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EFSA Spatial Data Version 1.1
Data Properties and Processing

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List of Acronyms

Acronym	Description
CAPRI	Common Agricultural Policy Regionalised Impact model
CLC2000	Corine Land cover data 2000
CORINE	Coordination of information on the environment programme
EFSA	European Food Safety Authority
ETRS89-LAEA	European Terrestrial Reference System 89, Lambert Azimuthal Equal Area projection
EU12	European Union Member States joined after 2004
EU15	European Union Member States joined before 2004
EU27	European Union of 27 Member States
FOCUS	FOrum for the Co-ordination of pesticide fate models and their Use
GISCO	Geographic Information System of the European Commission
IEEE	Institute of Electrical and Electronics Engineers
JRC	European Commission Joint Research Centre
NUTS	Nomenclature des Units Territoriales Statistiques
PPR	Plant Protection Products and their Residues

1 INTRODUCTION

In the context of the submissions of exposure estimates of pesticides in the soil and according to regulation (EC) 1107/2009[1] a set of spatial data pertinent to evaluating the environmental fate and behaviour of pesticides in the soil was published in 2011 as support to the FATE and the ECOREGION EFSA PPR Working Groups (Gardi, *et al*., 2011).

The EFSA spatial data set consisted of 52 spatial layers and was made available to the public from the JRC European Soil Portal[2] of the European Commission Joint Research Centre (JRC). This data set is subsequently referred to as EFSA Spatial Data Version 1.0.

After the data were made available on the JRC European Soil Portal in 2011 users commented on inconsistencies in the data, mainly with respect to the spatial characteristics of various layers. After the problems with the data were reported the matter was discussed at length between EFSA, the JRC and the working groups. The assessment of the JRC found that the problem was more complex than initially thought. It was concluded that the inconsistencies in the data could not be satisfactorily addressed be re-defining the spatial frame. To fully address the problem all data layers needed to be reprocessed from their respective sources and recompiled to comply with the specifications. This task was performed by the JRC, which resulted in an update to the previous data referred to as EFSA Spatial Data Version 1.1.

[1] OJ L 309, 24.11.2009, p. 1–50
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:309:0001:0050:EN:PDF
[2] http://eusoils.jrc.ec.europa.eu/library/Data/EFSA/

2 REVISION OF EFSA SPATIAL DATA VERSION 1.0

The main problem in consistency of the EFSA Spatial Data Version 1.0 layers is caused by shifts in the coverage of the layer frames. All thematic layers, with the exception of the land class layer derived from Corine Land Cover 2000 (CLC2000; EEA, 2012) show a vertical shift (rows) of one grid cell from their nominal position. The CLC2000 layer shows a vertical shift of two rows from the nominal position. The shift in the thematic data could be adjusted for by modifying the layer frame information. However, the data mask for all files is included in the layers. As a consequence of the vertical shifts in the data the mask is vertically off-set by one pixel with respect to the thematic layers and two pixels with respect to the reference position. Therefore, the data from Version 1.0 could only be adjusted to the reference position by re-applying the data mask with a shift of one pixel. This procedure would increase the size of the mask without correcting the vertical position of the previously applied mask, since this forms an integrated part of the layer data.

The problem of data and mask geographic shifts is illustrated in Figure 1.

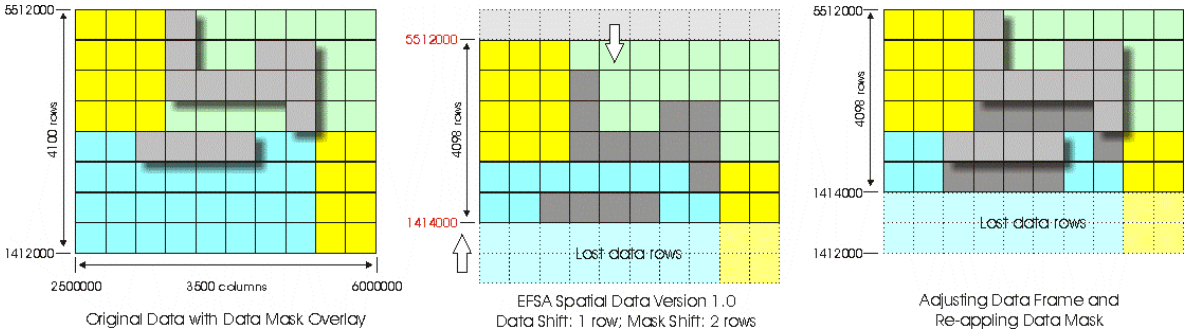

Figure 1: Spatial inconsistency in thematic layer and additional shift in data mask layer

The vertical off-set of one row in the thematic layers could in principle be adjusted for by resetting the specifications for the spatial frame. However, the data mask is off-set by one row to the thematic layer and two rows to the spatial frame. Because the data mask is part of the data adding a correct data mask increase the masked area, as shown in the graph at the bottom right.

An adjustment of the specification of the spatial frame could have been applied had the mask not been incorporated into the data. As a consequence, adjusting the existing data to the correct spatial frame would have meant retaining the existing off-set of the data mask or, when applying the data mask to the correct position, an increase in the masked

area. Neither approach was considered a satisfactory solution to the problem.

In addition to the spatial inconsistencies some other anomalies in the thematic data should also be corrected. The changes were mainly due to corrections needed for the temperature data. The layer size of the mean monthly temperature for January to July did not correspond to the layer size of the August to December data. One part used the 4,098 rows as specified, while the other layers contained the nominal number of 4,100 rows. The mean annual temperature was further found to deviate from the average of the mean monthly temperature. As a consequence, all layers in the data set using the temperature data, such as the Arrhenius Weighted Mean Annual Temperature or the FOCUS Zones, also had to be recalculated.

3 CHANGES IN EFSA SPATIAL DATA VERSION 1.1

Since the data had to be reprocessed from their various sources is was also decided to enlarge the spatial frame to cover all EU27 Member States (without overseas areas) and candidate countries. All data of the new version now cover also Malta and Cyprus, with the exception of the crop data.

The issues addressed in the up-date are:

- Enlargement of spatial frame to include all EU27 Member States and candidate countries.
- Country boundaries adjusted to Eurostat GISCO Country 2010.
- EU Regulatory Zones layer enlarged to EU27.
- Land use based on CLC2000, V16. CLC map reprocessed.
- General Land Use map reprocessed.
- EFSA data mask reprocessed.
- Mean monthly temperature data reprocessed.
- Mean annual temperature recalculated.
- Mean monthly precipitation data reprocessed.
- Mean annual precipitation recalculated.
- Arrhenius weighted mean annual temperature recalculated.
- FOCUS zones recalculated.
- All soil data reprocessed and extended to EU27.
- Topsoil Water Content at Field Capacity reprocessed.
- CAPRI2000 data reprocessed and adjusted to new EFSA spatial data frame.
- Units of CAPRI2000 data set to percent.
- Background value set consistently for integer (0) and real (-9000.0) data.

An overview of the 62 data files of EFSA Spatial Data Version 1.1, their title and cover is given in Table 1.

Table 1: EFSA Spatial Data Version 1.1 File names and Titles

File Name	Title	Area Covered
	General Data	
EFSA_DATA_MASK	EFSA Data Mask	EU27
EFSA_EU27	EFFSA European Union Cover	EU27
EFSA_EU_REGULATORY_ ZONES	EFSA EU Regulatory Zones	EU27
EFSA_CLC2000	EFSA Corine Land Cover Data	EU27
EFSA_GENERAL_LU	EFSA Generalized Land Use Map	EU27
EFSA_FOCUS_ZONES	FOCUS Zones	EU27
	Meteorological Data	
EFSA_TMEAN_MONTH1	Mean monthly temperature, January	EU27
EFSA_TMEAN_MONTH2	Mean monthly temperature, February	EU27
EFSA_TMEAN_MONTH3	Mean monthly temperature, March	EU27
EFSA_TMEAN_MONTH4	Mean monthly temperature, April	EU27
EFSA_TMEAN_MONTH5	Mean monthly temperature, May	EU27
EFSA_TMEAN_MONTH6	Mean monthly temperature, June	EU27
EFSA_TMEAN_MONTH7	Mean monthly temperature, July	EU27
EFSA_TMEAN_MONTH8	Mean monthly temperature, August	EU27
EFSA_TMEAN_MONTH9	Mean monthly temperature, September	EU27
EFSA_TMEAN_MONTH10	Mean monthly temperature, October	EU27
EFSA_TMEAN_MONTH11	Mean monthly temperature, November	EU27
EFSA_TMEAN_MONTH12	Mean monthly temperature, December	EU27
EFSA_TMEAN_YEAR	Annual mean temperature	EU27
EFSA_TEFF	Arrhenius Weighted Mean Annual Temperature	EU27
EFSA_PREC_MONTH1	Mean monthly precipitation sum, January	EU27
EFSA_PREC_MONTH2	Mean monthly precipitation sum, February	EU27
EFSA_PREC_MONTH3	Mean monthly precipitation sum, March	EU27
EFSA_PREC_MONTH4	Mean monthly precipitation sum, April	EU27
EFSA_PREC_MONTH5	Mean monthly precipitation sum, May	EU27
EFSA_PREC_MONTH6	Mean monthly precipitation sum, June	EU27
EFSA_PREC_MONTH7	Mean monthly precipitation sum, July	EU27
EFSA_PREC_MONTH8	Mean monthly precipitation sum, August	EU27
EFSA_PREC_MONTH9	Mean monthly precipitation sum, September	EU27
EFSA_PREC_MONTH10	Mean monthly precipitation sum, October	EU27
EFSA_PREC_MONTH11	Mean monthly precipitation sum, November	EU27
EFSA_PREC_MONTH12	Mean monthly precipitation sum, December	EU27
EFSA_PREC_YEAR	Annual mean precipitation sum	EU27
	Soil Data	
EFSA_OM_TOP	Topsoil Organic Matter content	EU27
EFSA_PH_TOP	Topsoil pH	EU27
EFSA_BD_TOP	Topsoil Bulk Density	EU27
EFSA_TEXT_TOP	Topsoil Texture Class	EU27
EFSA_THETA_FC_TOP	Topsoil Water Content at Field Capacity	EU27

File Name	Title	Area Covered
	CAPRI2000 Crop Data	
EFSA_CAPRI_MASK	EFSA-CAPRI Common Mask	EU25
EFSA_CAPRI_BARLEY	EFSA-CAPRI Barley	EU25
EFSA_CAPRI_COMMON_WHEAT	EFSA-CAPRI Common wheat	EU25
EFSA_CAPRI_DURUM_WHEAT	EFSA-CAPRI Durum wheat	EU25
EFSA_CAPRI_FALLOW	EFSA-CAPRI Fallow land	EU25
EFSA_CAPRI_FLOWER	EFSA-CAPRI Floriculture	EU25
EFSA_CAPRI_MAIZE	EFSA-CAPRI Maize	EU25
EFSA_CAPRI_OATS	EFSA-CAPRI Oats	EU25
EFSA_CAPRI_OTHER_CEREALS	EFSA-CAPRI Other cereals	EU25
EFSA_CAPRI_OTHER_ ANNUALCROPS	EFSA-CAPRI Other annual crops	EU25
EFSA_CAPRI_OTHER_FODDER	EFSA-CAPRI Fodder other on arable land	EU25
EFSA_CAPRI_OTHER_ INDUSTRIAL	EFSA-CAPRI Other non permanent industrial crops	EU25
EFSA_CAPRI_OTHER_ ROOTCROPS	EFSA-CAPRI Other root crops	EU25
EFSA_CAPRI_OTHER_ VEGETABLES	EFSA-CAPRI Other fresh vegetables	EU25
EFSA_CAPRI_POTATOES	EFSA_CAPRI Potatoes	EU25
EFSA_CAPRI_PULSES	EFSA-CAPRI Dry pulses	EU25
EFSA_CAPRI_RAPES	EFSA-CAPRI Rape and turnip rape	EU25
EFSA_CAPRI_RYE	EFSA-CAPRI Rye	EU25
EFSA_CAPRI_SOYA	EFSA-CAPRI Soya	EU25
EFSA_CAPRI_SUGARBEET	EFSA-CAPRI Sugar beet	EU25
EFSA_CAPRI_SUNFLOWER	EFSA-CAPRI Sunflower	EU25
EFSA_CAPRI_TEXTURE_CROPS	EFSA-CAPRI Fibre and oleaginous crops	EU25
EFSA_CAPRI_TOBACCO	EFSA-CAPRI Tobacco	EU25
EFSA_CAPRI_TOMATOES	EFSA-CAPRI Tomatoes	EU25

EU25: EU 27 without Malta, Cyprus and some smaller areas.

