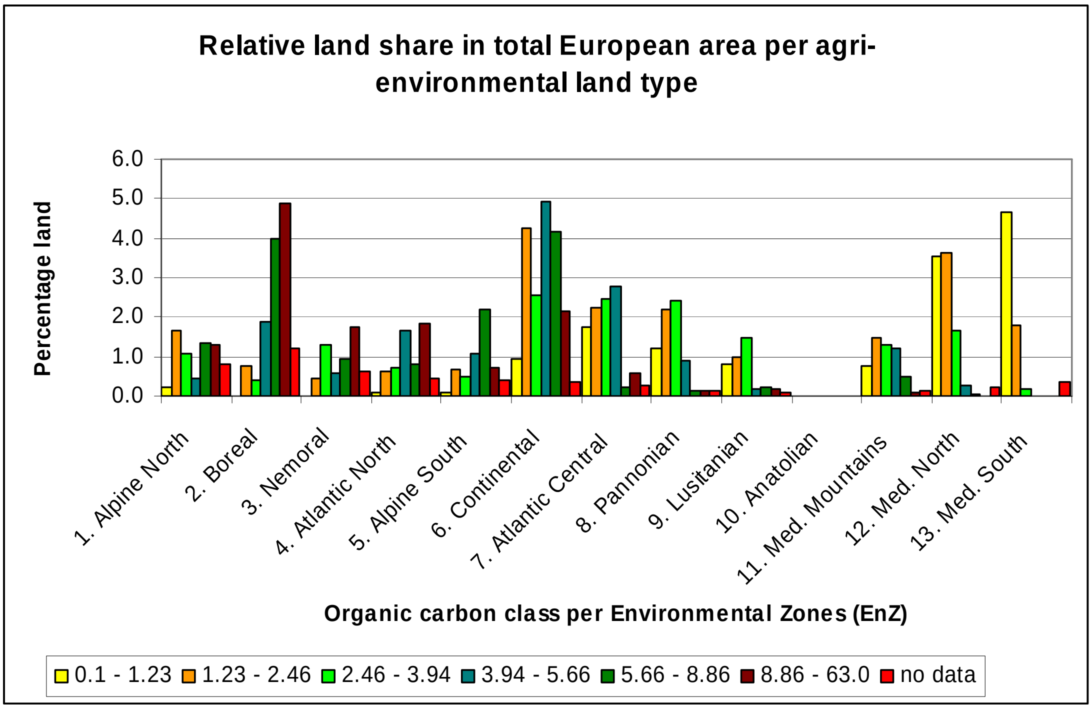


Figure 3.2. Relative share in total European area of the carbon classes within the environmental zones

The Tables 3.5 through 3.7 and Figures 3.3 through 3.5 give the area extent over the carbon classes for the areas of each Agrimask class.

The distribution of organic carbon in soils can be explained by climatic factors, landscape position, and especially the drainage conditions, parent material and land use. In the end it is the result of the balance between accumulation and decomposition. More organic carbon is found in the cooler AEnZ, in the wetter landscape positions, the geochemical poorer parent material, and in the absence of plowing.

Table 3.5. Share of land per AEnZ variable (%) for the area in agrimask class 0.

OCTOP Environmental Zone (EnZ)	class 1 0.1 - 1.23	class 2 1.23 - 2.46	class 3 2.46 - 3.94	class 4 3.94 - 5.66	class 5 5.66 - 8.86	class 6 8.86 - 63.0	class 9 no data
1. Alpine North (ALN)	0.1	0.1	0.1	0.1	0.1	0.1	0.3
2. Boreal (BOR)	0.0	0.3	0.3	1.2	3.9	3.5	1.2
3. Nemoral (NEM)		0.6	1.7	0.8	1.3	2.3	0.8
4. Atlantic North (ATN)	0.1	0.7	0.9	2.1	1.0	1.9	0.5
5. Alpine South (ALS)	0.1	0.3	0.2	0.7	0.8	0.3	0.0
6. Continental (CON)	1.2	5.4	3.2	5.8	4.3	2.6	0.5
7. Atlantic Central (ATC)	2.3	2.9	3.2	3.6	0.3	0.7	0.3
8. Pannonian (PAN)	1.6	2.7	3.1	1.1	0.2	0.1	0.2
9. Lusitanian (LUS)	0.9	1.2	1.7	0.2	0.2	0.1	0.1
10. Anatolian (ANA)							
11. Mediterranean Mountains (MDM)	0.6	1.2	1.0	0.8	0.2	0.0	0.1
12. Mediterranean North (MDN)	4.1	4.1	1.7	0.2	0.0	0.0	0.3
13. Mediterranean South (MDS)	5.4	1.9	0.2	0.0	0.0		0.4

* Total surface area AGRI_MASK class 0: 3840944 km2 (75.8%)

Table 3.6. Share of land per AEnZ variable (%) for the area in agrimask class 1.

Environmental Zone (EnZ) / OCTOP	class 1 0.1 - 1.23	class 2 1.23 - 2.46	class 3 2.46 - 3.94	class 4 3.94 - 5.66	class 5 5.66 - 8.86	class 6 8.86 - 63.0	class 9 no data
1. Alpine North (ALN)	1.0	9.2	5.5	2.2	7.5	7.2	3.3
2. Boreal (BOR)	0.0	3.2	1.1	5.7	5.8	12.9	1.8
3. Nemoral (NEM)							
4. Atlantic North (ATN)	0.0	0.3	0.1	0.1	0.1	0.6	0.1
5. Alpine South (ALS)	0.1	1.9	1.2	2.0	7.1	2.5	2.1
6. Continental (CON)	0.0	0.3	0.3	0.7	2.4	0.5	0.1
7. Atlantic Central (ATC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8. Pannonian (PAN)	0.0	0.0	0.0	0.1	0.0	0.0	0.0
9. Lusitanian (LUS)	0.2	0.1	0.1	0.1	0.1	0.1	0.0
10. Anatolian (ANA)							
11. Mediterranean Mountains (MDM)	0.7	1.4	1.1	1.7	1.3	0.3	0.2
12. Mediterranean North (MDN)	0.8	0.7	0.5	0.2	0.0	0.0	0.0
13. Mediterranean South (MDS)	0.6	0.3	0.1	0.0	0.0		0.1

* Total surface area AGRI_MASK class 1: 871076 km2 (17.2%)

Table 3.7. Share of land per AEnZ variable (%) for the area in agrimask class 2.

Environmental Zone (EnZ) / OCTOP	class 1 0.1 - 1.23	class 2 1.23 - 2.46	class 3 2.46 - 3.94	class 4 3.94 - 5.66	class 5 5.66 - 8.86	class 6 8.86 - 63.0	class 9 no data
1. Alpine North (ALN)	0.1	0.3	0.3	0.3	0.2	0.2	0.4
2. Boreal (BOR)		0.3	0.0	0.4	0.6	0.1	0.1
3. Nemoral (NEM)		0.0	0.0	0.0		0.0	0.0
4. Atlantic North (ATN)	0.1	0.4	0.3	0.7	0.6	3.8	0.5
5. Alpine South (ALS)	0.3	1.7	1.5	3.2	5.4	1.0	0.1
6. Continental (CON)	0.4	1.9	1.7	5.7	7.5	1.4	0.1
7. Atlantic Central (ATC)	0.2	0.2	0.2	0.5	0.1	0.5	0.0
8. Pannonian (PAN)	0.4	1.8	1.3	1.1	0.2	0.1	0.1
9. Lusitanian (LUS)	1.4	0.9	1.9	0.7	0.9	0.7	0.2
10. Anatolian (ANA)							
11. Mediterranean Mountains (MDM)	2.3	4.4	4.6	4.8	1.7	0.3	0.3
12. Mediterranean North (MDN)	4.7	5.6	4.0	0.8	0.1	0.0	0.3
13. Mediterranean South (MDS)	6.1	3.4	0.6	0.0	0.0		0.6

* Total surface area AGRI_MASK 2: 357439 km2 (7.1%)

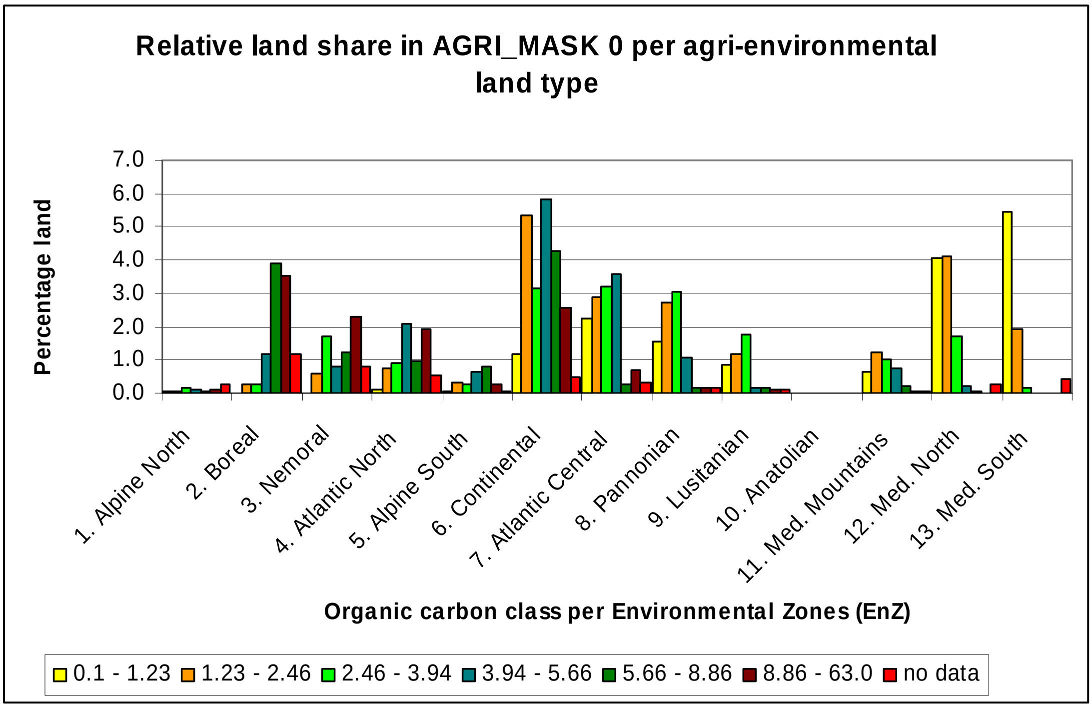


Figure 3.3. Relative share in AGRI_MASK class 0 area of the carbon classes within the environmental zones.

