

# Copernicus Land Monitoring Service – High Resolution Layer Grassland

## Product Specifications



## Copernicus land monitoring service – High resolution layer Grassland: Product Specifications Document

---

<b>Title</b>	Copernicus Land Monitoring Service – High Resolution Layer Grassland: Product Specifications Document
<b>Creator</b>	Tobias LANGANKE
<b>Creation date</b>	2017-03-15
<b>Subject</b>	Definitions and product specifications of Copernicus High Resolution Layer Grassland
<b>Status</b>	Final
<b>Publisher</b>	Copernicus team at EEA
<b>Type</b>	Text
<b>Description</b>	This document contains detailed product definitions and specifications for the pan-European Copernicus HRL Grassland layer for the 2015 reference year. It was created in close collaboration and with contributions from the service providers of Lot 3 in a consultative process.
<b>Contributor</b>	Regine RICHTER (GAF AG), Christopher SANDOW (GAF AG), Cornelia STORCH (GAF AG), Baudouin DESCLÉE (SIRS), Andrew MORAN (GeoVille)
<b>Format</b>	Microsoft Word document
<b>Source</b>	European Environment Agency and HRL Grassland service providers
<b>Rights</b>	European Environment Agency
<b>Identifier</b>	This is version 2 of 2018-04-10
<b>Language</b>	EN
<b>Relation</b>	Copernicus regulation
<b>Coverage</b>	2018

---

---

## TABLE OF CONTENTS

1. Background.....	5
2. HRL Product Overview.....	5
3. Data Used for HRL Grassland Generation .....	5
4. Grassland Mask (GRA) .....	6
5. Grass Vegetation Probability Index (GRAVPI) .....	9
6. Ploughing Indicator (PLOUGH) .....	10
7. INSPIRE Metadata and Mapping Tables.....	12
8. Thematic Accuracy .....	13
Annex I: Detailed Product Specifications .....	14
Annex II: Color Palettes .....	17

## LIST OF FIGURES

Figure 1: Overview on HRL2015 Grassland Layer .....	8
Figure 2: Grassland Vegetation Probability Index.....	10
Figure 3: PLOUGH (detailed view).....	11
Figure 4: Pan-European Ploughing Indicator .....	12

## LIST OF TABLES

Table 1: List of auxiliary data sets used for HRL Grassland production .....	6
Table 2: Definition of HRL2015 Grassland Layer.....	7

## LIST OF ACRONYMS

DWH	Data Warehouse
EEA	European Environment Agency
EO	Earth Observation
ESA	European Space Agency
GRA	Grassland Layer
GRAVPI	Grassland vegetation probability Index
HRL	High Resolution Layer
INSPIRE	INfrastructure for SPatial InfoRmation in Europe
LAEA	Lambert Azimuthal Equal Area Projection
LUCAS	Land Use and Coverage Area frame Survey
MMU	Minimum Mapping Unit
NGR	Natural and semi-natural grasslands
PLOUGH	Ploughing Indicator
USGS	United States Geological Survey

## 1. Background

This document captures detailed product specifications for the high resolution layer (HRL) Grassland for the 2015 reference year. It provides an overview of the HRL Grassland products, their specifications and EO and in-situ data that have been used for data generation. For each product, the general workflow of data creation is explained and overview maps are shown to present the layers. INSPIRE metadata and mapping tables established per layer are described and colour palettes designed are displayed. Tables with detailed product specifications for each product are presented in Annex I at the end of this document.

## 2. HRL Product Overview

The pan-European HRL Grassland 2015 product consists of three different layers, the

- Grassland (GRA)
- Grassland Vegetation Probability Index (GRAVPI) and the
- Ploughing Indicator (PLOUGH)

The main product of the “HRL Grassland” is the “**Grassland**” layer, a grassland/non-grassland mask for the EEA39 area. This grassy and non-woody vegetation baseline product includes all kinds of grasslands: managed grassland, semi-natural grassland and natural grassy vegetation. The layer is not directly comparable to the precursor HRL Grassland layer of the reference year 2012, which focused on natural (and parts of semi-natural) grasslands, and fully replaces the 2012 product.

Two additional (expert) products complete the HRL Grassland: the **Ploughing Indicator** (PLOUGH) and the **Grassland Vegetation Probability Index** (GRAVPI). While the PLOUGH concentrates on historic land cover features with the aim to indicate ploughing activities in preceding years, the GRAVPI provides a measure of classification reliability. Both products are designed for expert users, and are still in a testing phase.