To better reflect the nature of the data the layer names were modified in Version 1.1. For example, the data mask changed from EU27, which it did not cover, to EFSA_DATA_MASK.

When using EFSA Spatial Data Version 1.1 layers the treatment of the data with respect to the masks differs from Version 1.0 data. The up-date contains two mask layers

a) The EFSA data mask (EFSA_DATA_MASK), which is a combination of a mask derived from the EFSA_EU27 and the EFSA_CLC2000 layer.

b) The CAPRI2000 crop mask, which is a combination of a mask derived from the spatial cover of the crop data and a mask derived from the EFSA_EU27 layer.

In a deviation to the previous version the EFSA data mask is not applied to thematic layers. Only the soil layers are aligned to areas where CLC2000 gives surfaces without soil by excluding classes >38. Under artificial surfaces (CLC classes 1 to 11) the soil data is only estimated by a distance-based method. It is expected that these areas are not part of any analysis using the EFSA soil data.

All data were processed using the Idrisi[3] Taiga Edition Version 16.05. The various processing steps were automated as scripts in the Idrisi Macro Language. The scripts allow reproducibility of results and can be re-run for different input data. In general, the values of the EFSA Spatial Data layers should not depend on the GIS package used. However, differences in the values computed between GIS packages can result when reducing the spatial resolution by a majority method (EFSA_CLC2000 layer) and the floating-point data type used for computations of real values (Arrhenius Weighted Mean Annual Temperature, EFSA_TEFF layer). The issues are discussed under the comments for the relevant data layers.

[3] Clark Labs, Clark University, 950 Main Street, Worcester MA 01610-1477, USA
URL: clarklabs@clarku.edu Web: http://www.clarklabs.org

4 EFSA Spatial Data Version 1.1 Properties

Details on the EFSA Spatial Data Version 1.1 are presented by layer in the following Chapter.

4.1 Spatial Frame Properties

File format	ESRI ARCRASTER ASCII
Columns	5900
Rows	4600
Reference system	ETRS 89 LAEA
Reference unit	meter
Min. X	1500000.0
Max. X	7400000.0
Min. Y	900000.0
Max. Y	5500000.0
Resolution	1000.0

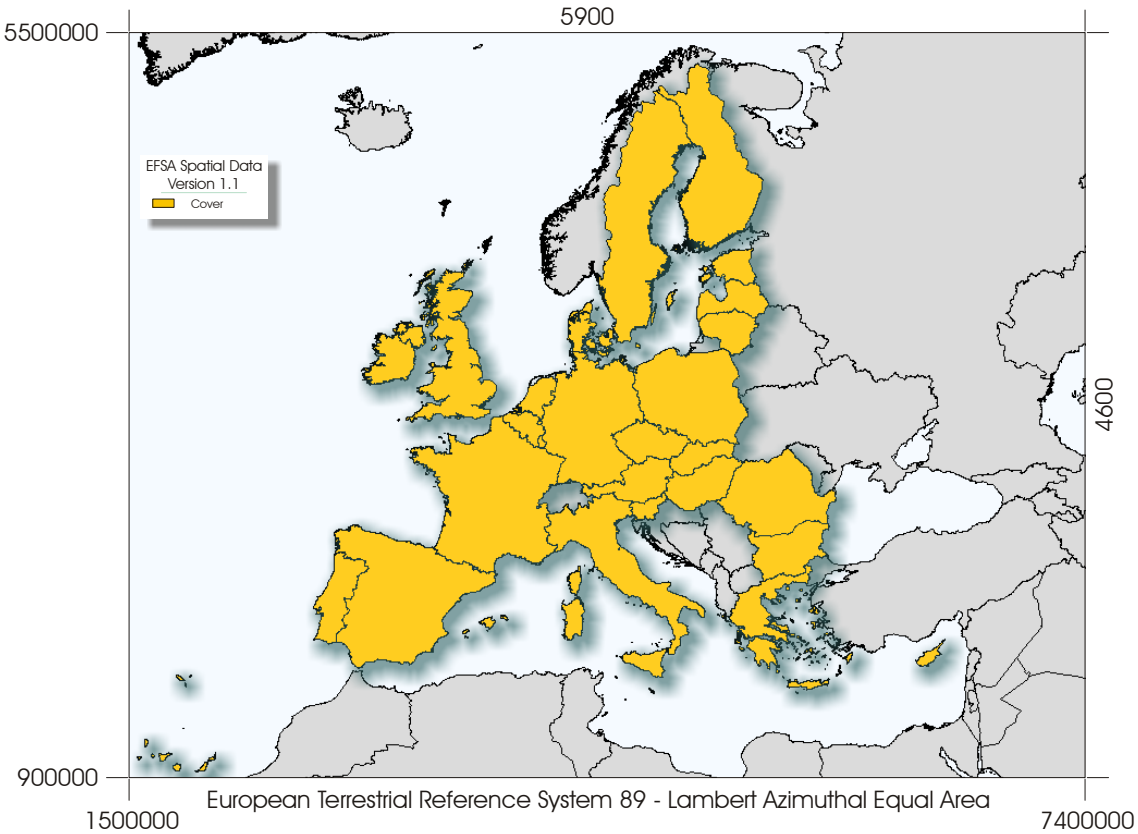

Figure 2: EFSA Spatial Layer Frame

Comment

The spatial frame of the data was adjusted to the extent of the EEA CLC2000 layer (EEA, 2012). The projection is compatible with the specifications of the INSPIRE Directive. The frame covers acceding countries (Croatia), candidate countries, such as Iceland and Turkey and potential candidate countries. Not included in the area covered are any overseas areas.

4.2 Layer 1: EFSA Data Mask

File name	EFSA_DATA_MASK
Layers	1
File type	integer
Data type	byte
Value units	none
Flag value	0
Flag definition	background
Source	EFSA_EU27, EFSA CLC2000, ESDB
Processing	JRC, 2012
Reference	this document

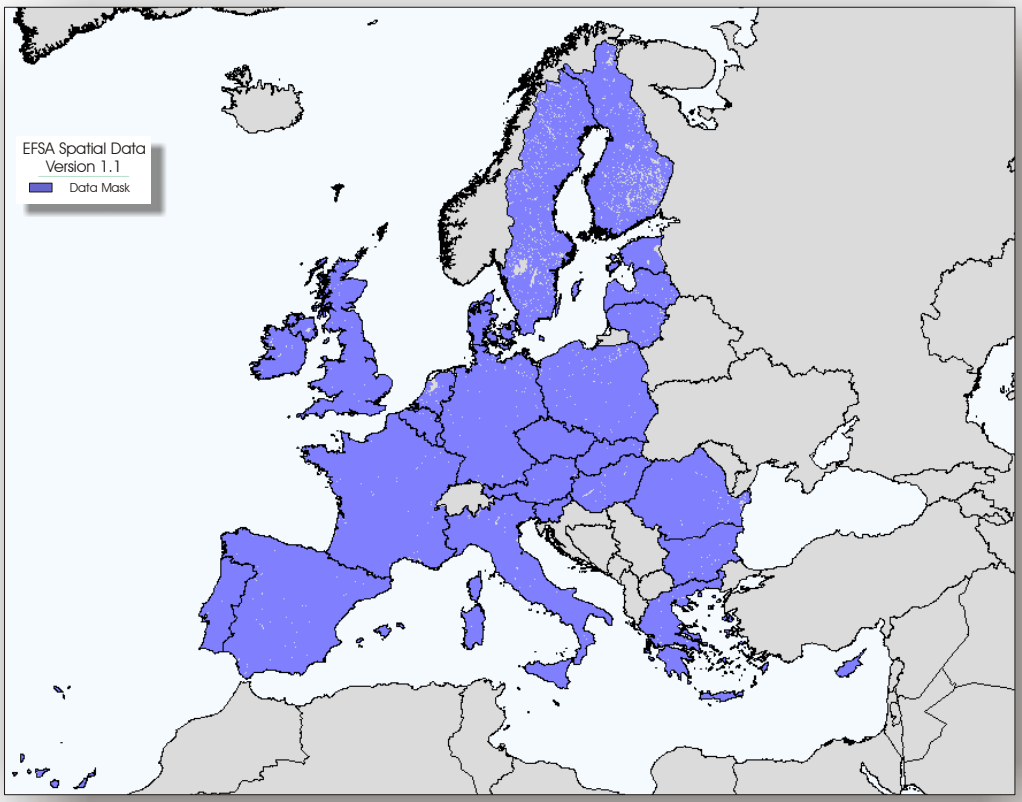

Figure 3: EFSA Data Mask

Comment

The EFSA data mask layer combines the Eurostat GISCO country layer (EFSA_EU27) with a mask generated from the land cover layer (EFSA_CLC2000) and a mask for soil data generated from the ESDB. The land cover mask includes CLC classes 111 to 422, except classes 332 (bare rock) and 335 (glaciers and permanent snow fields). The EFSA data mask includes areas not covered by the CAPRI data, such as Malta or Cyprus. For the CAPIR2000 data a specific mask layer was generated (EFSA_CAPRI_MASK).

The EFSA data mask is not applied to other thematic layers. This allows more flexibility in up-dating the various data layers without necessarily having to re-process all data. The land cover mask is applied to the soil data layers to exclude non-soil areas. However, because the land cover mask as defined includes artificial surfaces soil data are available for these areas. These areas should be excluded by masking also CLC classes 111 to 142. To remain coherent with the EFSA description of processing data this additional restriction was not applied to Version 1.1 data.