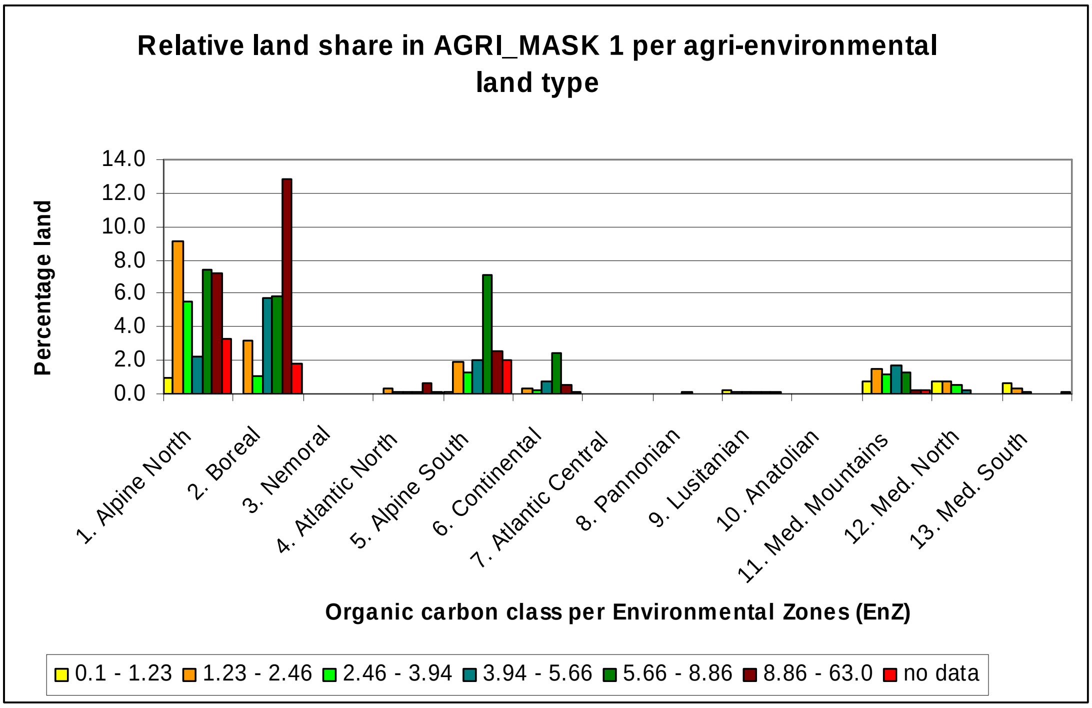


Figure 3.4. Relative share in AGRI_MASK class 1 area of the carbon classes within the environmental zones.

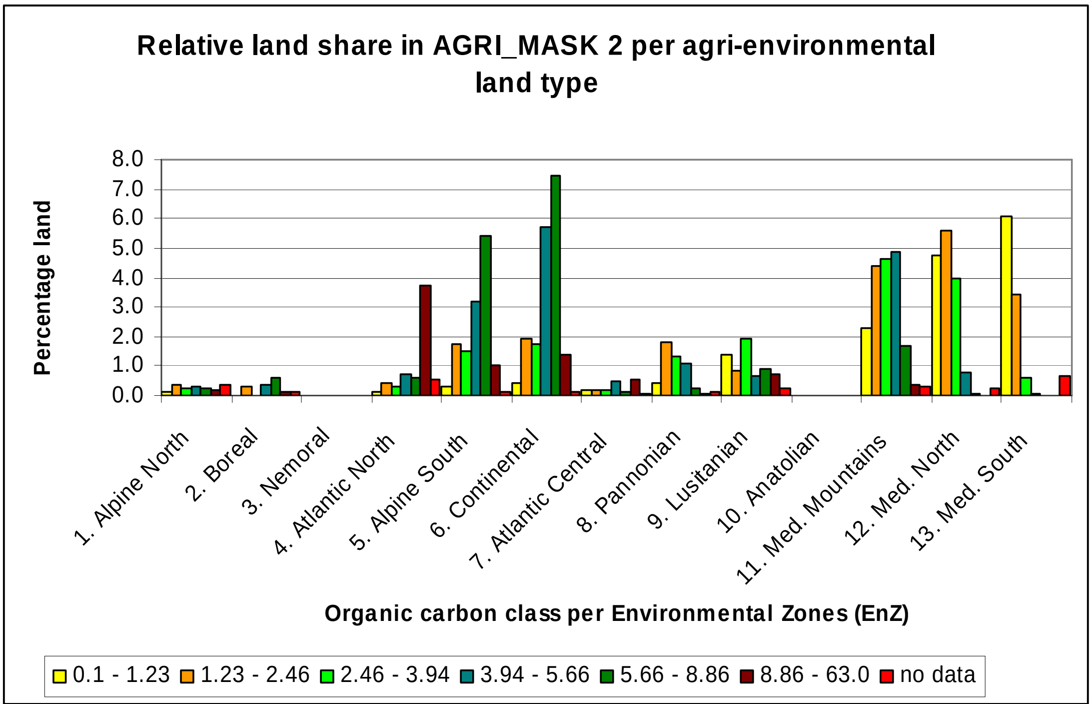


Figure 3.5. Relative share in AGRI_MASK class 2 area of the carbon classes within the environmental zones.

3.2.4 Distribution of land cover over the Agri-environmental types of land of Agrimask 0

Agricultural land use share is highest in the temperate climatic zones Atlantic, Continental and Pannonian zones. The share of agriculture in the southern zones Lusitanian and Mediterranean is somewhat lower. The lowest share is found in the cooler regions (Figure 3.6). Even within the area which is potentially suitable for agriculture we see that the lowest proportions of agriculture are found in the EnZ Alpine North, Boreal, Mediterranean Mountains, Nemoral and Alpine south. The AEnZ Alpine North OCTOP classes 1 and 3 and Boreal OCTOP class 1 are even without agriculture. This is not surprising given the much shorter growing season in these areas and other agricultural limiting factors, especially in Alpine North and Boreal zone (see figures 3.7-3.9).

Overall, we see that within an EnZ the proportion of agricultural land is highest on soils low in carbon, and the proportion of land used for agriculture decreases with increasing OCTOP for most EnZ. Across EnZ it can be observed that the share of agriculture on soils high in carbon increases going from north to south, from cool to warm regions.

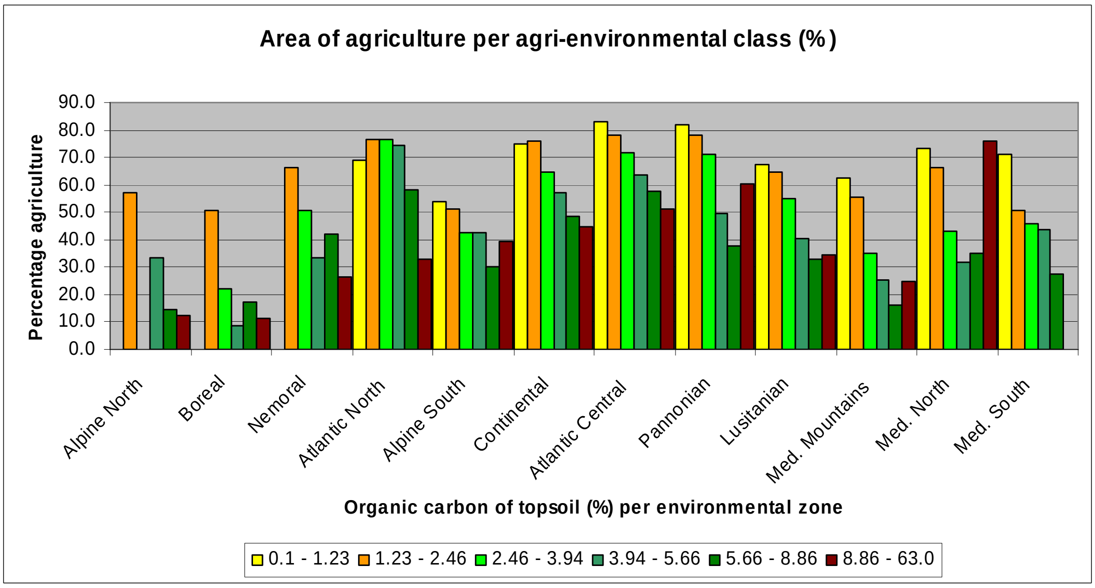


Figure 3.6. Relative share of topsoil organic carbon classes per environmental zone.

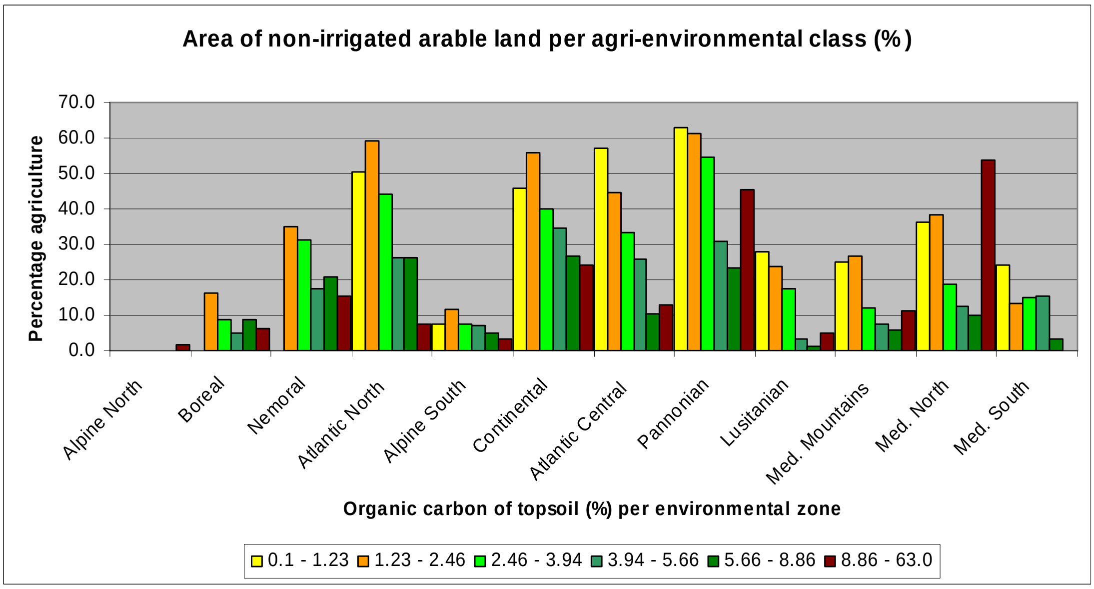


Figure 3.7. Relative share of non-irrigated arable land per AEnZ land type.

The largest concentrations of arable land are found on the low in carbon soils of the Pannonian, Continental and Atlantic zones, followed by Nemoral and Mediterranean North. Important share of pasture lands occur in the Atlantic and Alpine South. In Alpine South the share of pastures exceeds arable farming. In the Continental and Pannonian the largest share of agriculture consists of arable lands (see figures 3.7-3.9).

The inverse relation between soil carbon and agriculture especially applies to arable agriculture as figure 3.7 illustrates for non-irrigated arable land. The contrary is applicable to pasture which occurs more often in most EnZ in higher OCTOP classes.

Vineyards are much less widespread and over large regions their share in area amounts to a few percent only. As can be expected vineyards are more common in the warmer regions with the longer growing seasons and occur predominantly in the lower OCTOP classes.