## 3. Data Used for HRL Grassland Generation

A variety of high resolution satellite images with multiple spatial resolutions were utilized for the production of the HRL Grassland layers. These include primarily the dense time series of the Sentinel 1 and Sentinel 2 archives of the Copernicus programme. Furthermore, Earth observation (EO) data from the USGS Landsat programme and Copernicus DWH HR\_IMAGE\_2012 datasets were used as supplementary data sources. For the production of the grassland layer, the following primary EO data sources have been deployed: Sentinel-2A, Sentinel-1A and B and Landsat 8 OLI. Historical EO data sets applied for the generation of PLOUGH were Landsat 8 OLI, Landsat 5 TM and IRS-P6 LISS-3 (from HR\_IMAGE\_2012).

Besides EO data, a series of public available auxiliary data sets proved to be suitable to support training sample selection, plausibility checks and calibration of algorithms. Table 1 gives an overview on the utilized data.

**Table 1:** List of auxiliary data sets used for HRL Grassland production

Name of data set	Characteristics
Land Use and Coverage Area frame Survey (LUCAS)	<ul style="list-style-type: none"> <li>• In-situ; observation through survey</li> <li>• Points</li> <li>• Coverage: EU countries</li> <li>• 3-year-update cycle</li> </ul>
HRL Tree Cover Density (2012 & 2015)	<ul style="list-style-type: none"> <li>• Resolution: 20 m</li> <li>• Coverage: EEA</li> </ul>
HRL Forest Type (2012 & 2015)	<ul style="list-style-type: none"> <li>• Resolution: 20 m</li> <li>• Coverage: EEA</li> </ul>
HRL Impervious Degree (2012 & 2015)	<ul style="list-style-type: none"> <li>• Resolution: 20 m</li> <li>• Coverage: EEA</li> </ul>
HRL Water & Wetness (2012 & 2015)	<ul style="list-style-type: none"> <li>• Resolution: 20 m</li> <li>• Coverage: EEA</li> </ul>
Global Forest Change 2000–2014 (Hansen et al. 2013)	<ul style="list-style-type: none"> <li>• Resolution: 30 m</li> <li>• Coverage: global</li> </ul>
Corine Land Cover	<ul style="list-style-type: none"> <li>• Thematic map</li> <li>• Minimum mapping unit: 50 ha</li> <li>• Coverage: EEA</li> </ul>
National/regional thematic maps, e.g. SIOSE, LPIS data	<ul style="list-style-type: none"> <li>• High degree of detail, higher than Corine Land Cover 50 ha MMU</li> </ul>
National phenology dataset PHASE	<ul style="list-style-type: none"> <li>• Coverage: Germany only</li> </ul>

## 4. Grassland Mask (GRA)

The HRL Grassland Layer defines grassland as

- herbaceous vegetation with at least 30% ground cover, of which at least 30% graminoid species such as Poaceae, Cyperaceae and Juncaceae
- it can include additional non woody plants such as lichens, mosses and ferns
- scattered trees and shrubs may be present, covering a maximum 10 %.

Table 2 presents a detailed list of all grassland elements and of objects that are excluded from the grassland mask.

**Table 2:** Definition of HRL2015 Grassland Layer

Elements to be included in the grassland product	Elements to be excluded from the grassland product
<ul style="list-style-type: none"> <li><i>Natural, semi-natural, agricultural / managed grass-covered surfaces.</i></li> <li><i>Grasslands with scattered trees and shrubs covering a maximum 10 %.</i></li> <li><i>Heathland with high grass cover, maximum of 10 % non-grass cover</i></li> <li><i>Coastal grasslands, such as grey dunes and salt meadows located in intertidal flat areas with at least 30 % graminoid species of vegetation cover</i></li> <li><i>Sparsely vegetated grasslands (&gt; 30% vegetation cover – see comment below)</i></li> <li><i>Grasslands in urban areas: parks, urban green spaces in residential and industrial areas</i></li> <li><i>Semi-arid steppes with scattered Artemisia scrub</i></li> <li><i>Meadows: grassland which is not regularly grazed by domestic livestock, but rather allowed to grow unchecked in order to produce hay</i></li> <li><i>Grasslands in urban areas: sport fields, golf courses</i></li> <li><i>Grasslands on land without use</i></li> <li><i>Natural grasslands on military sites</i></li> </ul>	<ul style="list-style-type: none"> <li><i>Peat forming ecosystems dominated by sedges.</i></li> <li><i>Reed beds and helophytes dominated systems.</i></li> <li><i>Tall forbs, fern, shrub dominated vegetation.</i></li> <li><i>Grasslands that have been observed as tilled (in the reference year or a certain period before, in that case they are considered as arable fields)</i></li> <li><i>Rice fields</i></li> <li><i>Vineyards, orchards, olive groves, (if more than 10 % shrubs or trees)</i></li> <li><i>Tundras dominated by shrubs and lichens</i></li> <li><i>Grassland on fresh (and older) clear-cuts in the woods</i></li> </ul>