4.3 Layer 2: EFSA Cover EU Member States

File name	EFSA_EU27
Layers	1
File type	integer
Data type	byte
Value units	none
Flag value	0
Flag definition	background
Source	Eurostat GISCO Country 2010
Processing	JRC, 2012
Reference	Eurostat, 2012

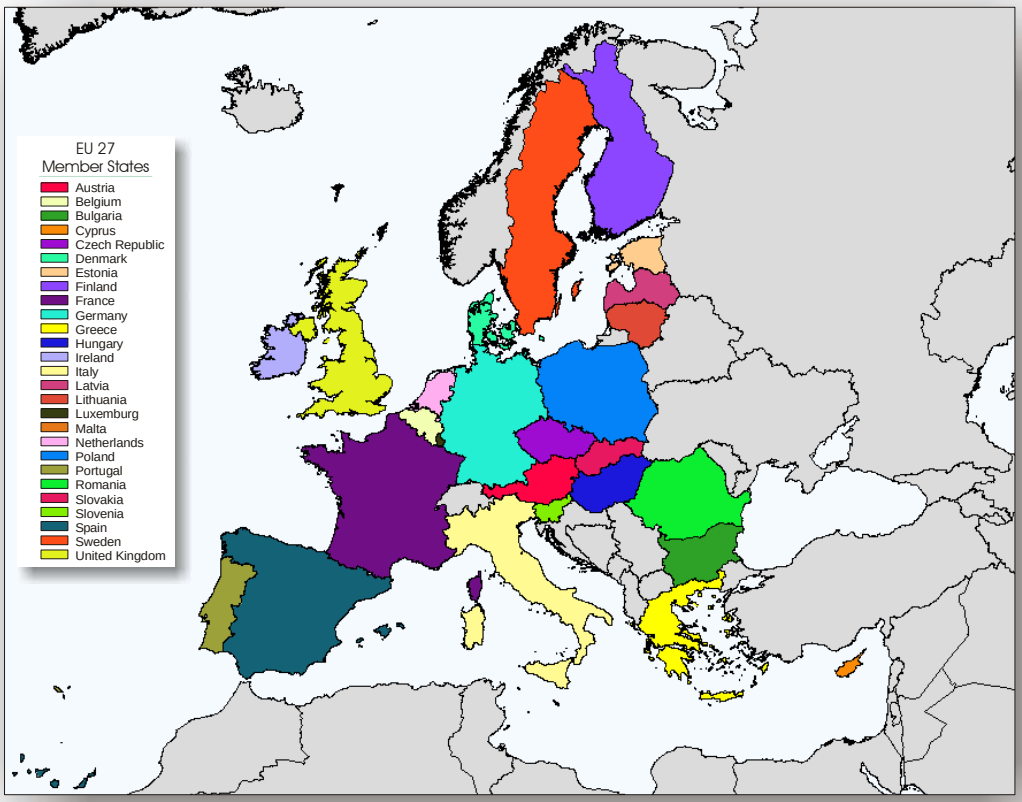

Figure 4: Cover of European Union of 27 Member States (EU27)

Comment

The layer uses a recent version of the Eurostat GISCO reference data for administrative boundaries (Country 2010 from 2012). Conversely, Version 1.0 was based on Eurostat GISCO Country 2006. No significant changes in the country outline for EU27 are expected from the change to the new version, although other areas were modified. The layer is now compatible with the latest data on administrative boundaries (NUTS). The vector data was rasterized to the EFSA specifications.

The country identifiers were re-assigned to the alphabetic order of the country names in English language, as given in Table 2.

Table 2: Legend for EFSA EU27 Codes and Regulatory Zones Layers

EFSA_EU27 ID	COUNTRY	EFSA_ZONE Code
1	Austria	2
2	Belgium	2
3	Bulgaria	3
4	Cyprus	3
5	Czech Republic	2
6	Denmark	1
7	Estonia	1
8	Finland	1
9	France	2
10	Germany	2
11	Greece	3
12	Hungary	2
13	Ireland	2
14	Italy	3
15	Latvia	1
16	Lithuania	1
17	Luxemburg	2
18	Malta	3
19	Netherlands	2
20	Poland	2
21	Portugal	3
22	Romania	2
23	Slovakia	2
24	Slovenia	2
25	Spain	3
26	Sweden	1
27	United Kingdom	2

4.4 Layer 3: EU Regulatory Zones

File name	EFSA_EU_REGULATORY_ZONES
Layers	1
File type	integer
Data type	byte
Value units	none
Flag value	0
Flag definition	background
Source	EFSA_EU27
Processing	JRC, 2012
Reference	EFSA, 2010

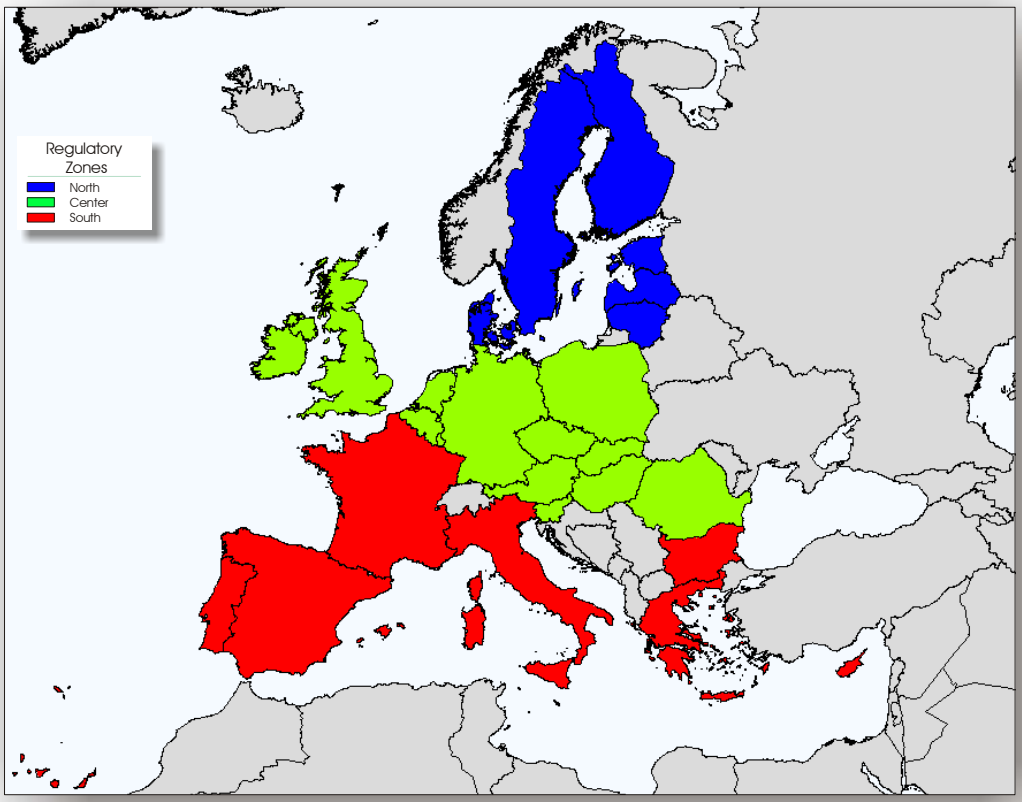

Figure 5: EU Regulatory Zones

Comment

The cover of the EU Regulatory Zones layer was extended to include Malta and Cyprus, as specified in EFSA, 2010. The legend of the regulatory zones is given in Table 3.

Table 3: Legend for EU Regulatory Zones

Legend ID	Name
1	North
2	Centre
3	South

4.5 Layer 4: EFSA Corine Land Cover Data

File name	EFSA_CLC2000
Layers	1
File type	integer
Data type	byte
Value units	none
Flag value	0
Flag definition	background
Source	Corine Land Cover 2000 raster data, Version 16 (4/2012), 250m
Processing	JRC, 2012
Reference	EEA, 2012

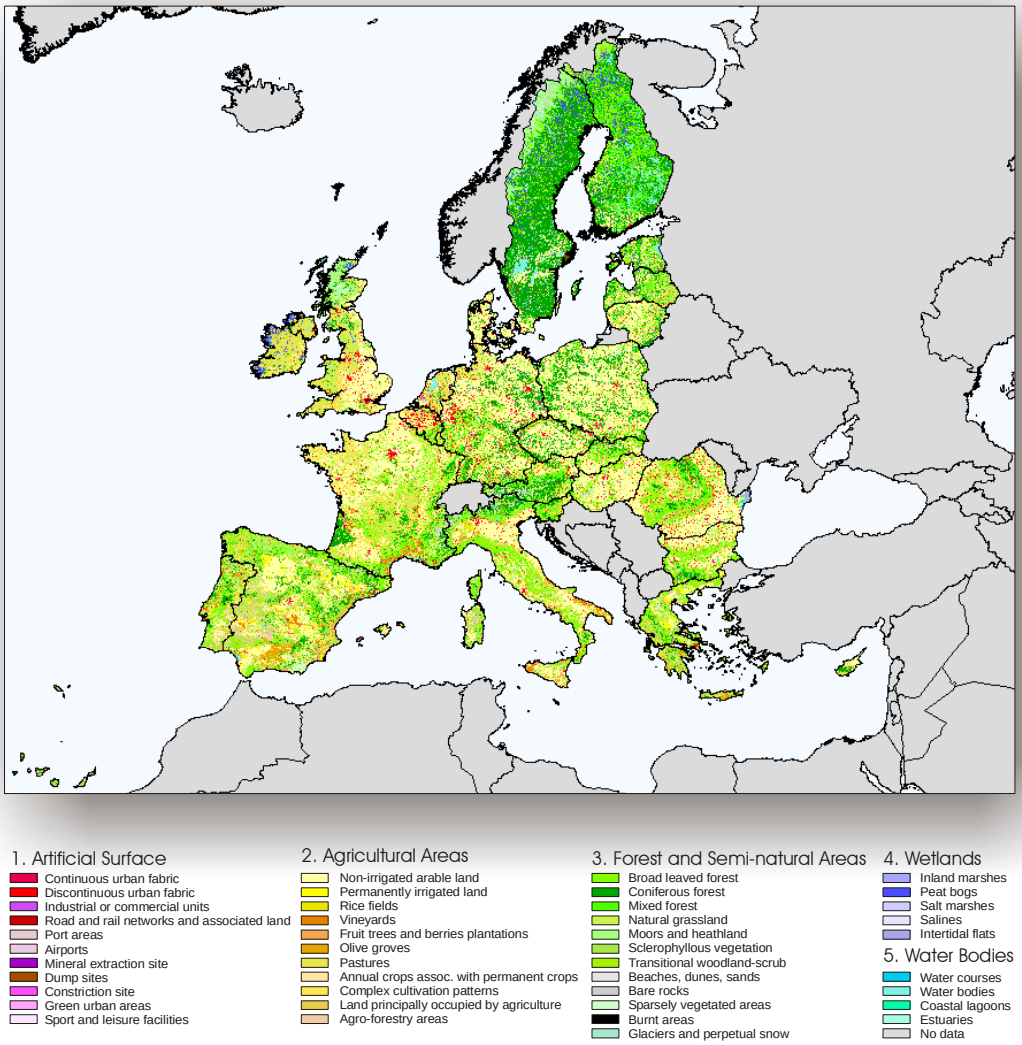

Figure 6: Corine Land Cover 2006, Version 16 (re-sampled to 1000 m grid)

Comment

The Corine Land Cover 2000 data (CLC2000) from the European Environment Agency (EEA) processed for the EFSA up-date was the raster layer at 250 m resolution of Version 16 from June, 2012 (EEA, 2012). In accordance with the documentation of EFSA Spatial Data Version 1.0 the reduction in spatial resolution to 1000 m was performed by re-sampling the data using a majority method. While this method may have advantages in reducing the spatial variation of data categories it produces a biased distribution of the categories in the re-sampled data. The resulting lower-resolution data depends on the algorithm used to resolve cases where no single category has a majority. As a consequence, the result may depend on the software package used to generate the lower-resolution layer.

Because neither the version of the CLC2000 data used to generate the EFSA data nor the software operated could be established, the data mask of EFSA Spatial Data Version 1.0 could not be re-generated. Although a technique other than the majority method to reducing the spatial resolution of the CLC2000 data used would have been preferred this method was applied to remain consistent with Version 1.0.

Differing from the data used for EFSA Spatial Data Version 1.0 Version 16 of CLC2000 does not contain data values > 44.