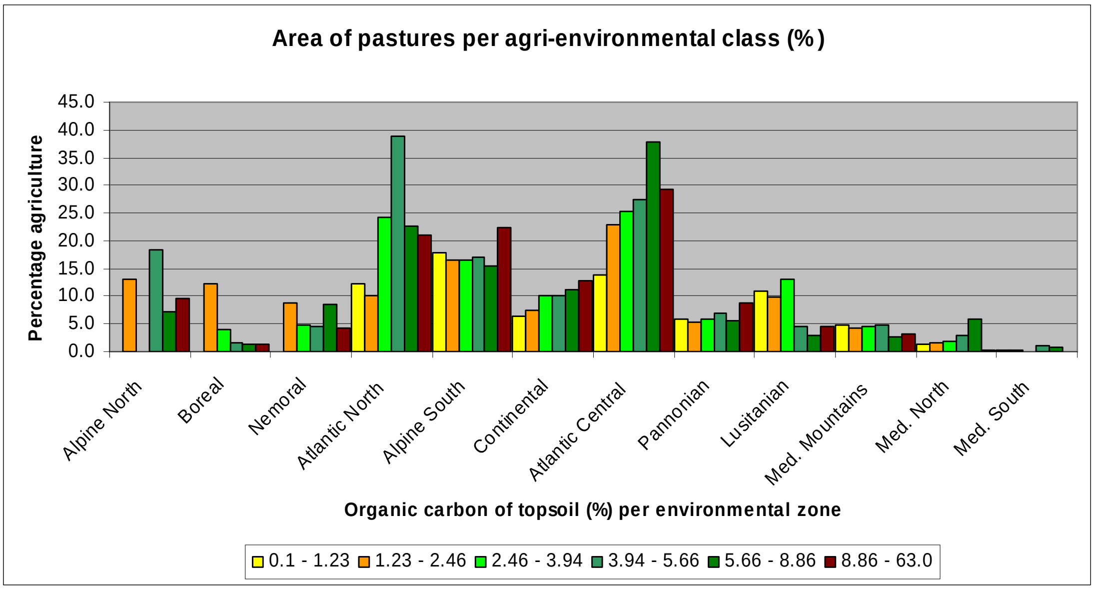


Figure 3.8. Relative share of pasture land per AEnZ land type.

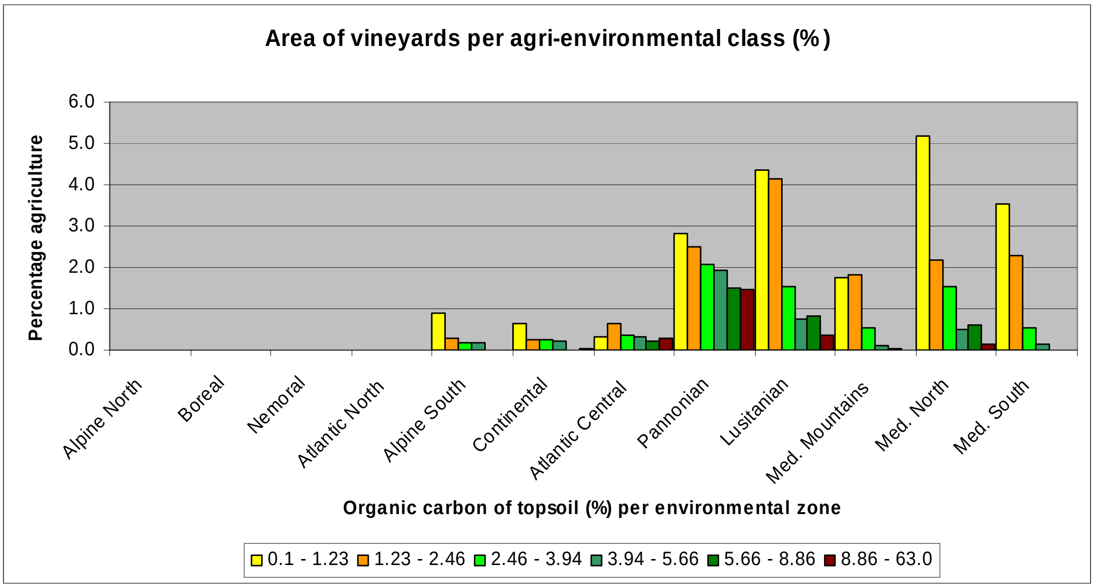


Figure 3.9. Relative share of vineyards per AEnZ land type.

3.2.5 Distribution of climate and biophysical variables over the Agri-Environmental types of Agrimask class 0

In this section an overview is given of the distribution of altitude, growing season, temperature range, summer drought, slope, AWHC, texture and rooting depth over the Agri-

Environmental types. The Agri-Environmental Zones (AEnZ) Nemoral with low organic carbon content (class 310) and Mediterranean South with high carbon content (class 1360) do not occur in the typology.

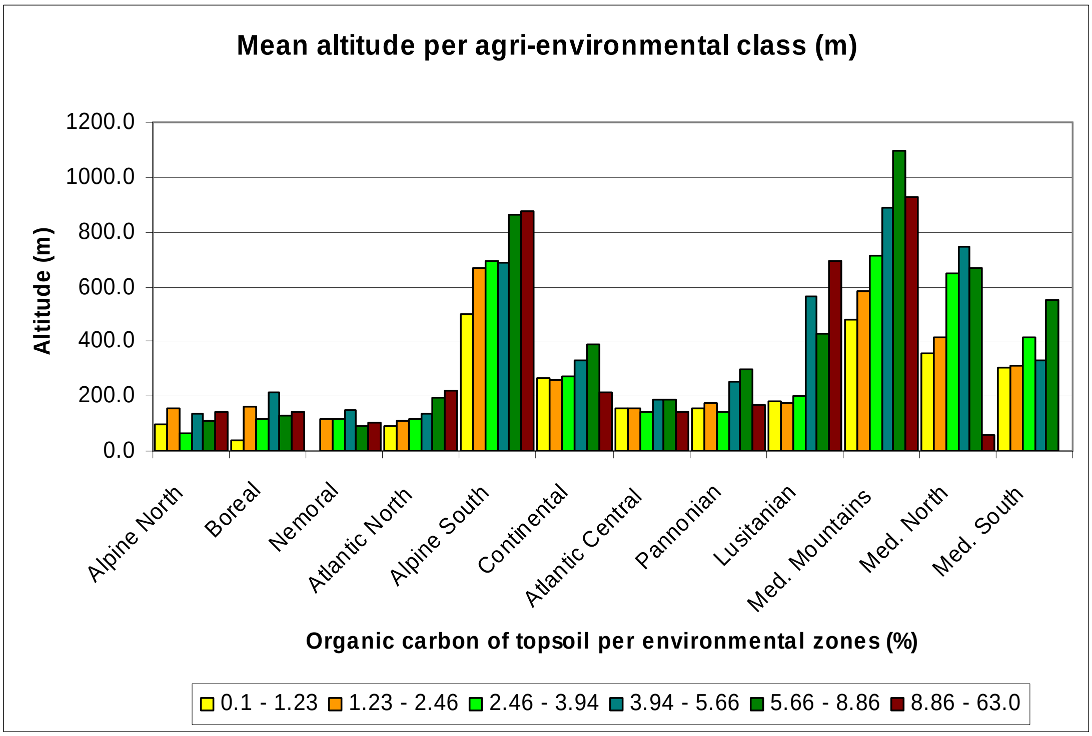


Figure 3.10. Mean altitude per AEnZ land type.

The agrimask class 0 land in most Environmental zones is situated largely below 200 meter, the variation in altitude within these zones is minimal and therefore the relation between altitude and organic carbon is weakly expressed, but yet it can be seen in Atlantic North, Continental and Pannonian, that higher carbon occurs at higher altitude. The low range in altitude holds also for the agrimask class 0 land in Alpine North which is limited to the lower altitudes. An important range of altitudes is found in Alpine South, Lusitanian, and Mediterranean environmental zones. Within these environmental zones (EnZ) the AEnZ classes with high OCTOP values are situated at higher altitudes (Figure 3.10).

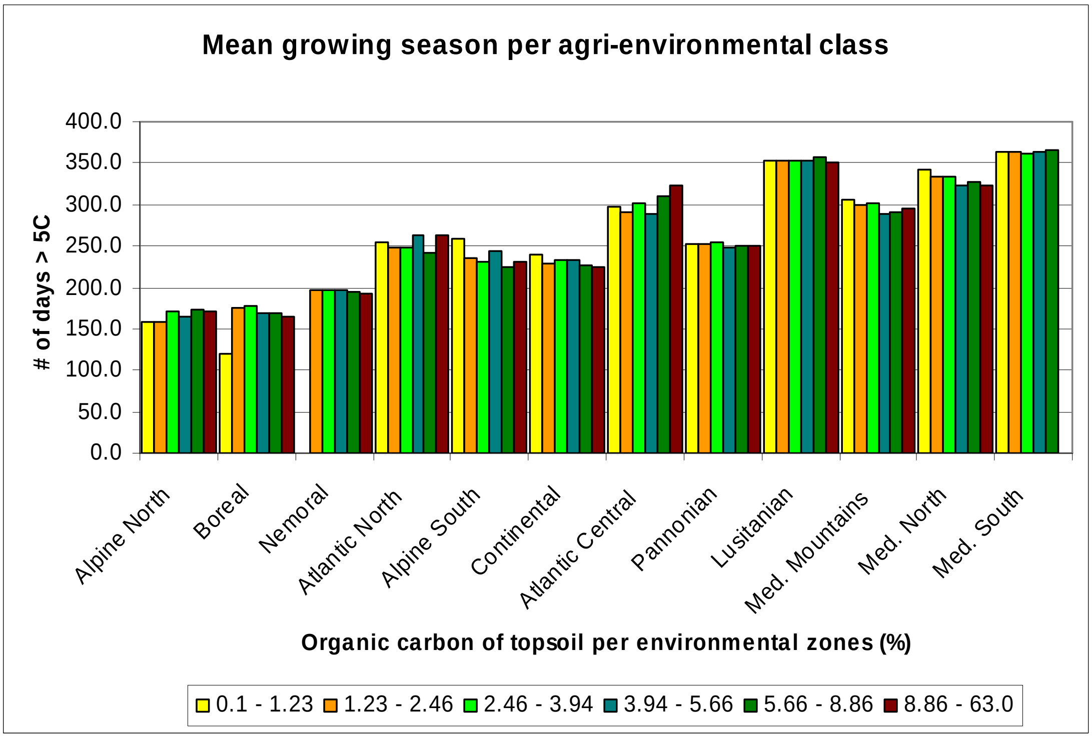


Figure 3.11. Mean growing season (number of days with >5°C) per AenZ land type.

The mean growing season shows a relation with the EnZ (see also Figure 2.1). The southern environmental zones have more than 250 days with temperatures above 5°C, whereas the northern zones (Boreal, Alpine North, Nemoral) have around 150 days with temperatures above 5°C. As expected, within an EnZ there is no or only very small variation in duration of growing season, and hence no relation between duration and OCTOP classes (Figure 3.11).

The Atlantic and Lusitanian EnZ's have a small temperature range below 15 °C reflecting the influence of the sea climate. The Pannonian and Boreal EnZ's have high temperature ranges between August and January (>20°C). The continental climate is reflected in these figures (Figure 3.12). Within an EnZ the differences in temperature range are very small, and there is no clear relation between OCTOP and temperature ranges. In a few regions a very slight tendency can be observed to find the OCTOP class with high organic carbon content (classes 4-6) within the smallest temperature ranges within an EnZ (Atlantic, Alpine South, Pannonian, Lusitanian, Mediterranean). This could be attributed to the larger accumulation of organic matter in the soil under the moist conditions in the mildest parts of these environmental zones.