The 30% ground cover density value defined above is understood as reference indicating that grasslands with  $\geq 30\%$  ground cover normally can be distinguished from open ground on satellite data, as the vegetation cover dominates bare soil reflection. It is understood as a guideline rather than a strict rule during production to focus on “dense grasslands” that can be identified in a reliable manner in EO data rather than on “sparsely vegetated grasslands”. Confusions with bare soil or sparsely vegetated grassland  $< 30\%$  ground cover can such be avoided.

The HRL2015 Grassland Layer was produced by using a combined optical/SAR data analysis approach based on data from the reference period 2015 +/-1 year. Image objects derived from multi-temporal optical EO data were utilized to classify the multi-temporal data base of both sensor types. Training samples of the main land use classes were selected and applied in a supervised classification approach to compute grassland maps of both sensors. A subsequent rule-based evaluation finally defined the optimum grassland mask. Additionally, recent and historic bare soil masks helped to identify grassland areas that show a ploughing indication and therefore were excluded from the mask. HRL2012/2015 layers on imperviousness, tree cover density and permanent water bodies were used for a plausibility analysis in order to identify and remove improper overlays. The final grassland mask was generalized by filter operations to derive a harmonized product with 1 ha minimum mapping unit (Figure 1).



Areas that could not be classified due to clouds/cloud shadows/snow cover or a lack of satellite data have been classified by a separate code (code 254). Cloud/cloud shadow/snow masks applied were either derived in a fully automated process using the Fmask algorithm or manually by the service providers. In the first case, overestimations of the areas affected could be observed which, however, mostly do not affect the grassland layer.

For detailed product specifications see Annex I. More information on the HRL Grassland colour palette can be found in Annex II.