Table 4: Corine Land Cover Codes

Legend ID	CLC Code	Description
1	111	Continuous urban fabric
2	112	Discontinuous urban fabric
3	121	Industrial or commercial units
4	122	Road and rail networks and associated land
5	123	Port areas
6	124	Airports
7	131	Mineral extraction sites
8	132	Dump sites
9	133	Construction sites
10	141	Green urban areas
11	142	Sport and leisure facilities
12	211	Non-irrigated arable land
13	212	Permanently irrigated land
14	213	Rice fields
15	221	Vineyards
16	222	Fruit trees and berry plantations
17	223	Olive groves
18	231	Pastures
19	241	Annual crops associated with permanent crops
20	242	Complex cultivation patterns
21	243	Land occupied by agriculture, with significant areas of natural vegetation
22	244	Agro-forestry areas
23	311	Broad-leaved forest
24	312	Coniferous forest
25	313	Mixed forest
26	321	Natural grasslands
27	322	Moors and heathland
28	323	Sclerophyllous vegetation
29	324	Transitional woodland-shrub
30	331	Beaches, dunes, sands
31	332	Bare rocks
32	333	Sparsely vegetated areas
33	334	Burnt areas
34	335	Glaciers and perpetual snow
35	411	Inland marshes
36	412	Peat bogs
37	421	Salt marshes
38	422	Salines
39	423	Intertidal flats
40	511	Water courses
41	512	Water bodies
42	521	Coastal lagoons
43	522	Estuaries
44*	523	Sea and Ocean

** Class 44 is not included in EFSA CLC2000 data layer.*

4.6 Layer 5: EFSA Generalized Land Use Map

File name	EFSA_GENERAL_LU
Layers	1
File type	integer
Data type	byte
Value units	none
Flag value	0
Flag definition	background
Source	EFSA_CLC2000
Processing	JRC, 2012
Reference	EEA, 2012; EFSA, 2010

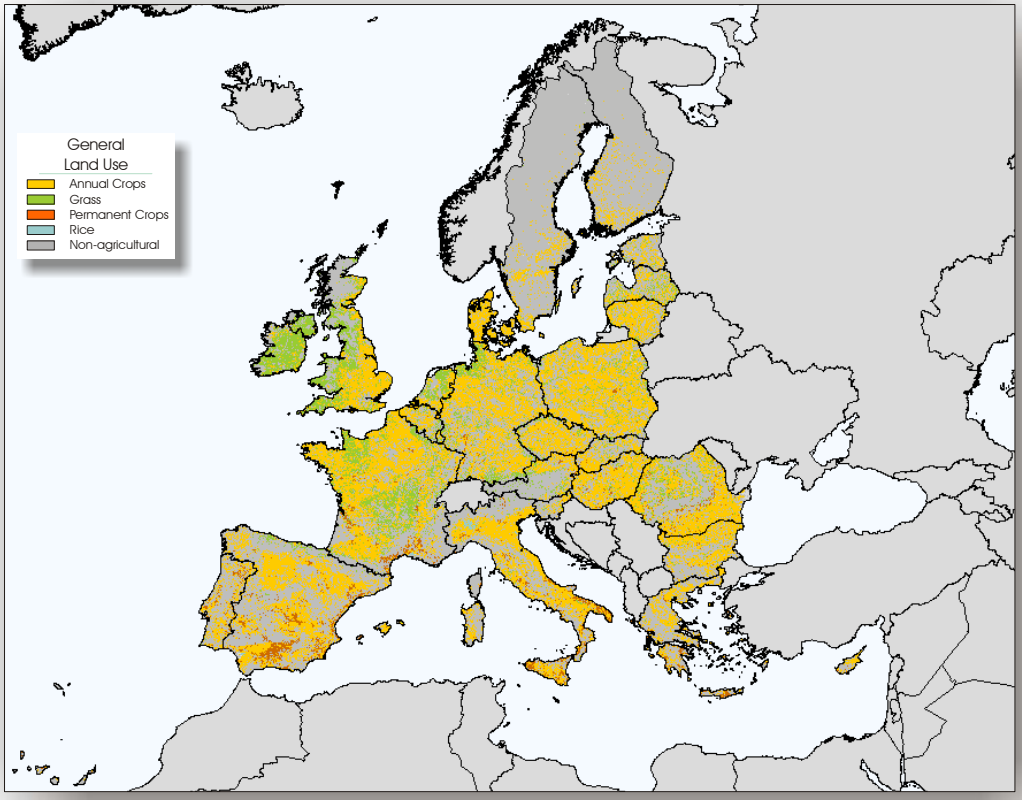

Figure 7: EFSA Generalized Land Use

Comment

The layer of Generalized Land Use is generated from the EFSA_CLC2000 layer by re-assigning classes according to the arrangement given in Table 5.

Table 5: General Land Use Legend and Corine Land Cover Classes

Legend ID	Description	Corine LC Legend ID
1	Annual Crops	12, 13, 19-21
2	Grass	18
3	Permanent crops	15-17 and 22
4	Rice	14
9	Non agricultural	all other classes

A change in Version 1.1 over the previous version is assigning all non-agricultural areas to ID 9 instead of ID 5.

4.7 Layer 6: Mean Monthly Temperature

File name	**EFSA_TMEAN_MONTH1 … EFSA_TMEAN_MONTH12**
Layers	12
File type	real
Data type	real
Value units	degree Celsius
Flag value	-9000.0
Flag definition	background
Source	WorldClim current conditions 30arc sec.
Processing	JRC, 2012
Reference	Hijmans, *et al.*, 2005

4.8 Layer 7: Mean Annual Temperature

File name	**EFSA_TMEAN_YEAR**
Layers	1
File type	real
Data type	real
Value units	degree Celsius
Flag value	-9000.0
Flag definition	background
Source	EFSA_TMEAN_MONTH1 … EFSA_TMEAN_MONTH12
Processing	JRC, 2012
Reference	Hijmans, *et al.*, 2005

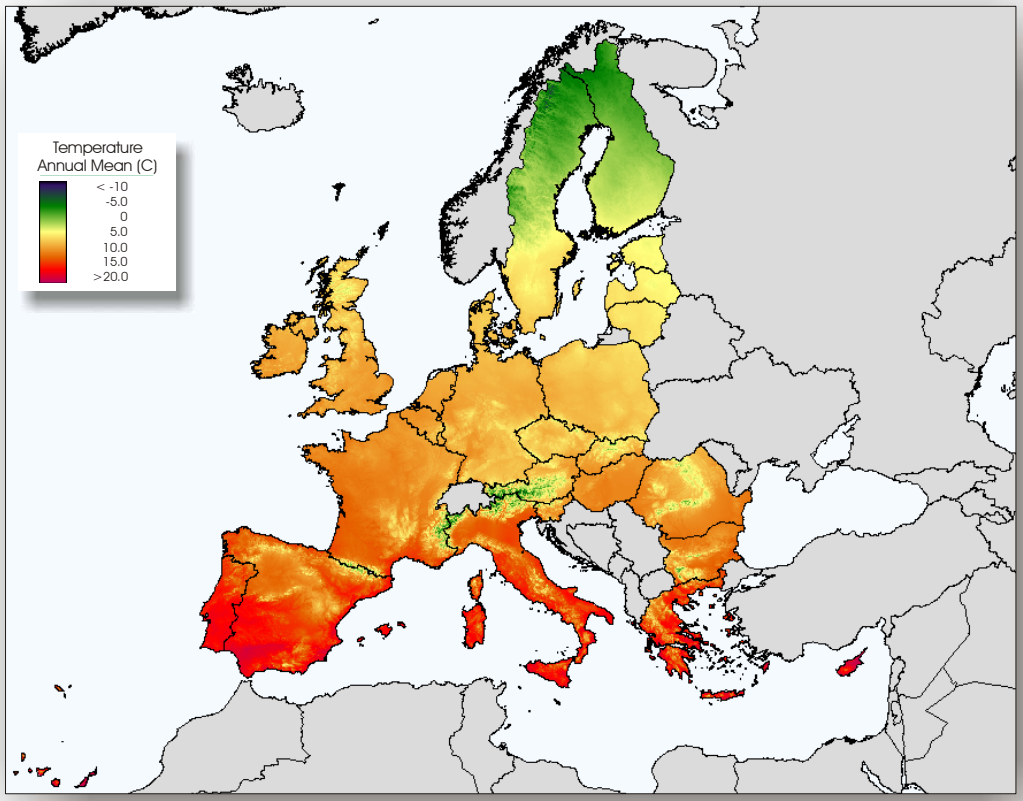

Figure 8: Mean Annual Temperature

Comment

The mean annual temperature is calculated form the mean monthly temperature weighted by calendar days for each month:

$$TMEAN_a = \frac{1}{365} \times \sum_{m=1}^{12} TMEAN_m \times d$$

where

$TMEAN_a$	mean annual temperature (*deg C*)
d	calendar days in month
m	month of year

The meteorological data originate from daily measurements from station data and not from a climate model, where months of equal days may be used.

4.9 Layer 8: Arrhenius Weighted Mean Annual Temperature

File name	EFSA_TEFF
Layers	1
File type	real
Data type	real
Value units	degree Celsius
Flag value	-9000.0
Flag definition	background
Source	EFSA_TMEAN_MONTH1 … EFSA_TMEAN_MONTH12
Processing	JRC, 2012
Reference	EFSA, 2010

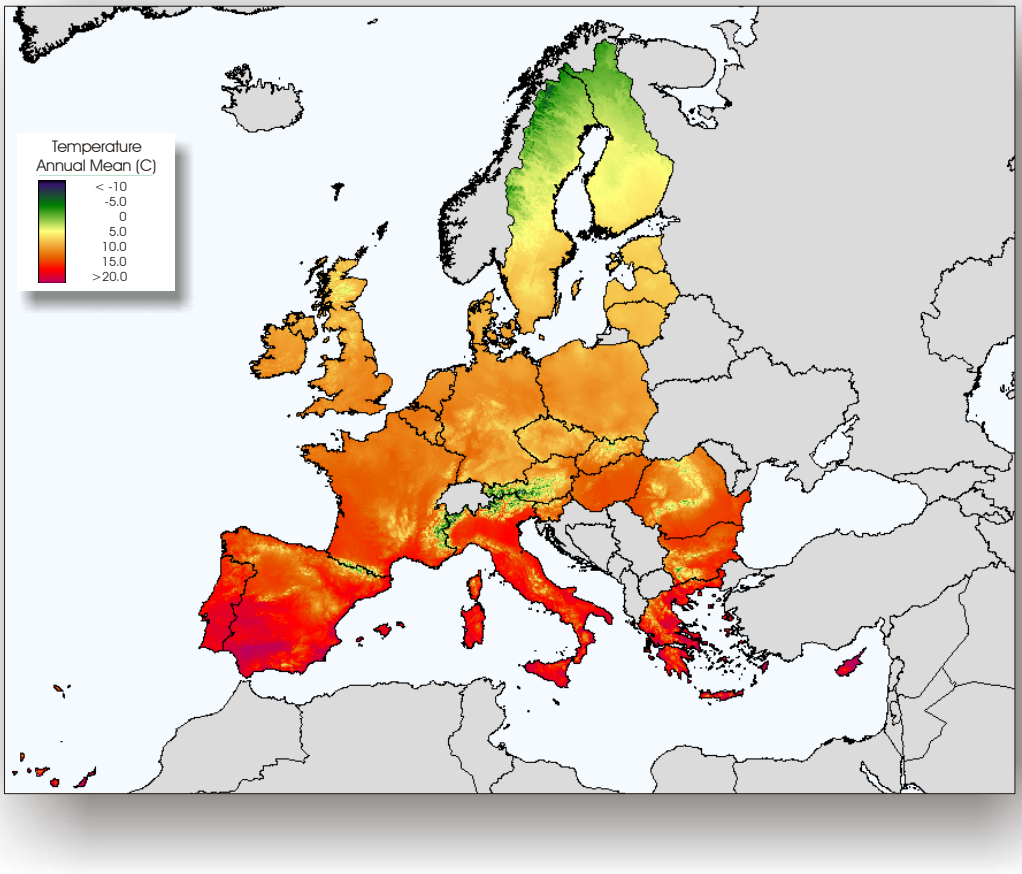

Figure 9: Arrhenius Weighted Mean Annual Temperature

Comment

For the calculation of the Arrhenius weighted mean annual temperature the equation given in EFSA 2010, Appendix A3 is:

$$T_{eff} = -\frac{E_{act}}{R\ln\left[\frac{1}{t_{end}}\int_{0}^{t_{end}} f(T,t)dt\right]}$$

$$if \quad T(t) > 273 \quad then \quad f(T,t) = \exp\left[-\frac{E_{act}}{RT(t)}\right]$$

$$else \quad f(T,t) = 0$$

where

T_{eff}	Arrhenius weighted mean annual temperature (*K*)
E_{act}	Arrhenius activation
R	gas constant
T	temperature (*K*)
t	time

Finding the antiderivative of the function of the defined integral is not trivial and an alternative approach was used to be used with mean monthly temperature data.