Mean summer drought is increasing in Europe from North to South. For all EnZ the rainfall deficit is less than 150 mm (sum of rainfall- ETPot summed over May, June and July). The exceptions are the Pannonian, Lusitanian and Mediterranean EnZ with deficits from 150 upto almost 450 mm (see Figure 3.13). Within a EnZ the variation in summer drought is very small, yet there is within most EnZ a slight tendency to find the higher OCTOP class (4-6) on the wetter places. Exceptions are the Boreal, Nemoral and Mediterranean Mountain EnZ's, where the occurrence of higher and lower soil carbon is probably more related to topographic position than to the local climate.

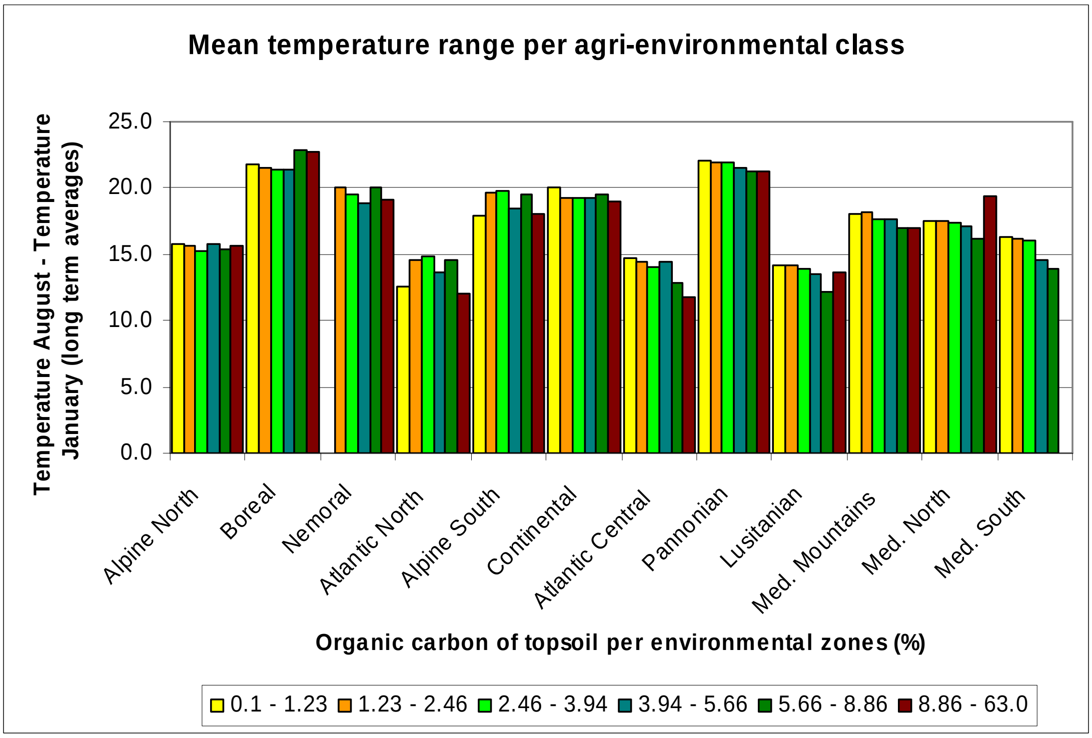


Figure 3.12. Mean temperature range (Temperature August – Temperature January) per AEnZ land type.

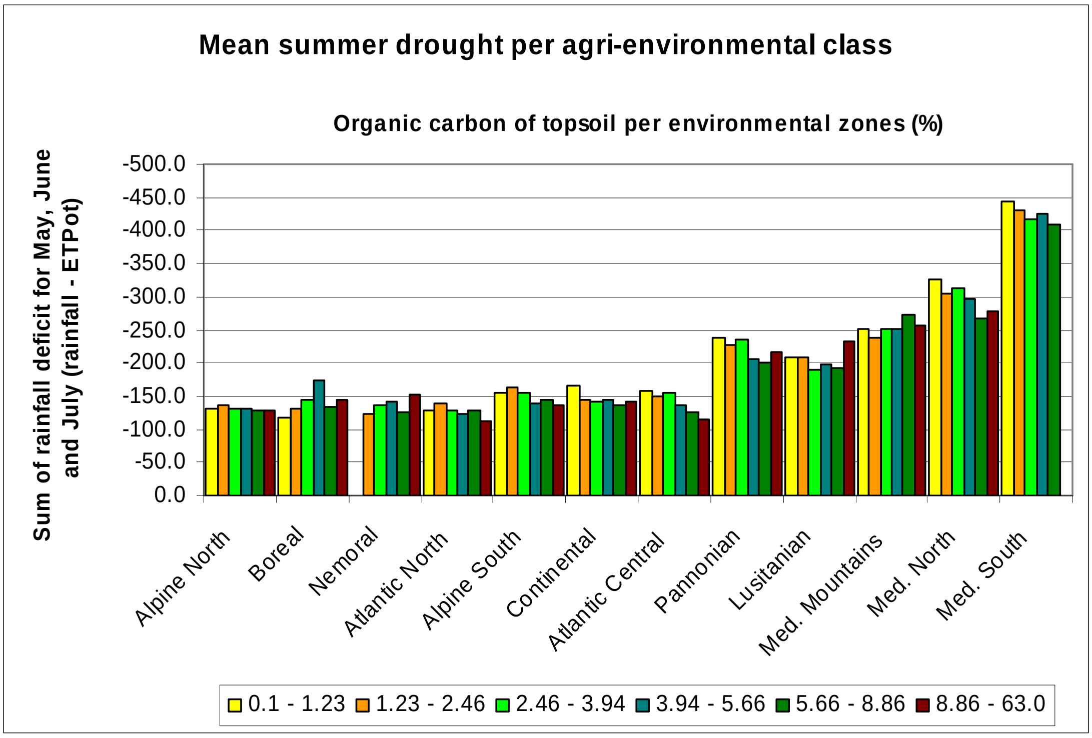


Figure 3.13. Mean summer drought (expressed as sum of rainfall deficit for May, June and July) per AenZ land type.

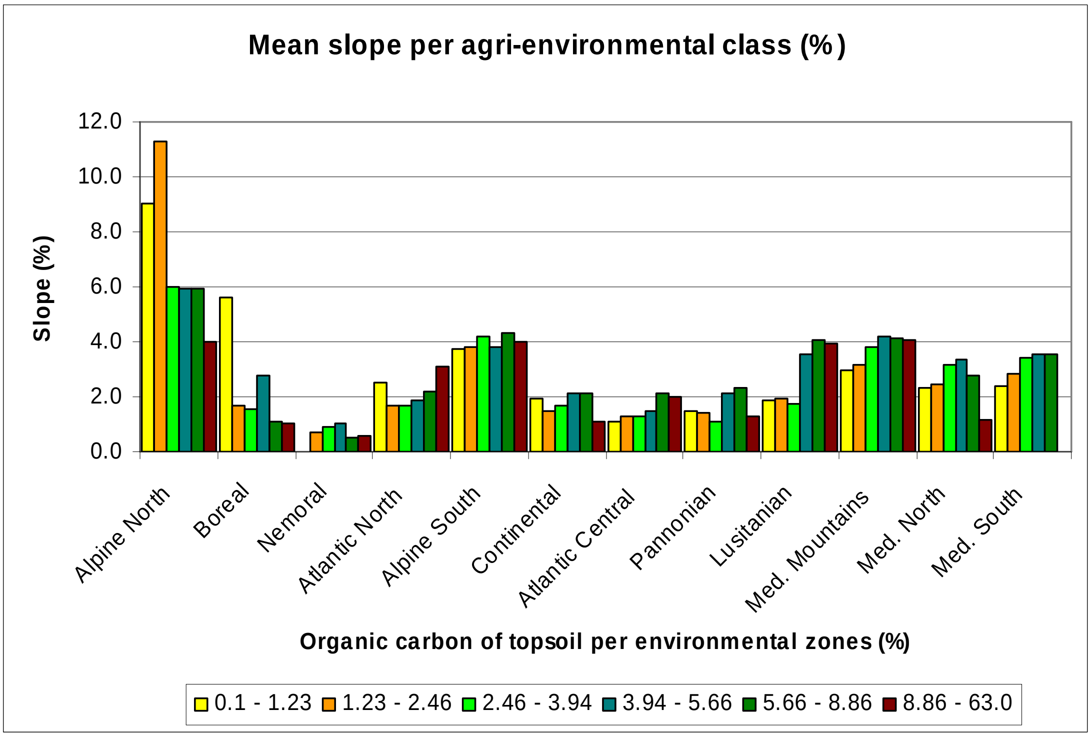


Figure 3.14. Mean slope (%) per AEnZ land type.

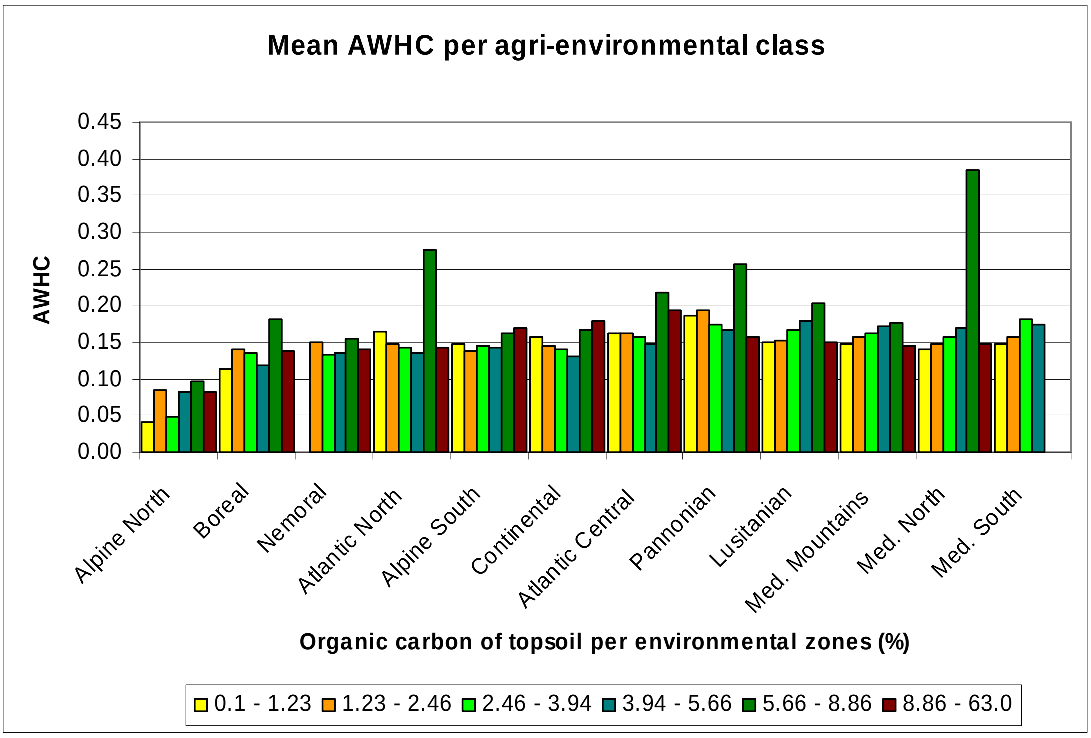


Figure 3.15. Mean Available Water Holding Capacity (AWHC) per AenZ land type.