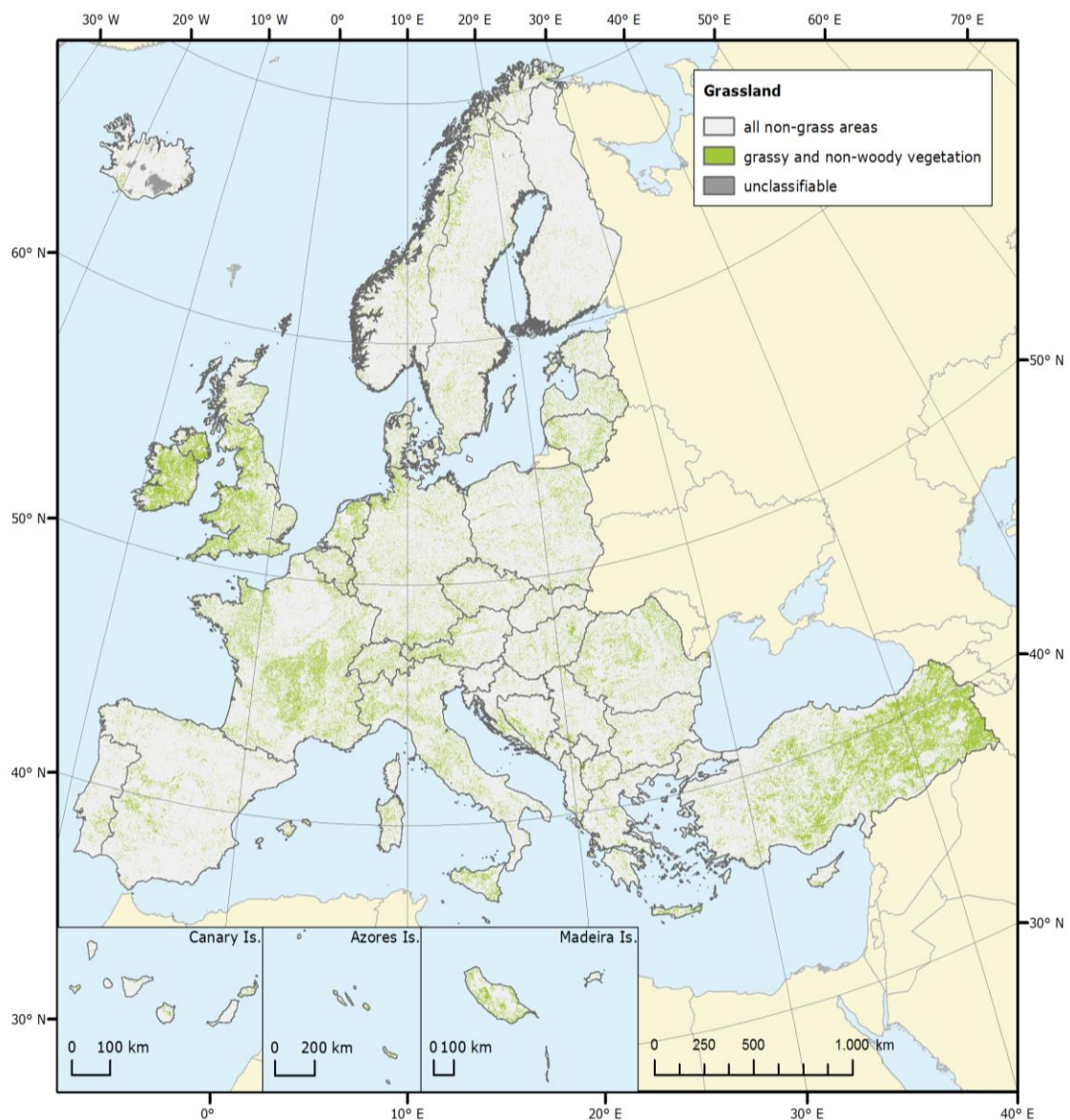


Figure 1: Overview on HRL2015 Grassland Layer, © EuroGeographics for the administrative boundaries



### **National Products and 100m products**

The pan-European HRL2015 Grassland Layer is available at two different pixel resolutions: 20m layer and 100m product. To achieve the 100m map, an aggregation process was carried out weighting grassland, non-grassland and unclassifiable pixels at 20m level within a 100m grid cell. The class majority determined the final assignment of the 100m grid cell to a specific class.

Both, the 20m product and the aggregated 100m HRL2015 Grassland Layers are provided in national projections as well. National country borders from EUROSTAT (European Boundary Map Version 11) and country-specific projection parameters provided by ESA via the HR/VHR\_IMAGE\_2015 were used to re-project the European 20m and 100m data sets to national layers. The national layers are provided with a buffer of 100m width.

## **5. Grass Vegetation Probability Index (GRAVPI)**

The Grass Vegetation Probability Index describes the reliability of the multi-seasonal optical grassland classification for the reference year 2015 (EO data from plus/minus 1 year). It is a measure for the reliability of the grassland class assignment and indicates to which degree grassland could be separated from other vegetated land cover types (see Figure 2).

The probability index is directly related to the EO data situation: while dense time series of meaningful scenes will lead to high classification reliabilities, poor data situations will provide low probability index rates. An optimum data scenario is used to calibrate the index to the range of 1-100%.

For detailed GRAVPI product specifications see Annex I. More information on the GRAVPI colour palette can be found in Annex II.