In the case of calculating the Arrhenius weighted mean annual temperature a single period of a periodic wave is used (12 months). The area under the curve may therefore be approximated by using the mean monthly temperatures as samples, for which the over- and underestimations of the area under the curve largely even out. Therefore, the computationally simpler approximation is frequently used, such as by Tencer, *et al.*, 2004, and formulated as:

$$T_{eff} = -\frac{E_{act}}{R\ln\left[\frac{\sum_{i=1}^{m} f(T,m)}{\sum_{i=1}^{m} d_m}\right]}$$

$$if \quad T(m) > 273.15 \quad then \quad f(T,m) = e^{\frac{-E_{act}}{R\times T_i}} \times d_m$$

$$else \quad f(T,m) = 0$$

where

T_{eff}	Arrhenius weighted mean annual temperature (*K*)
E_{act}	Arrhenius activation energy (65.4 *kJ mol*$^{-1}$)
R	gas constant (8.3144621 x 10^{-3} *kJ mol*$^{-1}$ *K*$^{-1}$)
T	temperature (*K*)

d_m	calendar days in month *m*
i	counter
m	month of year

E_{act} was set to 65.4 *kJ mol*$^{-1}$ according to EFSA, 2007 (see also EFSA, 2010). It should be noted that the temperatures in the equation are in Kelvin, whereas the temperature in the maps is in degree Celsius.

The condition set for calculating the Arrhenius weighted mean annual temperature allows for values for the temperature of < 273.15 *K* or 0 deg. *C*. This happens when the mean temperatures are below the threshold for several months and not much above it for the remaining months. For the value of the T_{eff} the actual temperature of *Tmean* below 273.15 *K* is not relevant. Significant is only the number of months in which the condition occurs relative to the average temperature of the months with a mean temperature > 273.15 *K*.

The situation is illustrated in Figure 10.

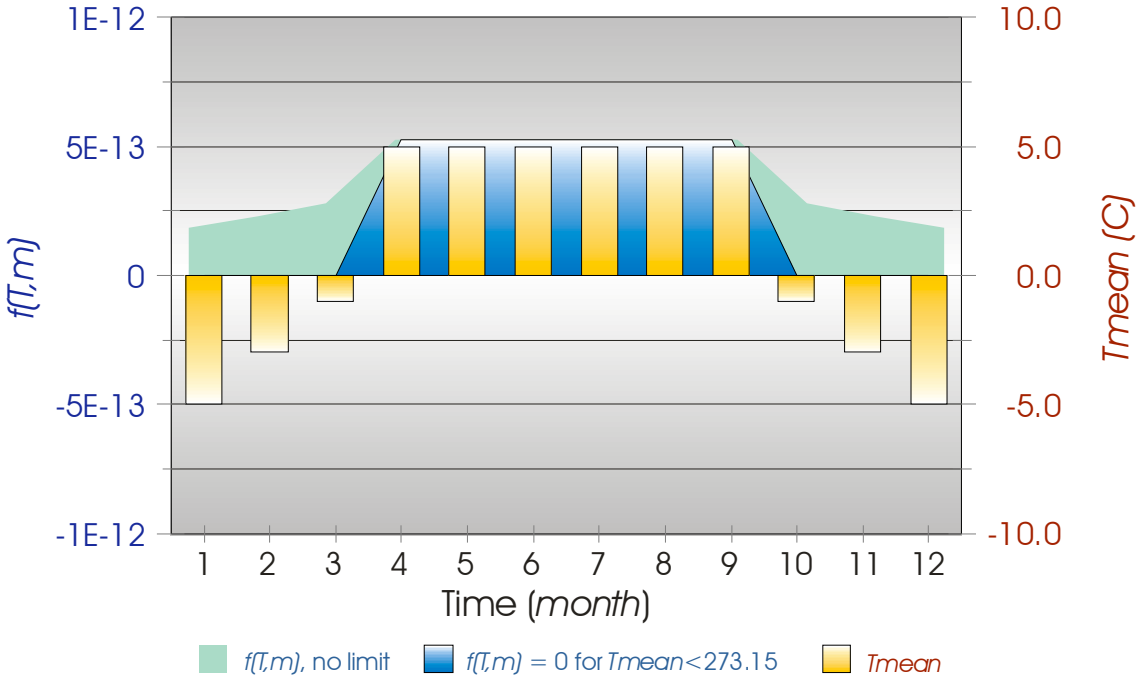

Figure 10: Negative value for Arrhenius Weighted Mean Annual Temperature (Illustration)

The graph shows a hypothetical example of the distribution of monthly mean temperatures and the values of the function *f(T,m)*. "*f(T,m), no limit*" shows the area under the function without the condition of setting the function value to 0 for temperatures < 273.15 K. "*f(T,m)=0 for T<273.15 K*" shows the area under the curve with the condition set. The monthly mean temperature values are given in deg. Celsius for a better visual separation of positive and negative values.

The area under the curve of the function *f(T,m)* (or *f(T,t)* for that matter) is always >0. When restricting the function to values of *Tmean* >273.15 *K* the area for the months with lower temperatures is 0. Therefore, the area under the curve decreases, but the value for the denominator *n* (or t_{end}) is not affected by the condition. i.e. counted are also conditions where *Tmean < 273.15 K*. When the area has decreased such that

$$\ln\left[\frac{1}{n}\sum_{i=1}^{n} f(T,m)\right] > -28.796678$$

the value of T_{eff} becomes < 273.15 *K*. In the example given in Figure 10 the value for T_{eff} is -1.7 deg. *C*. In practical terms there is little effect of values of T_{eff} < 0 deg. *C*, since the areas affected are restricted to the polar or alpine regions and thus outside the areas where annual crops are grown. However, when generating a mask from the layer the presence of values <0 in the data should be considered.

The distribution of the areas where T_{eff} < 0 C and the difference between T_{eff} and *Tmean* is shown in Figure 11.

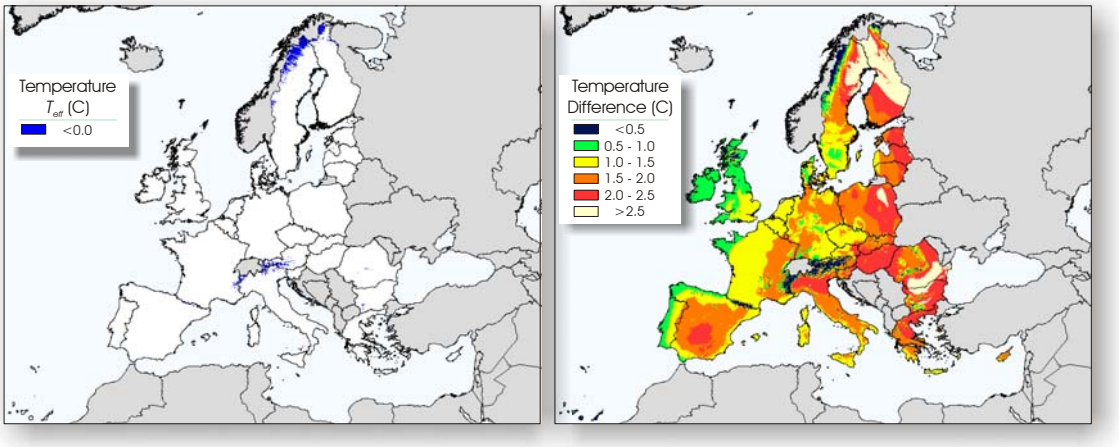

Figure 11: Areas with T_{eff} < 0C and Difference of T_{eff} to Tmean (C)

As regards the computation of the area under the curve the very small dimension of the area, in the region of 10^{-12} or less, can lead to variations in the results depending on the floating point data type used by software package to store real values. When real data are stored as binary32 (IEEE, 2008) the precision ranges between 6 to 9 significant decimal digits[4]. To avoid the issue of the dimension of the real data type the area under the curve was scales to values greater than 10^{-6}.

[4] http://en.wikipedia.org/wiki/Binary32

4.10 Layer 9: Mean Monthly Precipitation

File name	EFSA_PREC_MONTH1 … EFSA_PREC_MONTH12
Layers	12
File type	real
Data type	real
Value units	mm
Flag value	-9000.0
Flag definition	background
Source	WorldClim current conditions 30arc sec.
Processing	JRC, 2012
Reference	Hijmans, *et al*., 2005

4.11 Layer 10: Total Mean Annual Precipitation

File name	EFSA_PREC_YEAR
Layers	1
File type	real
Data type	real
Value units	mm
Flag value	-9000.0
Flag definition	background
Source	EFSA_PREC_MONT1 … EFSA_PREC_MONTH12
Processing	JRC, 2012
Reference	Hijmans, *et al*., 2005

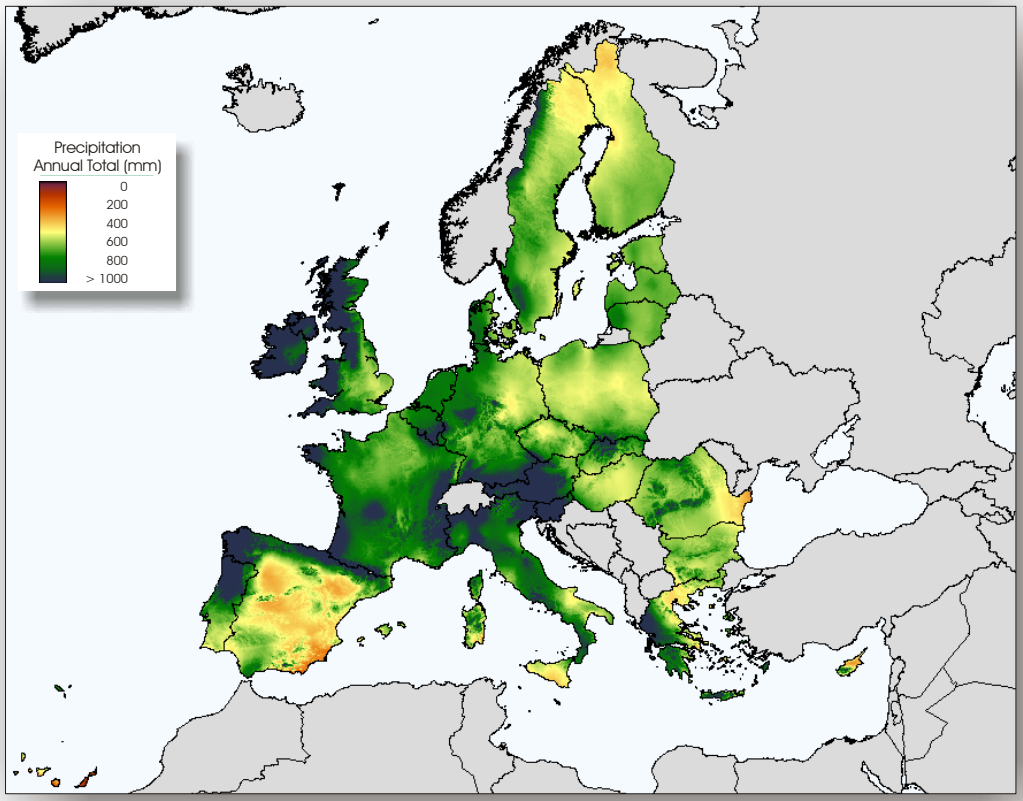

Figure 12: Total Mean Annual Precipitation

Comment

The total mean annual precipitation is calculated as the sum of the mean monthly precipitation:

$$PTOT_a = \sum_{m=1}^{12} PMEAN_m$$

where

$PTOT_a$	total mean annual precipitation (*mm*)
$PMEAN_m$	mean monthly precipitation for month *m* (*mm*)
m	month of year