Note that the AWHC of AEnZ class 1350 does not exist.

The interpretation of the slope and agri-environmental class starts from the notion that all slopes of more than 16 % have been placed in agrimask class 1, and those steeper than 8 percent in agrimask class 2. This means that even in a mountainous region the average slope class in the remaining class 0 is about 4 percent. Such mountainous regions are found in the Alpine South, Mediterranean and Lusitanian EnZ. OCTOP classes 4 and 5 seems to be more prominent on the steeper slopes within an EnZ (Figure 3.14). The exception is the Alpine North EnZ with slopes > 4%, which is due to data preprocessing with empty (nodata) data layers, so an artefact. In the other EnZ's the range in slopes is so low that a relation between mean slope and organic carbon can not be found.

The Available Water Holding Capacity (AWHC) is around 0.15 for Europe. The exception is the Alpine North EnZ (Figure 3.15). Within the EnZ there is no large variation between OCTOP classes. OCTOP class 5 is in several cases an exception with relatively high AWHC values.

Figure 3.16 shows the percentage of soils with no rooting depth obstacles within 0-80cm of the soil per AEnZ. High shares of deep soils are found in Atlantic, Continental, Pannonian and Nemoral, while there is no relation between soil depth and carbon in the topsoil. Mountainous regions as Alpine, Lusitanian and all Mediterranean EnZ's have low percentages of deep soils (<50%), with the exception that within the EnZ's Alpine North, Alpine South and Mediterranean South the soils with high organic carbon content (OCTOP classes 4-6) are relatively deep in comparison with the low carbon soils in the same zone. For all other EnZ's such a relation does not exist, while in the remaining Mediterranean Zones (North, Mountain, and Lusitanian) the soils with high carbon content are shallow.

Medium textured soils are nearly absent in the Alpine North EnZ. For most of the other EnZ's the percentage of medium textures soil surpasses 60%. The AEnZ with high organic carbon amounts seems to have a lower percentage of soils with medium texture. This may be due to the fact that medium textured soils are rich in minerals, which leads to faster decomposition of organic material. The reverse situation should occur in sandy soils, where high organic matter contents are common. Exceptions are the Alpine South, Lusitanian and Mediterranean Mountains Figure 3.17), where soils rich in organic matter are characterized as being usually medium textured.

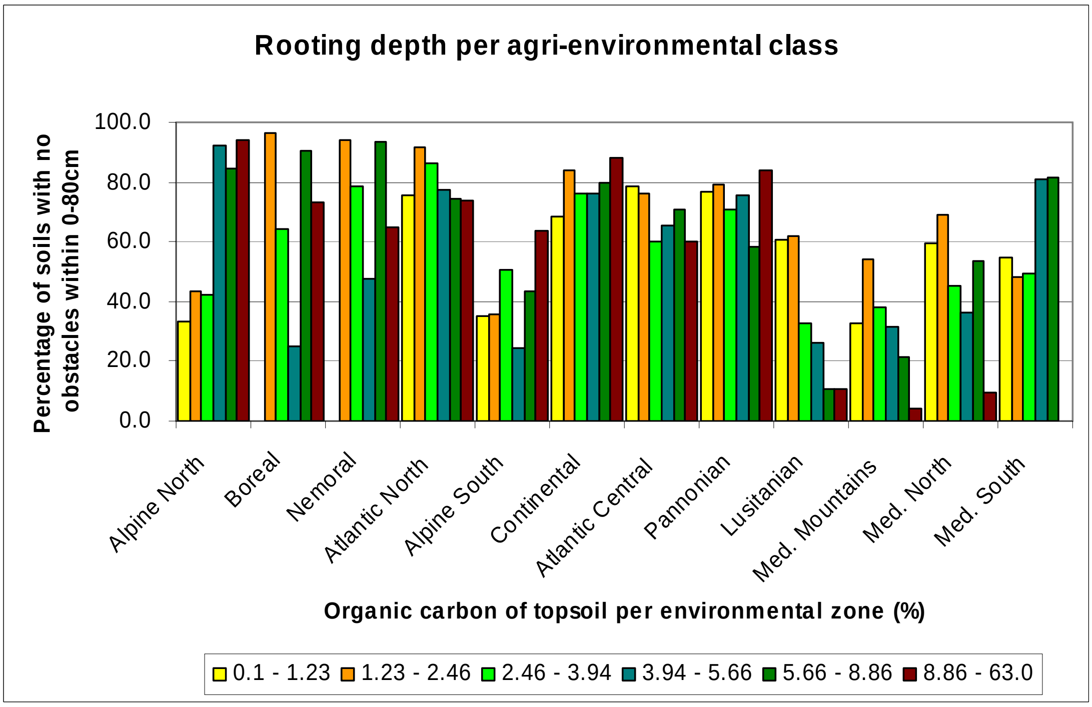


Figure 3.16. Percentage of soils with no obstacles in 0-80cm per AEnZ land type.

Note that data on the rooting depth of AEnZ class 210 (Boreal EnZ with OCTOP class 1) is not existing.

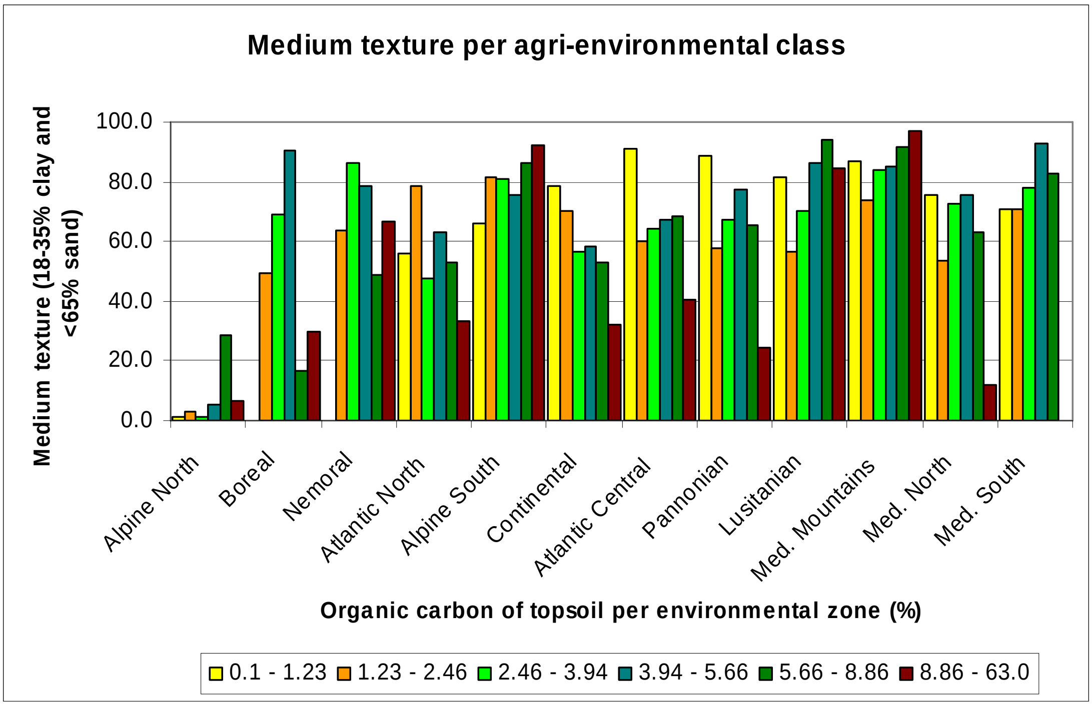


Figure 3.17. Percentage of soils with a medium texture (18-35% clay and <65% sand) per AEnZ land type.

Note that data on the medium texture of AEnZ class 210 (Boreal EnZ with OCTOP class 1) is not existing.

3.3 Applications of AEnZ

3.3.1 Selection sample regions

Within SEAMLESS a number of representative sample regions have to be selected to extrapolate the modelling outputs to Europe. Sample regions in the SEAMLESS context are defined by a combination of environmental and socio-economic data. The administrative boundaries of NUTS2 version7 are used as a framework for the socio-economic data. The AEnZ is used as a framework for the biophysical data.

The combination of the NUTS2 administrative boundaries with the environmental zones of the AEnZ resulted in 632 different regions. These regions are called sample regions and are described by their dominant OCTOP class. Two different options are presented to describe the sample regions by the dominant OCTOP class:

- dominant single OCTOP class (classes 1-6)
- dominant grouped OCTOP class (class 7: OCTOP classes 1-3 are summed up and class 8 : OCTOP classes 4-6 are summed up)

Appendix 4 shows a list of dominant OCTOP classes per EnZ/Nuts2 combination.

The selection of sample regions for which modelling will take place is defined by the EnZ's and the dominant OCTOP class within the NUTS2 region. Besides these biophysical parameters other (political, socio-economic) reason can influence the selection of sample regions.

3.3.2 Upscaling, downscaling and presentation of output

The upscaling of modelling results with use of the AEnZ typology is possible when a (spatial) relation between model outputs and the AEnZ is established. The allocation of a dominant soil type to an Agri-Environmental Zonation class makes it possible to upscale model outputs which have a relation with the soil attributes describing the soil type. Other examples of upscaling are the use of allocation of farm types and the allocation of land use. The allocation of land use by the Dynaspat approach is explained in more detail in PD471 and in Kempen et al (in prep). The land use allocated to the Homogeneous Spatial Mapping Units (HSMU) is aggregated with the AEnZ. Also the allocation of farms is aggregated with the AEnZ. However, the allocated farms are in the first place aggregated to farm types. The farm typology is described in PD442.

The use of the AEnZ for downscaling/upscaling has not implemented. In the future this section should be extended as upscaling and downscaling of model outputs are becoming available.

The AEnZ can be used to spatially present the results of the up- and/or downscaling excercise.

4 Conclusions

The Agri-Environmental Zonation (AEnZ) is a hierarchical and flexible subdivision of the European landscape into 238 relatively homogeneous units from an agronomic perspective. The AEnZ is based on 13 environmental zones, 6 organic carbon content classes and an agrimask that consist of three classes. The 238 classes of the AEnZ are described in terms of land cover, climate and biophysical parameters (altitude, growing season, temperature range, summer drought, slope, AWHC texture and rooting depth). Also the distribution of the share of land of the Agrimask over the environmental zones, OCTOP classes and the EnZ/OCTOP combination is described.

The Agri-Environmental Zonation (AEnZ) can be used at different levels of detail. A relatively coarse division of Europe can be obtained by looking only at the environmental zones. A more detailed biophysical subdivision of Europe can be generated by incorporating soil (organic carbon content) information. The Agrimask is adding additional information to the AEnZ through indicating possible restrictions for arable agriculture

The AEnZ provides one element of the framework for selection of sample regions within SEAMLESS. It has been decided that the sample regions, app. 30 in total, will be either one NUTS2 region or a group of neighbouring NUTS2 regions. The agri-environmental zones will be used to make a stratified sampling of the sample regions aiming to represent the heterogeneity of climate and soil conditions across the EU25 territory. The other element in the framework is aims to represent the heterogeneity of farming systems in EU25 (see PD4.4.3. However, it is also envisaged that the selection will also have to take more practical considerations such as availability of support from regional experts into account.