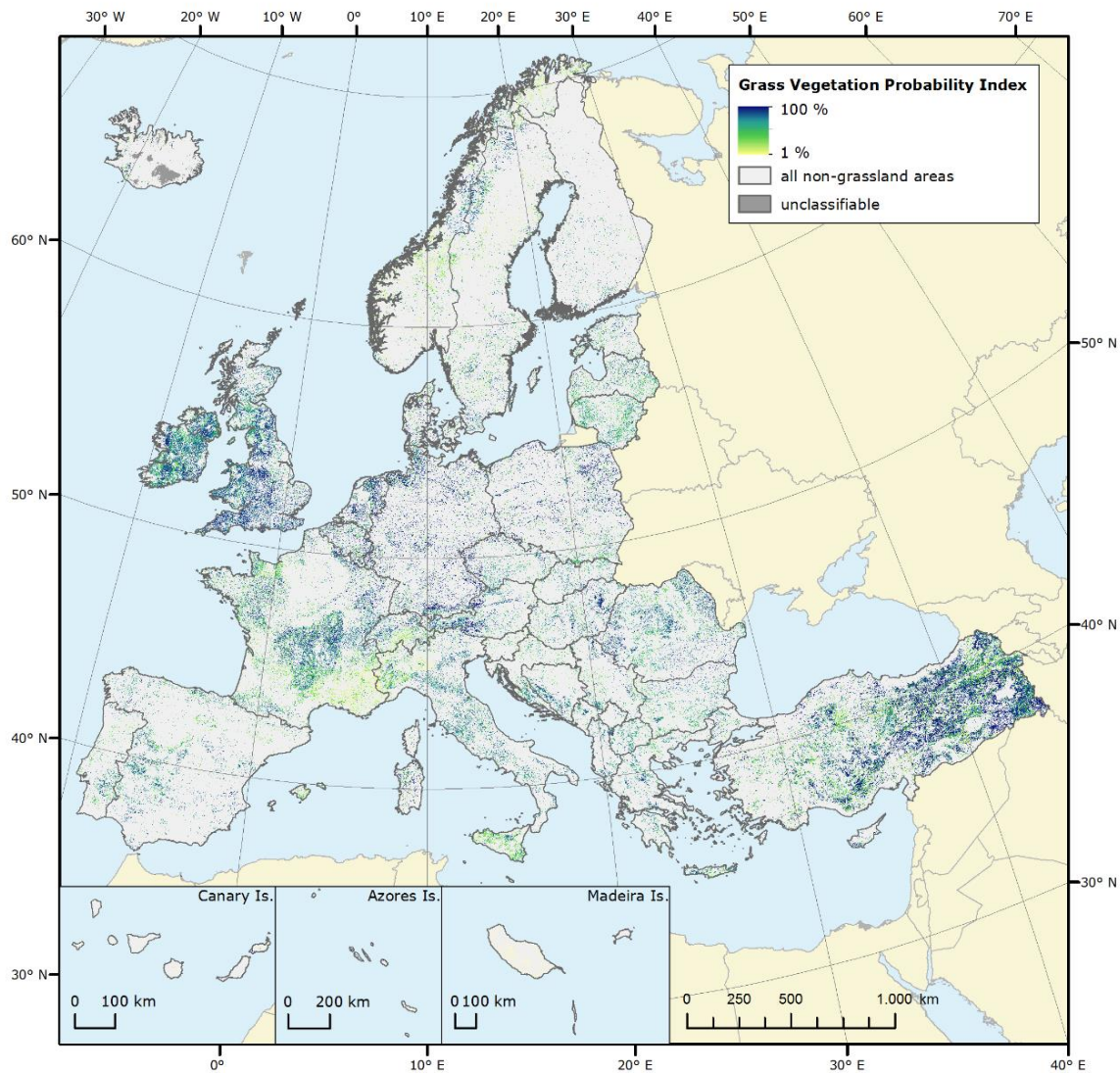


Figure 2: Grassland Vegetation Probability Index, © EuroGeographics for the administrative boundaries

## 6. Ploughing Indicator (PLOUGH)

The Ploughing Indicator estimates the temporal extent since last ploughing activity. PLOUGH is derived from historical bare soil time series (up to 6 years) of multi-temporal optical HR imagery. Primary EO data sources were Landsat 8 OLI and Landsat 5 TM data. For 2012, where neither Landsat 8 OLI nor Landsat 5 TM data have been available, data from HR\_IMAGE\_2012 were used to fill the temporal gap in the time series.

PLOUGH is a pixel-based layer where each pixel value represents the latest bare soil indication (number of years prior to the target year) within the grassland mask. The reliability of PLOUGH strongly depends on the availability of suitable historical EO data. Poor data situations (clouded

images, unfavourable data acquisition dates, only few data sets available) will lead to a less reliable PLOUGH, while an optimum coverage will raise the quality of the information provided. Moreover, the NDVI-based approach has its limitations in areas with dry climate where un-vegetated areas and dry vegetation is confused. In those regions dry vegetation as well as ploughed grassland is included in the ploughing indicator map.