4.12 Layer 11: FOCUS Zones

File name	EFSA_FOCUS_ZONES
Layers	1
File type	integer
Data type	byte
Value units	none
Flag value	0
Flag definition	background
Source	EFSA_TMEAN_YEAR, EFSA_PREC_YEAR
Processing	JRC, 2012
Reference	FOCUS (2000)

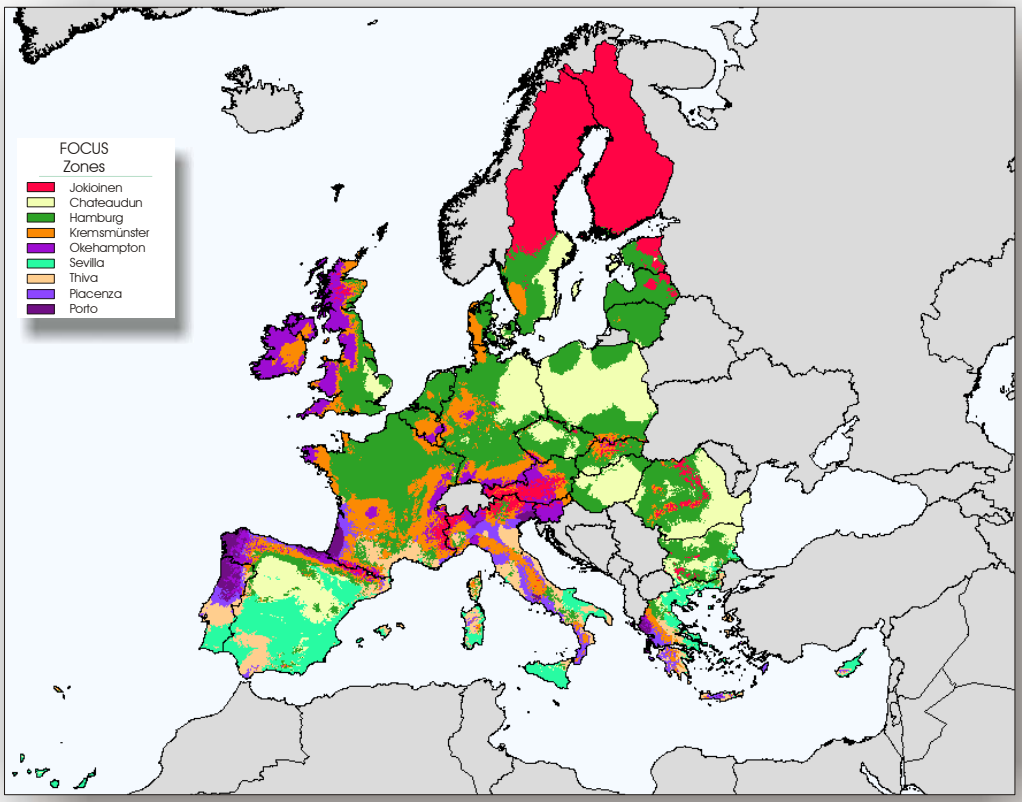

Figure 13: Focus Zones

Comment

The FOCUS Zones layer was calculated from the meteorological data by the classification scheme given in FOCUS (2000), *Table 2.1 Arable agriculture in EU climate zones*. The definitions of the climate zones used by the FOCUS Groundwater Workgroup are as given in Table 6.

Table 6: FOCUS EU climate zones for arable agriculture (modified)

Layer ID	Representative Location	Mean Annual Temperature	Total Mean Annual Precipitation
	Name	*deg. C*	*mm yr^{-1}*
1	Jokioinen	<5	< 600
2	Chateaudun	5 to < 12.5	< 600
3	Hamburg	5 to < 12.5	600 to < 800
4	Kremsmünster	5 to < 12.5	800 to < 1000
5	Okehampton	5 to < 12.5	≥ 1000
6	Sevilla	≥ 12.5	< 600
7	Thiva	≥ 12.5	600 to < 800
8	Piacenza	≥ 12.5	800 to < 1000
9	Porto	≥ 12.5	≥ 1000

The FOCUS climate zones are a subset of the 15 zones defined. The difference to the full list of climatic zones is the removal of the upper precipitation criterion of 1,400 *mm yr^{-1}* and no distinction in precipitation for temperatures < 5 deg. C.

In the computation the ranges given in the table were slightly modified to cover all values, since the original definition left some of the threshold values unassigned.

4.13 Layer 12: Topsoil Organic Matter

File name	EFSA_OM_TOP
Layers	1
File type	real
Data type	real
Value units	concentration (%)
Flag value	-9000.0
Flag definition	background
Source	JRC, ESDB, OC_TOP, HWSD V1.1 for Malta and Cyprus
Processing	JRC, 2012
Reference	Jones, *et al*., 2005; FAO/IIASA/ISRIC/ISS-CAS/JRC, 2009

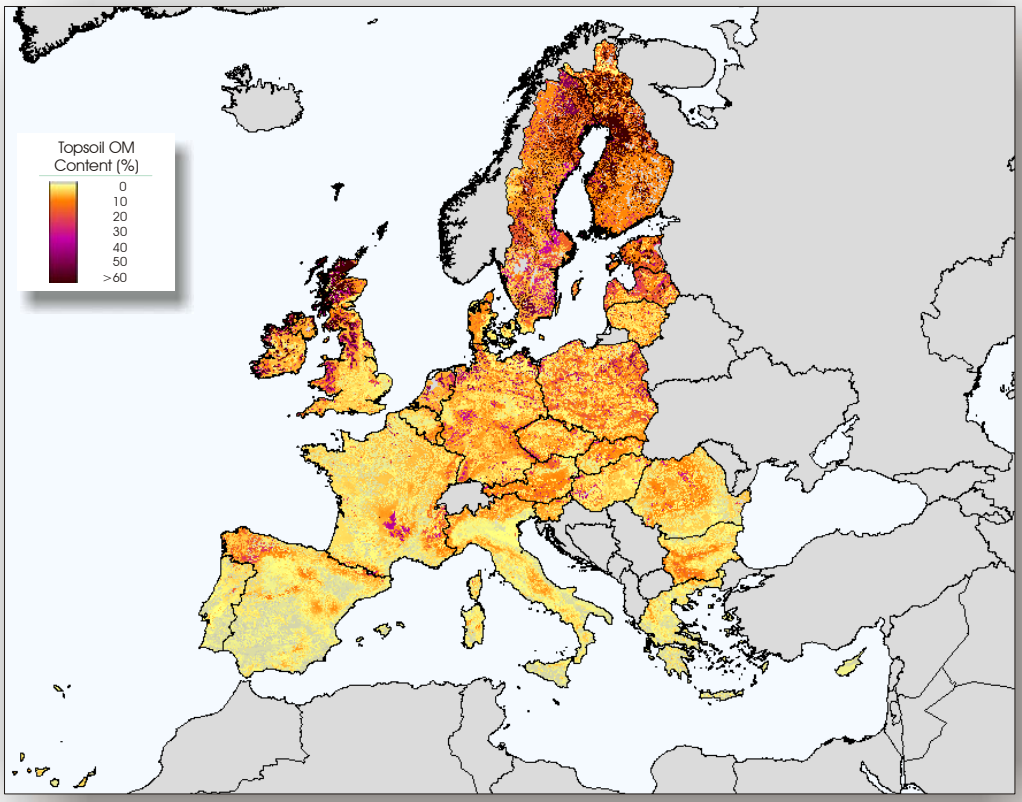

Figure 14: Topsoil Organic Matter Content

Comment

Note: Apply mask from EFSA_GENERAL_LU classes 1 to 4.

The layer of organic matter concentrations in the topsoil was calculated from the map of topsoil organic carbon by applying a factor of 1.72. This factor assumes an average organic carbon content of organic matter of 58%. The composition of organic matter varies with respect to the organic carbon content and the map of topsoil organic carbon uses a maximum of 63%. For the organic matter layer any organic matter concentrations >100 were therefore set to 100%.

The source data of the topsoil organic carbon map (European Soil Database Version 2.0) does not cover soil data for Malta and Cyprus. For these regions the data were taken from the Harmonized World Soil Database (Hiederer, 2011).

4.14 Layer 13: Topsoil pH

File name	EFSA_PH_TOP
Layers	1
File type	real
Data type	real
Value units	pH_{water}
Flag value	-9000.0
Flag definition	background
Source	HWSD V1.1
Processing	JRC, 2012
Reference	FAO/IIASA/ISRIC/ISS-CAS/JRC (2009); Hiederer & Köchy, 2011

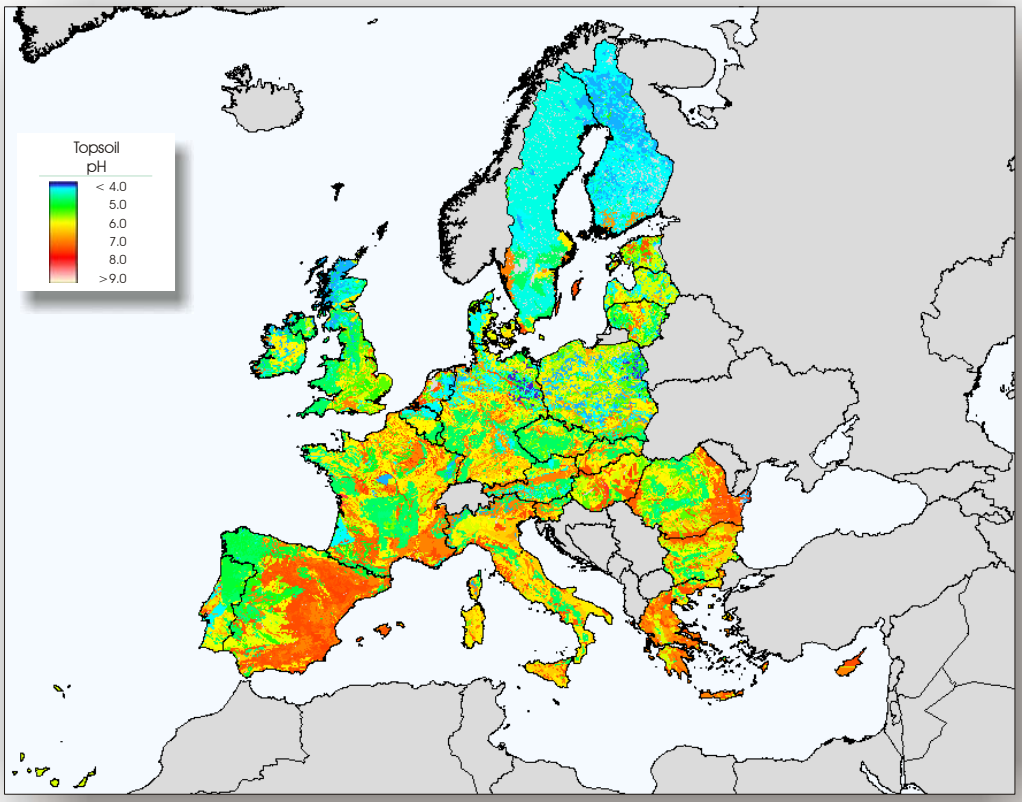

Figure 15: Topsoil pH

Comment

Note: Apply mask from EFSA_GENERAL_LU classes 1 to 4.

The topsoil pH_{water} layer is compiled from the Harmonized World Soil Database (HWSD) Version 1.1. The data represents the pH given for the dominant soil unit in the mapping unit.