The AEnZ can be used for the spatial presentation of results. Modelling results of APES and FSSIM runs can be made spatially explicit. The modelling results can be scaled up with help of the AEnZ as the dominant soil type per AEnZ class is known. However, until now the upscaling of modelling results has not been performed as model outputs from for example APES do not exist.

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Glossary

Agri-Environmental Zonation A biophysical typology based on environmental zones and soil data.

Agri-Environmental Land Types The elements of the Agri-Environmental Zonation (AEnZ)defined by the combination of Environmental Zones, Organic Carbon content and Agri_mask classes.

Enironmental Stratification A statistical environmental stratification of Europe consisting of 84 strata based on 20 most important environmental variables.

Environmental Zones An aggregation of the 84 environmental strata into 13 environmental zones.

OCTOP The Organic Carbon content of the TOPsoil (OCTOP) (in %) calculated for every 1km2 in Europe

Agri-mask A mask indicating which areas in Europe are have no or relatively small constraints, which areas are not suitable and which areas are strongly handicapped for arable agriculture

SGDBE The Soil Geographical DataBase of Eurasia (SGDBE) at scale 1:1,000.000 which is a digitized European soil map and related attributes.

PTRDB The Pedo Transfer Rules Database (PTRDB) version 2.0, which olds a number of pedotransfer rules which can be applied to the SGDBE; the results of the application of the pedotransfer rules to the SGDBE are delivered as a table with new attributes related to the European soil map.

Appendices

1. Attributes of the Soil Geographical DataBase of Eurasia (SGDBE) and the PedoTransfer Rules DataBase (PTRDB).

STU table		
Attribute Name	**Confidence Level**	**Short description**
AGLIM1	-	Code of the most important limitation to agricultural use of the STU
AGLIM2	-	Code of a secondary limitation to agricultural use of the STU
CFL	-	Code for a global confidence level of the STU description
FAO85-FULL	yes	Full soil code of the STU from the 1974 (modified CEC 1985) FAO-UNESCO Soil Legend
FAO85-LEV1	yes	Soil major group code of the STU from the 1974 (modified CEC 1985) FAO-UNESCO Soil Legend
FAO85-LEV2	yes	Second level soil code of the STU from the 1974 (modified CEC 1985) FAO-UNESCO Soil Legend
FAO85-LEV3	yes	Third level soil code of the STU from the 1974 (modified CEC 1985) FAO-UNESCO Soil Legend
FAO90-FULL	yes	Full soil code of the STU from the 1990 FAO-UNESCO Soil Legend
FAO90-LEV1	yes	Soil major group code of the STU from the 1990 FAO-UNESCO Soil Legend
FAO90-LEV2	yes	Second level soil code of the STU from the 1990 FAO-UNESCO Soil Legend
IL	-	Code for the presence of an impermeable layer within the soil profile of the STU
PAR-MAT-DOM	yes	Code for dominant parent material of the STU
PAR-MAT-DOM1	yes	Major group code for the dominant parent material of the STU
PAR-MAT-DOM2	yes	Second level code for the dominant parent material of the STU
PAR-MAT-DOM3	yes	Third level code for the dominant parent material of the STU
PAR-MAT-SEC	yes	Code for secondary parent material of the STU
PAR-MAT-SEC1	yes	Major group code for the secondary parent material of the STU
PAR-MAT-SEC2	yes	Second level code for the secondary parent material of the STU
PAR-MAT-SEC3	yes	Third level code for the secondary parent material of the STU
ROO	-	Depth class of an obstacle to roots within the STU
SLOPE-DOM	-	Dominant slope class of the STU
SLOPE-SEC	-	Secondary slope class of the STU
TEXT-DEP-CHG	-	Depth class to a textural change of the dominant and/or secondary surface texture of the STU

TEXT-SRF-DOM	-	Dominant surface textural class of the STU
TEXT-SRF-SEC	-	Secondary surface textural class of the STU
TEXT-SUB-DOM	-	Dominant sub-surface textural class of the STU
TEXT-SUB-SEC	-	Secondary sub-surface textural class of the STU
USE-DOM	-	Code for dominant land use of the STU
USE-SEC	-	Code for secondary land use of the STU
WM1	-	Code for normal presence and purpose of an existing water management system in agricultural land on more than 50% of the STU
WM2	-	Code for the type of an existing water management system
WR	-	Dominant annual average soil water regime class of the soil profile of the STU
WRB-ADJ1	yes	First soil adjective code of the STU from the World Reference Base (WRB) for Soil Resources
WRB-ADJ2	yes	Second soil adjective code of the STU from the World Reference Base (WRB) for Soil Resources
WRB-FULL	yes	Full soil code of the STU from the World Reference Base (WRB) for Soil Resources
WRB-LEV1	yes	Soil reference group code of the STU from the World Reference Base (WRB) for Soil Resources
WRB-SPE1	yes	Specifier of the first soil adjective of the STU from the World Reference Base (WRB) for Soil Resources
WRB-SPE2	yes	Specifier of the second soil adjective of the STU from the World Reference Base (WRB) for Soil Resources
ZMAX	-	Maximum elevation above sea level of the STU (in metres)
ZMIN	-	Minimum elevation above sea level of the STU (in metres)

PTRDB table	
Attribute Name	**Short description**
TEXT	Dominant surface textural class (completed from dominant STU)
AGLIM1NNI	Dominant limitation to agricultural use (without no information)
AGLIM2NNI	Secondary limitation to agricultural use (without no information)
USE	Regrouped land use class
ALT	ELEVATION
MAT1HEV	Dominant parent material code as translated from MAT1 by Hartwich & al
PAR-MAT-DOM	Code for dominant parent material of the STU (inferred)
PAR-MAT-SEC	Code for secondary parent material of the STU (inferred)
OC_TOP	Topsoil organic carbon content
PEAT	Peat
PMH	Parent material hydro-geological type
DGH	Depth to a gleyed horizon

DIMP	Depth to an impermeable layer
HG	Hydro-geological class
ALT_MIN	100 m class minimum altitudes
ALT_MAX	100 m class maximum altitudes
ATC	Accumulated temperature class
DIFF	Soil profile differentiation
MIN	Profile mineralogy
MIN_TOP	Topsoil mineralogy
MIN_SUB	Subsoil mineralogy
CEC_TOP	Topsoil cation exchange capacity
CEC_SUB	Subsoil cation exchange capacity
BS_TOP	Base saturation of the topsoil
BS_SUB	Base saturation of the subsoil
DR	Depth to rock
VS	Volume of stones
TD	Rule inferred subsoil texture
STR_TOP	Topsoil structure
STR_SUB	Subsoil structure
PD_TOP	Topsoil packing density
PD_SUB	Subsoil packing density
AWC_TOP	Topsoil available water capacity
EAWC_TOP	Topsoil easily available water capacity
AWC_SUB	Subsoil available water capacity
EAWC_SUB	Subsoil easily available water capacity
TEXT-CRUST	Textural factor of soil crusting
PHYS-CHIM	Physi-chemical factor of soil crusting & erodibility
CRUSTING	Soil crusting class
TEXT-EROD	Textural factor of soil erodibility
ERODIBILITY	Soil erodibility class

Appendix 2. Characteristics of the Environmental Zones

Characteristics	**Alpine north**	**Boreal**	**Nemoral**	**Atlantic North**	**Alpine South**	**Continental**	**Atlantic Central**	**Pannonian**	**Lusitanian**	**Mediterranean Mountains**	**Mediterranean North**	**Mediterranean South**
Mean altitude (m)	572	216	127	190	1253	435	140	160	371	905	433	277
Mean slope (degrees)	5.0	1.0	0.4	2.0	7.8	2.1	0.7	0.9	2.6	4.6	2.4	2.3
Length growing season (days)	130	157	196	255	220	227	296	250	353	298	335	363
sum of active temperatures (+10° C)	1416	1966	2717	3198	3005	3294	3849	4099	4749	4548	5104	6021
Mean anual precipitation (mm)	1317	624	679	1356	1144	743	892	570	1118	794	734	529
% urban	0.1	1.0	1.6	4.9	1.8	1.0	8.0	6.5	3.4	2.5	2.7	2.9
% forest (1)	39.5	59.9	28.9	13.8	49.8	33.0	15.7	15.3	27.8	41.0	17.5	10.0
% agricultural land use (1)	51.0	30.4	27.6	79.4	40.2	63.0	75.0	75.8	67.5	54.9	78.5	85.6
% arable (1):	0.0	15.0	48.5	30.5	7.6	61.8	45.8	72.9	27.8	20.5	44.2	26.9
of which rainfed (1)	0.0	15.0	48.5	30.5	7.5	61.8	45.8	72.8	27.4	18.6	38.4	22.3
Irrigated (1)	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.3	1.9	5.8	4.6
% grassland (1)	3.0	3.2	11.9	41.3	46.1	16.8	36.4	10.2	19.3	20.8	5.7	7.1
% HNV farmland (1+2)	0.1	14.9	43.0	29.2	34.7	8.7	3.8	14.4	33.9	60.9	27.9	40.3
Most important intensity systems (% UAA) (3)												
High input (3)	0	42	100	41	28	60	58		43	26	18	8
Medium input (3)	0	45	0	31	60	39	33		43	47	39	25
Low input (3)	0	6	0	28	12	1	9		14	27	42	67
Most important land use systems in EU15 countries (% UAA) (3):												
Cropping cereals(3)	0	26	0	21	24	48	25	..	20	21	36	11
Cropping fallow land(3)	0	14	0	1	6	0	2	..	7	19	22	15
Cropping mixed crops(3)	0	7	0	5	6	11	10	..	3	5	10	5
Cropping specialist crops(3)	0	0	0	2	2	0	5	..	11	4	12	14
Grazing livestock forage crops(3)	0	21	23	9	19	16	11	..	12	9	6	10
Grazing livestock permanent grass(3)	0	0	0	59	43	24	42	..	19	34	10	43
Grazing livestock Temporary grass(3)	0	33	77	3	0	2	5	..	28	9	4	0
Permanent Crops(3)	0	0	0	0	0	0	0	..	0	0	1	1
Mixed cropping livestock(3)	0	0	0	0	0	0	0	..	0	0	0	1
Most important agricultural crops in EU10 countries (% UAA) (3):												
Most important environmental pressures (4):												
Erosion	low	low	low	medium	high	medium	medium	medium	medium	high	high	high
Soil compaction	low	medium	medium	medium	low	medium	high	low	medium	low	low	low
Eutrophication	low	medium	medium	medium/high	medium	medium	high	low	medium	low	low	low
Pesticide pollution	low	low	medium	medium	low	medium	high	low	medium	low	medium	medium
Water abstraction	low	low	low	low	low	low	low	medium	medium	high	high	high
Fire risk	low	low	low	low	medium	low	low	medium	medium	high	high	high
Land abandonment	high	high	medium	medium	high	medium	low	high	medium	high	high	high

Appendix 3a. Area distribution of Agrimask classes over the Environmental zones and OCTOP classes (km2).