PLOUGH can be used as additional, independent information layer for a flexible application of different grassland definitions. The maps shown in Figure 4 and Figure 3 illustrate the product. For detailed PLOUGH product specifications see Annex I. More information on the PLOUGH colour palette can be found in Annex II.

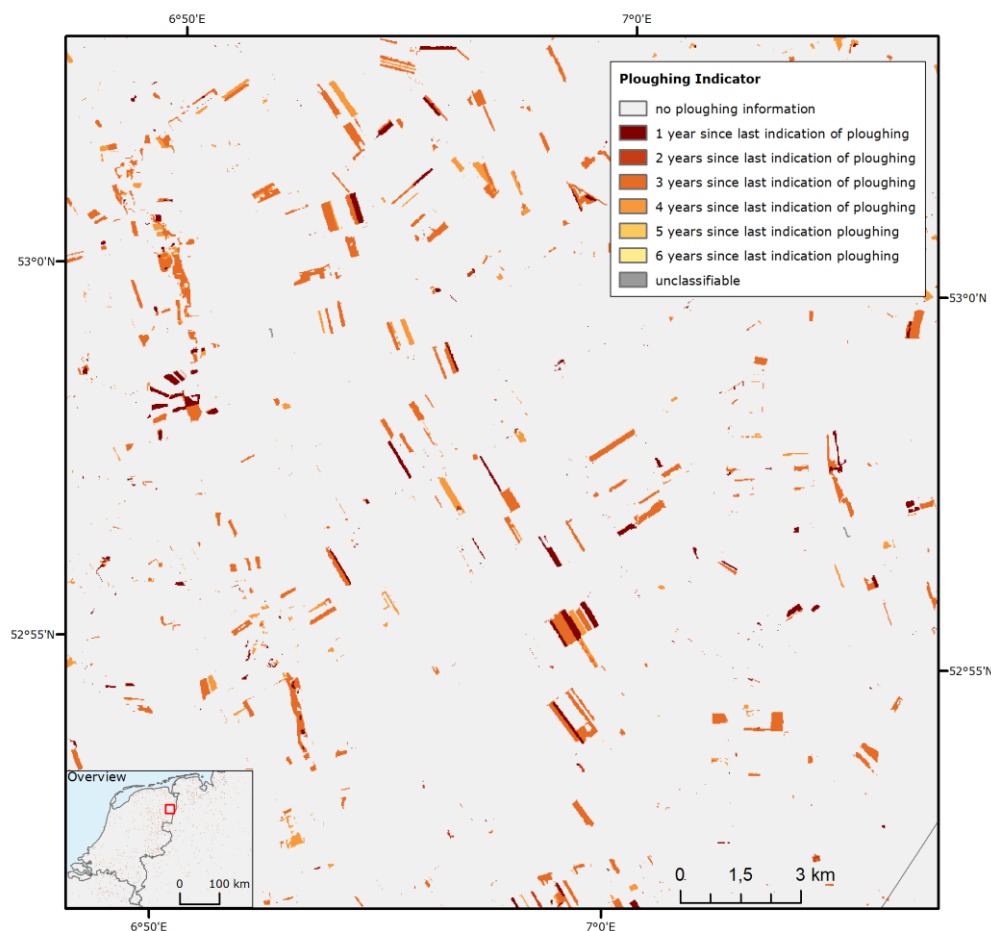


Figure 3: PLOUGH (detailed view)