4.15 Layer 14: Topsoil Bulk Density

File name	EFSA_BD_TOP
Layers	1
File type	real
Data type	real
Value units	kg m^{-3}
Flag value	-9000.0
Flag definition	background
Source	EFSA_OM_TOP
Processing	JRC, 2012
Reference	Tiktak, *et al.*, 2002

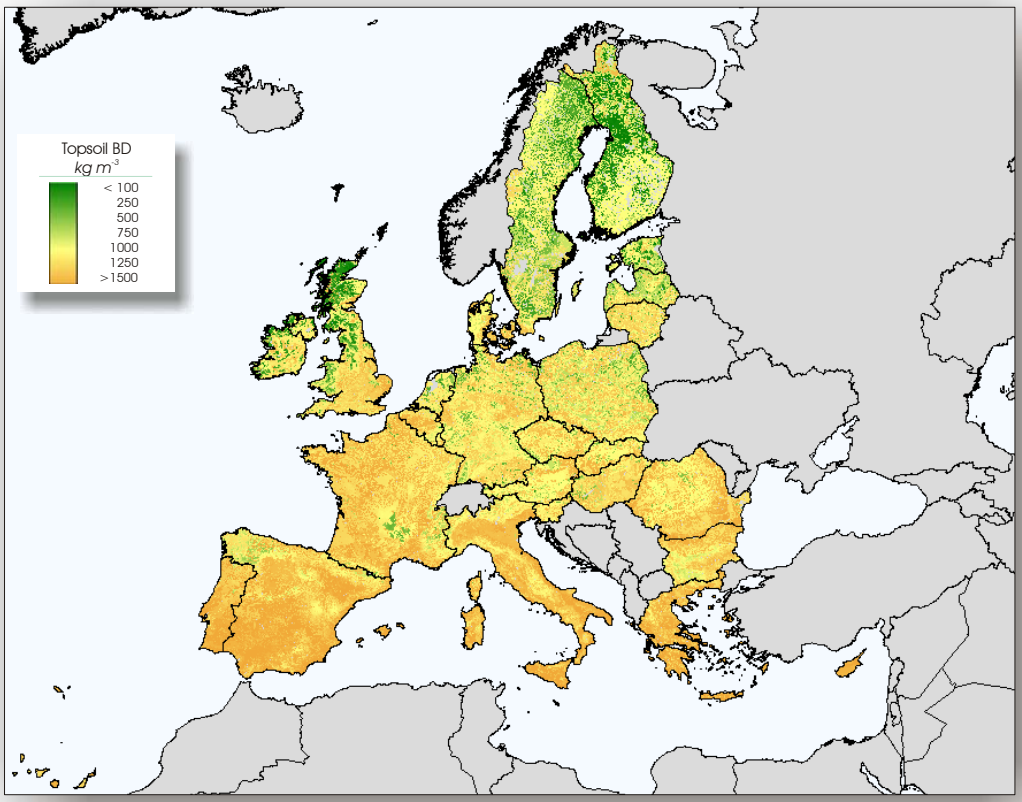

Figure 16: Topsoil Bulk Density

Comment

Note: Apply mask from EFSA_GENERAL_LU classes 1 to 4.

The EFSA topsoil bulk density layer was derived from the organic matter layer using a pedo-transfer function (PTF) (Tiktak, *et al*., 2002). The PTF is defined as:

$$\rho = 1800 + 1236 \times OM - 2910 \times OM^{0.5}$$

where

ρ	dry bulk density ($kg\ m^{-3}$)
OM	soil organic matter concentration

4.16 Layer 15: Topsoil Texture Class

File name	EFSA_TEXT_TOP
Layers	1
File type	real
Data type	real
Value units	relative proportion (%)
Flag value	-9000.0
Flag definition	background
Source	JRC, ESDB, TEXT_TOP; HWSD V1.1
Processing	JRC, 2012
Reference	ESDB, V2.0, 2001; FAO/IIASA/ISRIC/ISS-CAS/JRC, 2009

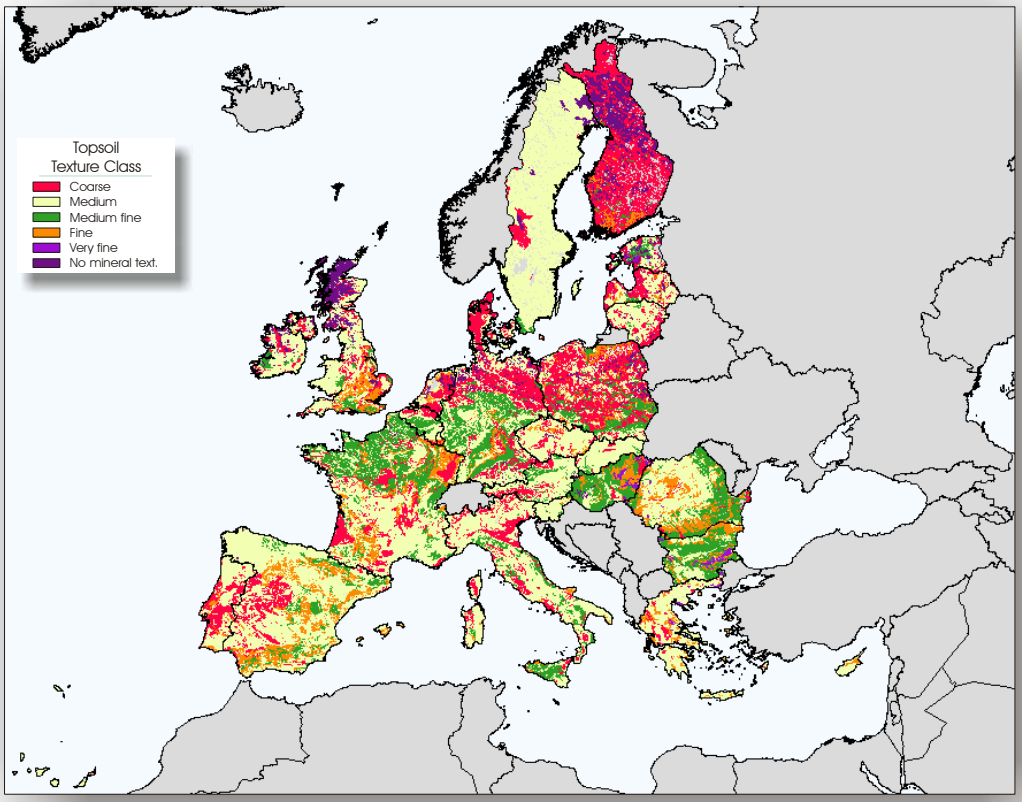

Figure 17: Topsoil Texture Class

Comment

Note: Apply mask from EFSA_GENERAL_LU classes 1 to 4.

The EFSA texture classes for the topsoil are aligned to the classes used in the ESDB. The 6 classes are defined as given in Table 7.

Table 7: Topsoil Texture Legend

Value ID	Texture
1	Coarse (18% < clay and > 65% sand)
2	Medium (18% < clay < 35% and >= 15% sand, or 18% < clay and 15% < sand < 65%)
3	Medium fine (< 35% clay and < 15% sand)
4	Fine (35% < clay < 60%)
5	Very fine (clay > 60 %)
9	No mineral texture (Peat soils)

For the areas covered by the ESDB the topsoil texture classes are defined by the dominant soil typological unit of a mapping unit. For areas outside the ESDB the texture classes were generated from the HWSD. The continuous values for texture categories of the HWSD were converted to the texture classes for the dominant soil type. Because texture values are also given to peat soils in the HWSD class 9 was given priority over texture information.

4.17 Layer 16: Topsoil Water Content at Field Capacity

File name	EFSA_THETA_FC_TOP
Layers	1
File type	real
Data type	real
Value units	$m^3\ m^{-3}$
Flag value	-9000.0
Flag definition	background
Source	EFSA_TEXT_TOP
Processing	JRC, 2012
Reference	EFSA, 2010

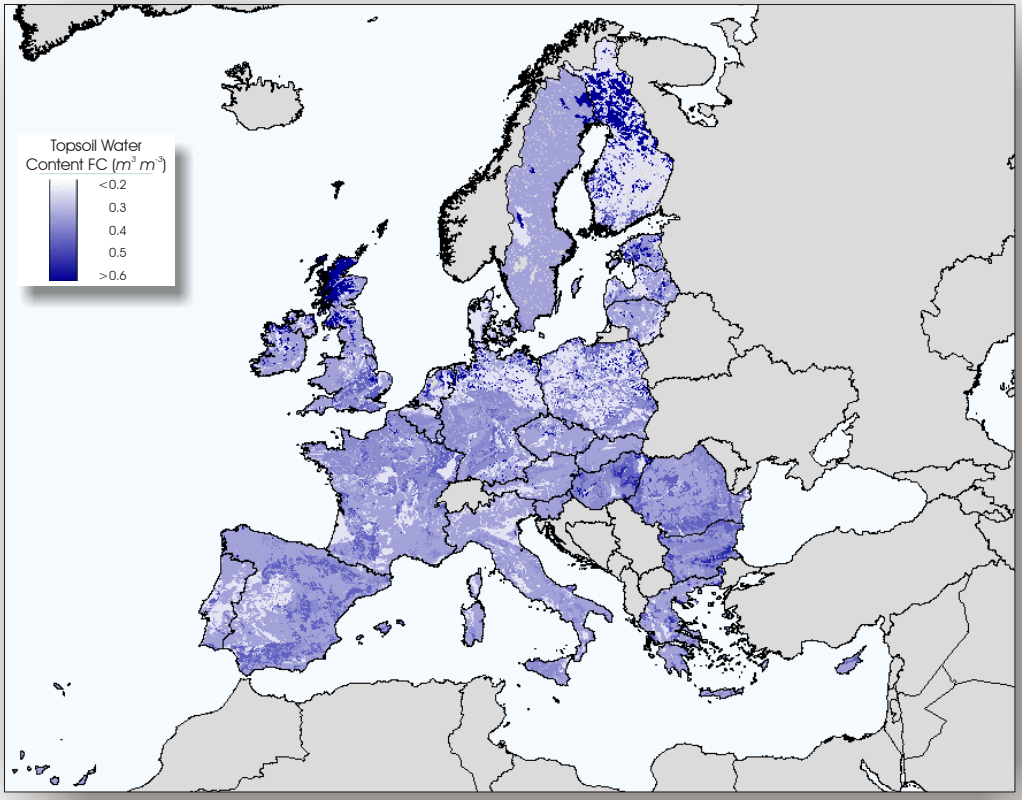

Figure 18: Topsoil Water Content at Field Capacity

Comment

Note: Apply mask from EFSA_GENERAL_LU classes 1 to 4.

The equation used to calculate the topsoil water content at field capacity is given in several publications. In EFSA (2010) and subsequent publications a small error has been introduced into the formulation of the Mualem-Van Genuchten equation (van Genuchten, 1980). The correct formulation of the equation should be:

$$\theta(\psi) = \theta_r + \frac{\theta_s - \theta_r}{\left(1 + a|h|^n\right)^m}$$

with

$$m = 1 - \frac{1}{n}$$

where

θ	volume fraction of water ($m^3\ m^{-3}$)
ψ	soil water pressure head (cm)
θs	volume fraction of water at saturation ($m^3\ m^{-3}$)
θr	residual water content in extremely dry range ($m^3\ m^{-3}$)
a	inverse of air entry suction (cm^{-1})
n	empirical measure of pore size distribution (*unitless*)

The parameters used to calculate the topsoil water content at field capacity are given in Table 8.

Table 8: Parameters to calculate topsoil water content at field capacity by soil textural classes

Texture	Volume Fraction at Saturation θ_s	Residual Water content θ_r	Inverse of Air Entry Suction a	Pore Size Distribution n
Class	$m^3\ m^{-3}$	$m^3\ m^{-3}$	cm^{-1}	
Coarse	0.40	0.03	0.0383	1.377
Medium	0.44	0.01	0.0310	1.180
Medium fine	0.43	0.01	0.0080	1.254
Fine	0.52	0.01	0.0370	1.101
Very fine	061	0.01	0.0270	1.103
Organic	0.77	0.01	0.0130	1.204

The resulting data was not further classified and the EFSA layer contains the topsoil water content at field capacity as continuous values.