Sum of area km2		ARG_MASK			
ENZ	CTOP_CL	0	1	2	Grand Total
1	1	2359	8658	436	11453
	2	2172	79861	1189	83222
	3	5147	48321	902	54370
	4	3320	19293	1120	23733
	5	2136	65066	799	68001
	6	3156	62790	603	66549
	9	10303	28568	1376	40247
1 Total		28593	312557	6425	347575
2	1	90	261		351
	2	10192	27935	979	39106
	3	10874	9288	75	20237
	4	44332	49829	1352	95513
	5	149016	50520	2092	201628
	6	135510	112059	513	248082
	9	45032	15278	485	60795
2 Total		395046	265170	5496	665712
3	2	23548		2	23550
	3	65243		28	65271
	4	30420		15	30435
	5	48099			48099
	6	88569		1	88570
	9	31145		8	31153
3 Total		287024		54	287078
4	1	3800	392	393	4585
	2	28125	2367	1584	32076
	3	34406	988	1095	36489
	4	79764	1074	2515	83353
	5	37452	543	2073	40068
	6	73784	5649	13409	92842
	9	20206	1286	1859	23351
4 Total		277537	12299	22928	312764
5	1	2731	1061	1094	4886
	2	12067	16712	6157	34936
	3	9482	10715	5481	25678
	4	25244	17234	11346	53824
	5	30944	61929	19324	112197
	6	10762	21907	3672	36341
	9	1095	17963	466	19524
5 Total		92325	147521	47540	287386
6	1	45801	237	1507	47545
	2	205787	2533	6883	215203
	3	121926	2197	6169	130292
	4	223659	6152	20336	250147
	5	163930	21027	26630	211587
	6	99504	4367	5002	108873
	9	18404	500	351	19255
6 Total		879011	37013	66878	982902

Sum of area km2		ARG_MASK			
ENZ	CTOP_CL	0	1	2	Grand Total
7	1	86749	66	718	87533
	2	111745	73	592	112410
	3	123628	62	743	124433
	4	137910	75	1674	139659
	5	11272	52	428	11752
	6	27560	182	1886	29628
	9	13053	27	168	13248
7 Total		511917	537	6209	518663
8	1	60419	64	1418	61901
	2	103687	278	6497	110462
	3	117765	346	4666	122777
	4	41885	473	3974	46332
	5	5917	221	864	7002
	6	5626	10	297	5933
	9	6532	10	379	6921
8 Total		341831	1402	18095	361328
9	1	33772	1931	4974	40677
	2	45838	862	3060	49760
	3	66914	1136	6951	75001
	4	7123	591	2440	10154
	5	6898	771	3197	10866
	6	4805	1043	2488	8336
	9	3871	272	811	4954
9 Total		169221	6606	23921	199748
11	1	24317	6063	8173	38553
	2	46921	12627	15763	75311
	3	39362	9723	16451	65536
	4	28885	15197	17317	61399
	5	7980	11019	6061	25060
	6	1779	2180	1198	5157
	9	2989	1727	984	5700
11 Total		152233	58536	65947	276716
12	1	155569	6590	16976	179135
	2	158681	6184	20069	184934
	3	65125	4465	14172	83762
	4	8495	1471	2784	12750
	5	1121	139	241	1501
	6	510	19	82	611
	9	10449	356	930	11735
12 Total		399950	19224	55254	474428
13	1	208805	5460	21748	236013
	2	74565	2961	12318	89844
	3	6303	793	2120	9216
	4	457	120	170	747
	5	82	32	57	171
	9	16044	845	2279	19168
13 Total		306256	10211	38692	355159
(blank)	(blank)				
(blank) Total					
Grand Total		3840944	871076	357439	5069459

Appendix 3b. Area distribution of Agrimask classes over the Environmental zones and OCTOP classes (%).

Area in %		ARG_MASK		
ENZ	CTOP_CL	0	1	2
1	1	20.6	75.6	3.8
	2	2.6	96.0	1.4
	3	9.5	88.9	1.7
	4	14.0	81.3	4.7
	5	3.1	95.7	1.2
	6	4.7	94.4	0.9
	9	25.6	71.0	3.4
1 Total		8.2	89.9	1.8
2	1	25.6	74.4	0.0
	2	26.1	71.4	2.5
	3	53.7	45.9	0.4
	4	46.4	52.2	1.4
	5	73.9	25.1	1.0
	6	54.6	45.2	0.2
	9	74.1	25.1	0.8
2 Total		59.3	39.8	0.8
3	2	100.0	0.0	0.0
	3	100.0	0.0	0.0
	4	100.0	0.0	0.0
	5	100.0	0.0	0.0
	6	100.0	0.0	0.0
	9	100.0	0.0	0.0
3 Total		100.0	0.0	0.0
4	1	82.9	8.5	8.6
	2	87.7	7.4	4.9
	3	94.3	2.7	3.0
	4	95.7	1.3	3.0
	5	93.5	1.4	5.2
	6	79.5	6.1	14.4
	9	86.5	5.5	8.0
4 Total		88.7	3.9	7.3
5	1	55.9	21.7	22.4
	2	34.5	47.8	17.6
	3	36.9	41.7	21.3
	4	46.9	32.0	21.1
	5	27.6	55.2	17.2
	6	29.6	60.3	10.1
	9	5.6	92.0	2.4
5 Total		32.1	51.3	16.5
6	1	96.3	0.5	3.2
	2	95.6	1.2	3.2
	3	93.6	1.7	4.7
	4	89.4	2.5	8.1
	5	77.5	9.9	12.6
	6	91.4	4.0	4.6
	9	95.6	2.6	1.8
6 Total		89.4	3.8	6.8

Area in %		ARG_MASK		
ENZ	CTOP_CL	0	1	2
7	1	99.1	0.1	0.8
	2	99.4	0.1	0.5
	3	99.4	0.0	0.6
	4	98.7	0.1	1.2
	5	95.9	0.4	3.6
	6	93.0	0.6	6.4
	9	98.5	0.2	1.3
7 Total		98.7	0.1	1.2
8	1	97.6	0.1	2.3
	2	93.9	0.3	5.9
	3	95.9	0.3	3.8
	4	90.4	1.0	8.6
	5	84.5	3.2	12.3
	6	94.8	0.2	5.0
	9	94.4	0.1	5.5
8 Total		94.6	0.4	5.0
9	1	83.0	4.7	12.2
	2	92.1	1.7	6.1
	3	89.2	1.5	9.3
	4	70.1	5.8	24.0
	5	63.5	7.1	29.4
	6	57.6	12.5	29.8
	9	78.1	5.5	16.4
9 Total		84.7	3.3	12.0
11	1	63.1	15.7	21.2
	2	62.3	16.8	20.9
	3	60.1	14.8	25.1
	4	47.0	24.8	28.2
	5	31.8	44.0	24.2
	6	34.5	42.3	23.2
	9	52.4	30.3	17.3
11 Total		55.0	21.2	23.8
12	1	86.8	3.7	9.5
	2	85.8	3.3	10.9
	3	77.8	5.3	16.9
	4	66.6	11.5	21.8
	5	74.7	9.3	16.1
	6	83.5	3.1	13.4
	9	89.0	3.0	7.9
12 Total		84.3	4.1	11.6
13	1	88.5	2.3	9.2
	2	83.0	3.3	13.7
	3	68.4	8.6	23.0
	4	61.2	16.1	22.8
	5	48.0	18.7	33.3
	9	83.7	4.4	11.9
13 Total		86.2	2.9	10.9
Grand Total		75.8	17.2	7.1

Appendix 4a. List of dominant OCTOP classes per EnZ/NUTS2 combination (EnZ 1-5). The column *single* indicates the dominant OCTOP class 1 – 6. The column *group* indicates the dominant cluster of OCTOP class. Note: Class 7 indicates that OCTOP class 1-3 are dominant, class 8 indicated that OCTOP classes 4-6 are dominant.

EnZ	NUTS2	group	single
1	FI15	8	6
1	NO	8	4
1	NO02	7	2
1	NO03	7	2
1	NO04	7	2
1	NO05	7	2
1	NO06	8	3
1	NO07	7	3
1	PL06	8	5
1	SE07	7	3
1	SE08	8	5
1	SK03	8	5
1	SK04	8	5
1	(blank)	7	2

EnZ	NUTS2	group	single
2	EE	8	6
2	FI	8	5
2	FI13	8	5
2	FI14	8	5
2	FI15	8	6
2	FI16	8	5
2	FI17	8	5
2	LV	8	6
2	NO01	8	5
2	NO02	8	2
2	NO03	8	2
2	NO04	8	4
2	NO06	8	6
2	NO07	7	3
2	SE02	8	4
2	SE06	8	6
2	SE07	8	4
2	SE08	8	6
2	SE0A	7	3
2	(blank)	7	3

EnZ	NUTS2	group	single
3	EE	8	5
3	FI	8	5
3	FI16	8	5
3	FI17	8	5
3	FI2	7	2
3	LT	7	3
3	LV	8	6
3	NO01	8	4
3	NO03	8	5
3	PL0A	8	6
3	PL0B	8	2
3	PL0E	7	2
3	SE	8	6
3	SE01	8	6
3	SE02	8	6
3	SE04	8	6
3	SE06	8	6
3	SE09	8	6
3	SE0A	8	6
3	(blank)	8	3

EnZ	NUTS2	group	single
4	DEC	8	4
4	DE5	8	4
4	DE6	8	4
4	DE71	8	6
4	DE72	8	4
4	DE73	8	4
4	DE91	8	4
4	DE92	7	2
4	DE93	8	3
4	DE94	8	3
4	DEA1	8	4
4	DEA2	8	4
4	DEA3	8	4
4	DEA4	7	2
4	DEA5	8	6
4	DEB1	8	4
4	DEB2	8	5
4	DEB3	8	6
4	DEE2	8	5
4	DEE3	8	5
4	DEF	8	4
4	DEG	8	4
4	DK	8	5
4	IE01	8	6
4	NL	8	4
4	NL11	8	4
4	NL12	8	4
4	NL13	8	4
4	NL21	8	4
4	NL22	8	4
4	NL23	8	4
4	NO	7	2
4	NO04	7	3
4	NO05	8	4
4	NO06	7	1
4	UK	8	4
4	UKC1	8	4
4	UKC2	8	4
4	UKD1	8	6
4	UKD2	8	4
4	UKD3	8	4
4	UKD4	8	4
4	UKD5	7	2
4	UKE1	7	3
4	UKE2	8	4
4	UKE3	8	4
4	UKE4	8	4
4	UKF1	8	4
4	UKG1	7	4
4	UKG2	8	4
4	UKL1	8	6
4	UKL2	8	6
4	UKM1	8	4
4	UKM2	8	6
4	UKM3	8	6
4	UKM4	8	6
4	UKN	8	4
4	(blank)	8	4

EnZ	NUTS2	group	single
5	AT11	8	4
5	AT12	8	6
5	AT21	8	5
5	AT22	8	5
5	AT31	8	5
5	AT32	8	5
5	AT33	8	5
5	AT34	8	5
5	BG04	8	5
5	BG05	8	5
5	CH	7	2
5	CH01	8	5
5	CH02	8	5
5	CH05	8	5
5	CH06	8	5
5	CH07	8	5
5	CZ02	7	3
5	CZ03	8	5
5	CZ04	8	5
5	CZ05	8	5
5	CZ06	8	5
5	CZ07	8	5
5	CZ08	7	3
5	DE13	8	6
5	DE21	8	2
5	DE22	8	5
5	DE23	8	6
5	DE24	8	5
5	DE26	8	5
5	DE27	7	2
5	DE73	8	5
5	DE91	8	5
5	DED1	8	6
5	DEE3	8	5
5	DEG	8	5
5	ES11	8	6
5	ES12	7	1
5	ES13	8	4
5	ES22	8	5
5	ES23	8	5
5	ES24	8	2
5	ES41	8	5
5	ES51	8	6
5	FR61	8	6
5	FR62	8	6
5	FR63	8	4
5	FR71	8	5
5	FR72	8	4
5	FR81	8	6
5	FR82	8	5
5	GR11	8	5
5	GR12	8	4
5	GR13	8	4
5	HU03	8	4
5	IT	7	3
5	IT11	8	5
5	IT12	8	4
5	IT2	8	5
5	IT31	8	5
5	IT32	8	4
5	IT33	8	4
5	LI	8	5
5	PL01	8	4
5	PL06	8	5
5	PL08	7	5
5	PL09	8	5
5	RO01	8	5
5	RO02	8	5
5	RO03	8	5
5	RO04	8	5
5	RO05	8	5
5	RO06	8	5
5	RO07	8	5

Appendix 4b. List of dominant OCTOP classes per EnZ/NUTS2 combination (EnZ 6-9). The column *single* indicates the dominant OCTOP class 1 – 6. The column *group* indicates the dominant cluster of OCTOP class. Note: Class 7 indicates that OCTOP class 1-3 are dominant, class 8 indicated that OCTOP classes 4-6 are dominant.