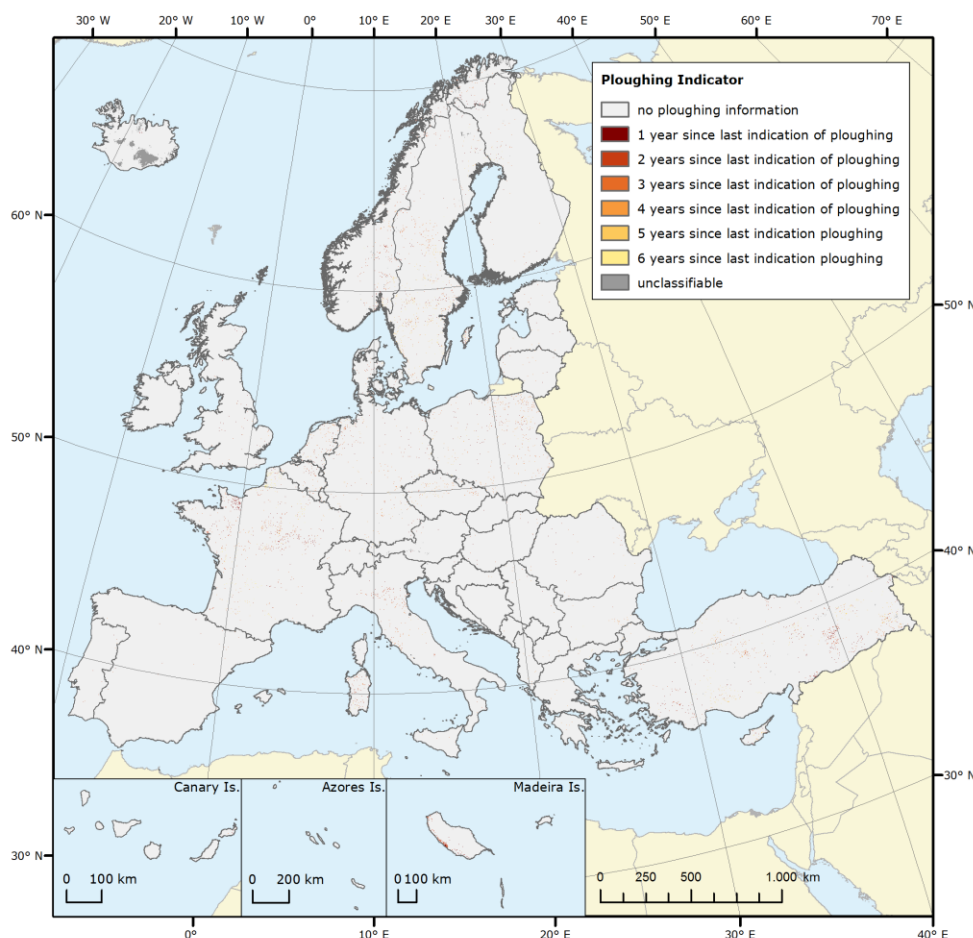


Figure 4: Pan-European Ploughing Indicator, © EuroGeographics for the administrative boundaries

## 7. INSPIRE Metadata and Mapping Tables

Metadata are provided together with the products as INSPIRE-compliant XML files according to the EEA Metadata Standard for Geographic Information (EEA-MSGI). EEA-MSGI has been developed by EEA to meet needs and demands for inter-operability of metadata. EEA's standard for metadata is a profile of the ISO 19115 standard for geographic metadata and contains more elements than the minimum required to comply the INSPIRE metadata regulation. Detailed conceptual specifications on EEA-MSGI and other relevant information on metadata can be found online at <http://www.eionet.europa.eu/gis>.

INSPIRE mapping tables show the evidence that the products delivered are compatible with the INSPIRE Data Specification on Land Cover. This evidence is provided as table document showing the associations between the source (product/deliverable) and the target data model (INSPIRE Data Specification on Land Cover).

## 8. Thematic Accuracy

For HRL Grassland, thematic accuracy assessment will be made on the main product, the grassland mask. The target is set at 85 % thematic accuracy to be achieved within each biogeographic region. A quantitative approach will be used based on a set of stratified systematic point samples that will be compared to internal EO data sets (Sentinel-1/2, DHW IMAGE20XX, Landsat, etc.) and suitable external data archives (e.g. GoogleEarthPro, national orthophotos or national grassland datasets). There will be three levels of accuracy assessment:

- a) an internal validation by SPs to report on the accuracy as part of the delivery report,
- b) further assessments on samples of the 20m products by ETC in the early production phase, and
- c) a full independent validation of the full European product after production.

While the additional products are not part of the thematic accuracy assessment, these products are at least checked regarding semantic accuracy.