4.18 Layer 17: CAPRI 2000

File name	EFSA_CAPRI_crop
Layers	24
File type	real
Data type	real
Value units	proportion area (%)
Flag value	-9000.0
Flag definition	background
Source	JRC AFOU project
Processing	JRC, 2012
Reference	Leip, *et al.*, 2008

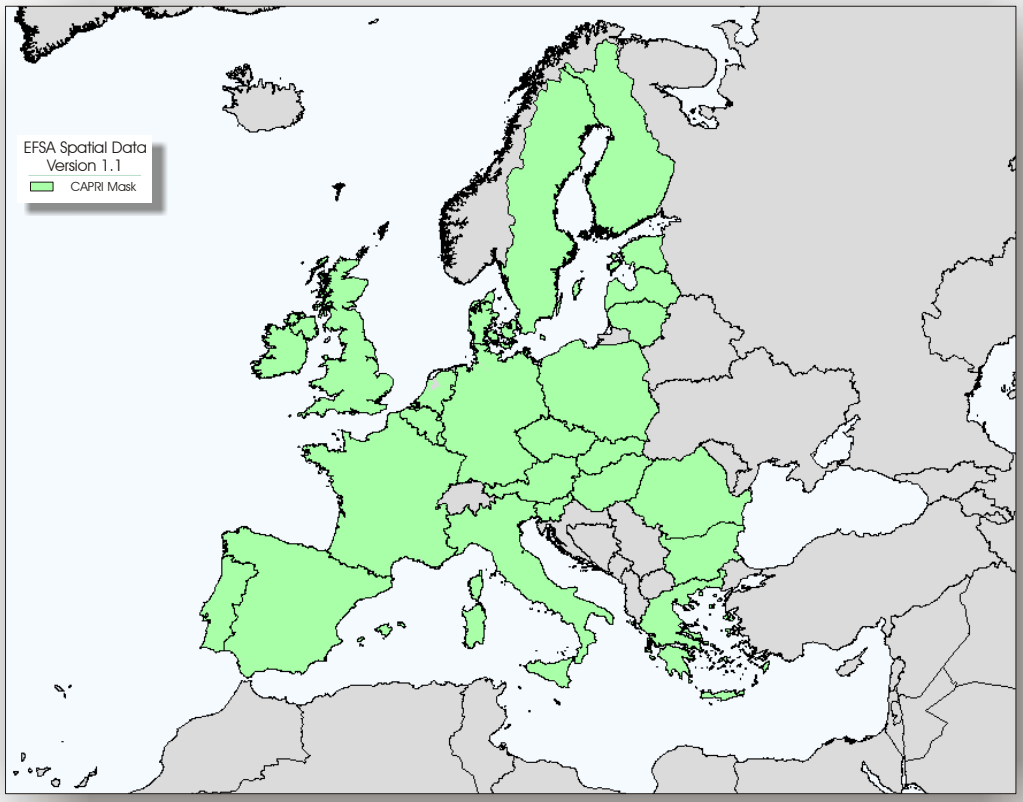

Figure 19: Mask Of EFSA-CAPRI Data

Comment

The data set "*Agricultural Landuse 2000*" (referred to as CAPRI2000) was made available to EFSA by the JRC AFOLU project "*Greenhouse Gases in Agriculture, Forestry and other land uses in Europe*". Meta-information on the data set and a download option is available from the project portal (http://afoludata.jrc.ec.europa.eu/index.php/dataset/detail/34). The data are documented in Leip, *et al*., 2008. Any questions concerning the data and their use should be addressed to the point of contact.

The data are distributed using a vector layer for the spatial information and an attribute table containing the data on the proportions of crops categories in each spatial element. The attribute data is linked to the spatial layer by an identifier. The data are provided separately for EU15 (EU Member States until 2004) and EU12 (new Member States since 2004). The versions given on the portal were:

- Agricultural_Landuse2000_EU15: 28.09.2010
- Agricultural_Landuse2000_EU12: 25.11.2011

For the EFSA-CAPRI crop data the vector file was rasterized to the EFSA specifications and the crop categories were mapped to individual spatial layers. The raster layers combine data from EU15 with those from EU12 into a single spatial layer by crop category.

The crop categories of the "*Agricultural Landuse 2000*" tables for EU15 and EU12 mapped to the raster layers of Version 1.0 and Version 1.1 are listed in Table 9.

Table 9: EFSA CAPRI Files

EFSA File Name EFSI_CAPRI_*crop*	EFSA Version 1.0 File Name	CAPRI Field Name	Agricultural Landuse 2000 Field Name
MASK	-	-	Grid Code x EFSA_EU27
-	Arable	-	-
BARLEY	Barley	barl	Barley
COMMON_WHEAT	SoftWheat	swhe	Common wheat
DURUM_WHEAT	DurumWheat	dwhe	Durum wheat
FALLOW	Fall	lfall	Fallow land
FLOWER	Flowers	flow	Floriculture
MAIZE	Maize	lmaiz	Maize
OATS	Oats	oats	Oats
OTHER_CROPS	OtherAnnualCrops	ocro	Other crops
OTHER_CEREALS	OtherCereals	ocer	Other cereals
OTHER_FODDER	OtherFodder	ofar	Fodder other on arable land
OTHER_INDUSTRIAL	OtherIndustrial	oind	Other non permanent industrial crops
OTHER_ROOTCROPS	RootCrops	roof	Other root crops
OTHER_VEGETABLES	Vegetables	oveg	Other fresh Vegetables
POTATOES	-	pota	Potatoes
PULSES	Pulses	puls	Dry pulses
RAPES	-	lrape	Rape and turnip rape
RYE	Rye	ryem	Rye
SOYA	Soya	soya	Soya
SUGARBEET	Sugarbeet	sugb	Sugarbeet
SUNFLOWER	Sunflowers	sunf	Sunflower
TEXTURE_CROPS	TextureCrops	ltext	Fibre and oleaginous crops
TOBACCO	-	toba	Tobacco
TOMATOES	Tomatoes	toma	Tomatoes

- Not included in EFSA Version 1.0.

It could not be ascertained by the AFOLU project whether the data made available to EFSA for Version 1.0 are the data now available form the portal and included in Version 1.1. The date of the last revision for EU12 (25.11.2011) indicates a time well after the data were made available to EFSA for processing and after Version 1.0 was made available through the JRC Soil data portal. As for data from other sources the JRC now maintains an archive of all data from which the EFSA Spatial Data Version 1.1 were generated for future reference.

Some crop categories not available in Version 1.0 are included in the up-date for completeness, such as potatoes, rapes and tobacco. Not included in the up-date is a layer on "*Arable*" land. The CAPRI database does not contain a specific field for this category and it is not evident how this layer was constructed in Version 1.0.

There is some uncertainty about the status of the categories "*oveg*" (Other fresh vegetables) and "*toma*" (Tomatoes). In the CAPRI legend files "*CAPRI_filenamecodes.xls*" for EU15 and EU12 these categories are found under the heading "*additional grid*" with the comment "*missing*". Under the heading "*grids with the dissagregated crop share (a pixel value of 10000 corresponds to 100%)*" the category "*ovto*" (Tomatoes and Other fresh Vegetables) is listed. However, the database tables do not contain the field "*ovto*", but separate data for "*oveg*" and "*toma*". Data for the category "*oveg*" are available for EU12 and EU15, although data for the category "*toma*" are only available for EU12. To remain consistent with the crops of Version 1.0 the CAPRI crop layers of Version 1.1 also include the incomplete layer for tomatoes.

A data mask for the CAPRI2000 data was added to the set, because the CAPRI2000 data cover a slightly different area than EU27. Data for Croatia are included, but not for Malta, Cyprus or the Isle of Man and some other smaller regions. It was noted that compared to the Eurostat GISCO data used the cover of the CAPRI2000 data shows approx. one grid cell less land cover on the western part of land sea borders, although it is aligned to the land / sea border on the eastern parts. This situation is presented in Figure 20 for Denmark as an example. However, the situation is found for all other land / sea borders.

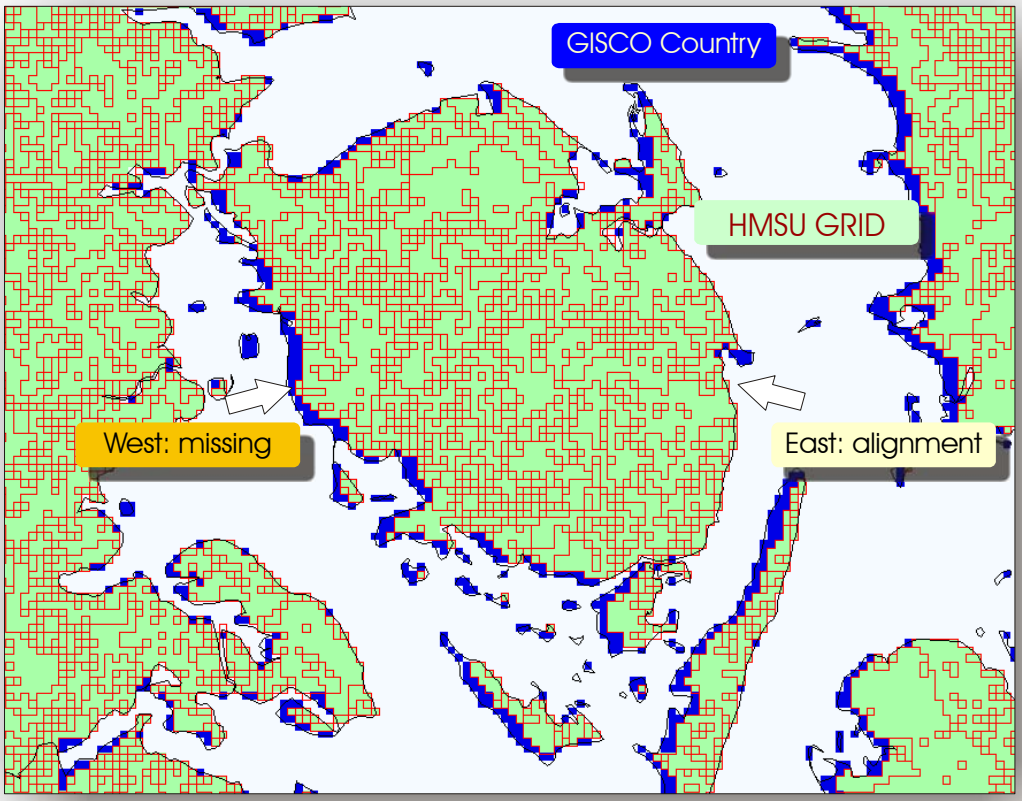

Figure 20: Overlap of CAPRI2000 data with Eurostat GISCO Country 2010

The EFSA_CAPRI_MASK layer contains the area common of the CAPRI grid and the EFSA_EU27 layer. The entries of 0 in the CAPRI2000 data were maintained. Thus, depending on the processing needs, the EFSA-DATA_MASK layer may be included to define an EFSA-CAPRI data mask. To maintain flexibility for the processing needs the EFSA_CAPRI_MASK layer does not incorporate the EFSA-DATA_MASK layer.

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Abstract

In the context of the submissions of exposure estimates of pesticides in the soil and according to regulation (EC) 1107/2009 a set of spatial data pertinent to evaluating the environmental fate and behaviour of pesticides in the soil was published in 2011 as support to the FATE and the ECOREGION EFSA PPR Working Groups.
After the first EFSA Spatial Data set was made available in 2011 users commented on inconsistencies in the data, mainly with respect to the spatial characteristics of various layers. The JRC found that the problem was more complex than just a geographic misalignment of layers and concluded that to fully address the problem all data layers needed to be reprocessed from their respective sources and recompiled to comply with the specifications. This task was performed by the JRC, which resulted in an update to the previous data referred to as EFSA Spatial Data Version 1.1.

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