EnZ	NUTS2	group	single	EnZ	NUTS2	group	single	EnZ	NUTS2	group	single	EnZ	NUTS2	group	single
6	AT	7	2	7	DEC	8	4	8	AT11	7	2	9	ES11	8	3
6	AT11	8	4	7	BE1	7	2	8	AT12	7	2	9	ES12	7	1
6	AT12	8	5	7	BE21	7	3	8	AT13	7	4	9	ES13	7	3
6	AT21	8	5	7	BE22	7	3	8	AT22	7	2	9	ES21	7	3
6	AT22	8	5	7	BE23	7	3	8	BG01	7	2	9	ES22	8	4
6	AT31	8	5	7	BE24	7	1	8	BG02	7	3	9	ES23	7	2
6	AT32	8	4	7	BE25	7	1	8	BG03	7	2	9	ES41	7	3
6	AT33	8	5	7	BE31	7	1	8	BG04	7	3	9	FR	7	3
6	AT34	8	6	7	BE32	7	1	8	BG05	7	2	9	FR24	7	3
6	BE22	7	2	7	BE33	7	2	8	BG06	7	2	9	FR51	7	3
6	BE32	7	4	7	BE34	7	2	8	CZ06	7	2	9	FR52	7	3
6	BE33	8	5	7	BE35	7	2	8	DE12	7	3	9	FR53	7	3
6	BE34	8	4	7	CH	7	2	8	DE13	8	4	9	FR61	7	3
6	BE35	7	4	7	CH01	7	2	8	DE71	7	3	9	FR62	7	2
6	BG01	8	5	7	CH02	8	4	8	DEB3	7	3	9	FR63	7	3
6	BG02	8	4	7	CH03	7	2	8	FR42	8	4	9	FR71	7	1
6	BG03	8	4	7	DE11	7	2	8	GR11	7	4	9	FR72	7	3
6	BG04	8	5	7	DE12	7	2	8	GR12	7	1	9	PT11	7	2
6	BG05	8	5	7	DE13	7	2	8	HU	7	3	9	PT12	7	2
6	BG06	8	5	7	DE14	7	3	8	HU01	7	3	9	PT13	7	1
6	CH	7	2	7	DE71	8	4	8	HU02	7	2				
6	CH01	7	5	7	DE94	8	4	8	HU03	7	3				
6	CH02	8	5	7	DEA1	7	2	8	HU04	7	3				
6	CH03	8	4	7	DEA2	7	2	8	HU05	8	4				
6	CH04	7	4	7	DEA3	8	4	8	HU06	7	3				
6	CH05	7	2	7	DEA4	8	4	8	HU07	7	3				
6	CH06	7	2	7	DEA5	7	2	8	RO01	7	1				
6	CZ01	7	2	7	DEB1	8	4	8	RO02	7	3				
6	CZ02	8	4	7	DEB2	8	4	8	RO03	7	2				
6	CZ03	8	5	7	DEB3	8	4	8	RO04	7	2				
6	CZ04	7	2	7	ES21	7	2	8	RO05	7	3				
6	CZ05	8	2	7	ES41	7	3	8	RO06	7	1				
6	CZ06	8	5	7	FR	7	2	8	RO08	7	3				
6	CZ07	8	5	7	FR1	7	1	8	SI	8	4				
6	CZ08	8	5	7	FR21	8	4	8	SK01	8	4				
6	DE	7	2	7	FR22	7	1	8	SK02	7	1				
6	DE11	8	3	7	FR23	7	1	8	SK03	7	2				
6	DE12	8	4	7	FR24	7	3	8	(blank)	7	3				
6	DE13	8	6	7	FR25	7	2								
6	DE14	8	4	7	FR26	7	4								
6	DE21	7	2	7	FR3	7	1								
6	DE22	7	2	7	FR41	7	4								
6	DE23	8	4	7	FR42	7	2								
6	DE24	8	5	7	FR43	7	4								
6	DE25	8	4	7	FR51	7	3								
6	DE26	8	4	7	FR52	7	3								
6	DE27	7	3	7	FR53	7	1								
6	DE3	8	2	7	FR61	7	3								
6	DE4	8	3	7	FR62	8	4								
6	DE6	7	2	7	FR63	7	4								
6	DE71	8	4	7	FR71	7	1								
6	DE72	7	4	7	FR72	7	2								
6	DE73	8	4	7	IE	7	1								
6	DE8	8	2	7	IE01	8	4								
6	DE91	8	4	7	IE02	8	4								
6	DE92	8	4	7	LU	7	2								
6	DE93	8	4	7	NL	8	4								
6	DE94	8	4	7	NL12	8	4								
6	DEA2	8	5	7	NL21	8	4								
6	DEB1	8	4	7	NL22	8	4								
6	DEB2	8	5	7	NL23	8	4								
6	DEB3	8	4	7	NL31	8	4								
6	DED1	8	4	7	NL32	8	4								
6	DED2	8	4	7	NL33	8	4								
6	DED3	7	2	7	NL34	8	4								
6	DEE1	7	2	7	NL41	8	4								
6	DEE2	7	2	7	NL42	7	4								
6	DEE3	7	2	7	UKD2	7	3								
6	DEF	7	2	7	UKD3	7	2								
6	DEG	8	4	7	UKD4	7	4								
6	DK	7	2	7	UKD5	7	2								
6	FR	7	2	7	UKE1	7	2								
6	FR21	8	4	7	UKE2	7	3								

Appendix 4c. List of dominant OCTOP classes per EnZ/NUTS2 combination (EnZ 10-13). The column *single* indicates the dominant OCTOP class 1 – 6. The column *group* indicates the dominant cluster of OCTOP class. Note: Class 7 indicates that OCTOP class 1-3 are dominant, class 8 indicated that OCTOP classes 4-6 are dominant.

EnZ	NUTS2	group	single
11	AT22	7	1
11	BG05	8	4
11	CH	7	2
11	CH04	8	5
11	CH05	7	2
11	CH06	7	5
11	CH07	7	3
11	ES11	8	5
11	ES12	7	1
11	ES13	8	4
11	ES21	7	3
11	ES22	8	4
11	ES23	7	3
11	ES24	7	4
11	ES3	8	5
11	ES41	8	2
11	ES42	7	3
11	ES43	7	2
11	ES51	8	4
11	ES52	7	3
11	ES61	7	2
11	ES62	7	3
11	FR61	7	3
11	FR62	7	3
11	FR63	8	4
11	FR71	7	3
11	FR72	8	4
11	FR81	7	3
11	FR82	8	4
11	FR83	7	1
11	GR	7	1
11	GR11	7	2
11	GR12	7	2
11	GR13	7	2
11	GR14	7	2
11	GR21	7	2
11	GR22	7	1
11	GR23	7	1
11	GR24	7	2
11	GR25	7	1
11	HU01	7	3
11	HU02	7	2
11	HU03	7	3
11	IT	7	2
11	IT11	7	2
11	IT13	7	3
11	IT2	7	2
11	IT31	8	4
11	IT32	7	2
11	IT33	7	1
11	IT4	7	2
11	IT51	7	3
11	IT52	7	3
11	IT53	7	3
11	IT6	7	4
11	IT71	8	4
11	IT72	8	4
11	IT8	7	3
11	IT92	7	3
11	IT93	7	3
11	ITA	7	2
11	ITB	8	5
11	PT11	7	3
11	SI	7	3
11	(blank)	7	2
12	BG04	7	2
12	BG05	7	3
12	BG06	7	3
12	ES11	7	3
12	ES21	7	2
12	ES22	7	2
12	ES23	7	1
12	ES24	7	1
12	ES3	7	2
12	ES41	7	2
12	ES42	7	1
12	ES43	7	1
12	ES51	7	3
12	ES52	7	2
12	ES61	7	1
12	ES62	7	1
12	FR	7	1
12	FR61	7	2
12	FR62	7	2
12	FR71	7	1
12	FR81	7	1
12	FR82	7	1
12	FR83	7	1
12	GR	7	2
12	GR11	7	1
12	GR12	7	2
12	GR13	7	2
12	GR14	7	1
12	GR21	7	1
12	GR22	7	1
12	GR23	7	1
12	GR24	7	1
12	GR25	7	1
12	IT	7	2
12	IT11	7	2
12	IT13	7	2
12	IT2	7	1
12	IT32	7	2
12	IT33	7	2
12	IT4	7	2
12	IT51	7	2
12	IT52	7	2
12	IT53	7	1
12	IT6	7	2
12	IT71	7	1
12	IT72	7	2
12	IT8	7	2
12	IT91	7	1
12	IT92	7	2
12	IT93	7	2
12	ITA	7	3
12	ITB	7	2
12	PT11	7	3
12	PT12	7	2
12	PT13	7	2
12	PT14	7	1
12	SI	7	1
12	(blank)	7	1
13	ES24	7	1
13	ES3	7	1
13	ES41	7	1
13	ES42	7	1
13	ES43	7	1
13	ES51	7	1
13	ES52	7	1
13	ES53	7	1
13	ES61	7	1
13	ES62	7	1
13	FR	7	1
13	FR81	7	1
13	FR82	7	2
13	FR83	7	1
13	GR11	7	1
13	GR12	7	2
13	GR14	7	1
13	GR21	7	1
13	GR22	7	1
13	GR23	7	1
13	GR24	7	1
13	GR25	7	1
13	GR3	7	1
13	GR41	7	1
13	GR42	7	1
13	GR43	7	1
13	IT6	7	1
13	IT8	7	1
13	IT91	7	1
13	IT92	7	1
13	IT93	7	1
13	ITA	7	1
13	ITB	7	2
13	MT	7	1
13	PT12	7	2
13	PT14	7	1
13	PT15	7	1
13	(blank)	7	1