## Annex I: Detailed Product Specifications

Grassland Layer 2015 (20m /100m)	Acronym GRA
<b>Reference year</b> 2015 (+/- 1 year)	
<b>Geometric resolution</b> Pixel resolution 20m x 20 m, fully conform with the EEA reference grid	
<b>Coordinate Reference System</b> European Terrestrial Reference System 1989 (ETRS89), LAEA projection	
<b>Geometric accuracy (positioning accuracy)</b> Less than half a pixel. According to ortho-rectified satellite image base delivered by ESA.	
<b>Thematic accuracy</b> 85 % thematic accuracy to be achieved within each biogeographic region.	
<b>Data type</b> 8bit unsigned raster, LZW compression	
<b>Minimum Mapping Unit (MMU)</b> 1 ha (20m product)	
<b>Min. Width of linear features</b> 20 m/100m (for Grassland main product only)	
<b>Raster coding</b> 0: all non-grass areas 1: grassy and non-woody vegetation 254: unclassifiable (no satellite image available, or clouds, shadows, or snow) 255: outside area	
<b>Metadata</b> XML metadata files are to be produced according to INSPIRE metadata standards	
<b>Delivery format</b> GeoTIFF	







<b>Grassland Vegetation Probability Index</b>	<b>Acronym</b> GRAVPI
<b>Reference year</b> 2015 (+/- 1 year)	
<b>Geometric resolution</b> Pixel resolution 20m x 20 m, fully conform with the EEA reference grid	
<b>Coordinate Reference System</b> European Terrestrial Reference System 1989 (ETRS89), LAEA projection	
<b>Geometric accuracy (positioning accuracy)</b> Less than half a pixel. According to ortho-rectified satellite image base delivered by ESA.	
<b>Thematic accuracy</b> Not applicable	
<b>Data type</b> 8bit unsigned raster, LZW compression	
<b>Minimum Mapping Unit (MMU)</b> 20 m	
<b>Min. Width of linear features</b> 20 m	
<b>Raster coding</b> 0: all non-grassland areas 1-100: grassland vegetation probability index value 254: unclassifiable (no satellite image available, or clouds, shadows, or snow) 255: outside area	
<b>Metadata</b> XML metadata files are to be produced according to INSPIRE metadata standards	
<b>Delivery format</b> GeoTIFF	

<b>Ploughing Indicator</b>	<b>Acronym</b> PLOUGH
<b>Reference year</b> 2015 (+/- 1 year) and 6 preceding years	
<b>Geometric resolution</b> Pixel resolution 20m x 20 m, fully conform with the EEA reference grid	
<b>Coordinate Reference System</b> European Terrestrial Reference System 1989 (ETRS89), LAEA projection	
<b>Geometric accuracy (positioning accuracy)</b> Less than half a pixel. According to ortho-rectified satellite image base delivered by ESA.	
<b>Thematic accuracy</b> Not applicable	
<b>Data type</b> 8bit unsigned raster, LZW compression	
<b>Minimum Mapping Unit (MMU)</b> 20 m	
<b>Min. Width of linear features</b> 20 m	
<b>Raster coding</b> 0: no ploughing information 1-6: the number of years since last indication of ploughing 254: unclassifiable (no satellite image available, or clouds, shadows, or snow) 255: outside area	
<b>Metadata</b> XML metadata files are to be produced according to INSPIRE metadata standards	
<b>Delivery format</b> GeoTIFF	







## Annex II: Color Palettes

For each product, a GIS file (\*.clr) specifying the colour palette and a text file (\*.txt) listing the RGB values for possible non-GIS products and material will be provided.









### GRA - Grassland

Class Code	Class Name	Red	Green	Blue	
0	all non-grass areas	240	240	240	
1	grassy and non-woody vegetation	163	199	56	
254	unclassifiable (no satellite image available, or clouds, shadows, or snow)	153	153	153	
255	outside area	0	0	0	

### GRAVPI- Grass Vegetation Probability Index

Class Code	Class Name	Red	Green	Blue	
0	all non-grassland areas	240	240	240	
1	1% grassland vegetation probability index	186	255	172	
50	50% grassland vegetation probability index	85	160	89	
100	100% grassland vegetation probability index	28	92	36	
254	unclassifiable (no satellite image available, or clouds, shadows, or snow)	153	153	153	
255	outside area	0	0	0	

### PLOUGH- Additional product Ploughing Indicator

Class Code	Class Name	Red	Green	Blue	
0	no ploughing information	255	255	255	
1	1 year since last indication of ploughing	20	255	20	
2	2 years since last indication of ploughing	0	150	0	
3	3 years since last indication of ploughing	255	0	0	
4	4 years since last indication of ploughing	255	128	0	
5	5 years since last indication of ploughing	191	191	191	
6	6 years since last indication of ploughing	191	255	191	
254	unclassifiable in any of parent status layers	153	153	153	
255	outside area	0	0	0	