

# Copernicus Land Monitoring Service – High Resolution Layer Water and Wetness

## Product Specifications



## Copernicus land monitoring service – High Resolution Layer Water and Wetness: Product Specifications Document

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## ABBREVIATIONS & ACRONYMS

CLC	CORINE Land Cover
EEA	European Environment Agency
EEA-39	39 member and cooperating countries of the EEA
EO	Earth Observation
ETC	European Topic Centre
HOT	Haze Optimized Transformation
HR	High Resolution
HRL	High Resolution Layer
LAEA	Lambert Azimuthal Equal-Area
MMU	Minimum Mapping Unit
MSGI	Metadata Standard for Geographic Information
NDVI	Normalised Difference Vegetation Index
NDWI	Normalised Difference Water Index
NMDI	Normalised Multiband Drought Index
SAR	Synthetic Aperture Radar
SP	Service Provider
SWIR	Short-wavelength infrared
TCBI	Tasselled Cap Brightness Index
TIF	Tagged Image File Format
TU	Technical University
TWI	Topographic wetness index
VHR	Very High Resolution
WAW	Water and Wetness
WWPI	Water-Wetness-Probability-Index

## 1. Background

This document captures the detailed definitions and product specifications for the Copernicus land monitoring service Water and Wetness (WAW) High Resolution Layer (HRL) for the 2015 reference year. In the past, permanent water and wetlands were produced together for the 2012 reference year production but published as separate products. Based on our experience with the 2012 production, and widespread misunderstanding of the “wetland” product, the products were modified and re-named, such that only one combined layer of “Water and Wetness” is produced. Therefore, the 2015 Water and Wetness layers are not comparable to the 2012 “wetlands” layer. The document evolved during the production period as a specification document and was then adopted for the final users of the datasets.

## 2. Product overview

The combined Water and Wetness product is a thematic product showing the occurrence of water and wet surfaces over the period from 2009 to 2015. This layer is based on multi-temporal and multi-seasonal optical high-resolution Landsat data, image coverages (HR IMAGE2009, HR IMAGE2012 and HR IMAGE2015 from the ESA DataWare House, DWH), the Copernicus space and contributing Missions (SPOT, IRS), whereas HR IMAGE2015 serves as geometric reference for all satellite data. In addition, this layer is also based on radar information (Sentinel-1 data) with a geometric resolution of 10m on a pan-European basis. Hence, a multitude of optical and SAR imagery is ingested over a prolonged time series of 7 years. From this, seasonal image composites are derived which aim at capturing the intra-annual dynamics as much as possible within a given area and lead to one image composite per season (each season covered by 3 months), and year during the observation period. They form the basis for the following products:

- The main Water and Wetness (WAW) product with defined classes of (1) permanent water, (2) temporary water, (3) permanent wetness and (4) temporary wetness.
- The additional expert product: Water & Wetness Probability Index (WWPI)

The products show the occurrence of water and indicate the degree of wetness in a physical sense, assessed independently of the actual vegetation cover and are thus not limited to a specific land cover class and their relative frequencies.

## 3. Data specifications

This chapter comprises an overview of all technical product specifications and definitions, including a list of EO (Earth Observation) and ancillary input data and file nomenclature.

### 3.1 Input data

A number of multi temporal and multi sensor high resolution (HR) optical and SAR imagery was used for the production of the HRL Water and Wetness and the WWPI secondary (expert) product.

Primary EO data sources used in production were from the USGS Landsat programme and Copernicus DWH HR\_IMAGE\_2012 datasets.

- Landsat seasonal composites LS-5, -6, -7 and -8
- (main indices: mNDWI, NDWI, NDVI)
- Sentinel-1A (10m spatial resolution)
- ENVISAT-ASAR Wide Swath (75m spatial resolution)

Additional ancillary datasets:

- Corine Land Cover 2012
- Riparian Zones (LCLU)
- EU-DEM (30m spatial resolution)
- Topographic Wetness Index (TWI)

## **3.2 Specification of Products**

### **3.2.1 Main classified Water and Wetness product**

The main Water and Wetness product provides a combined thematic information on water and wetness for the 2009-2015 period on the following classes:

- permanent water (e.g. rivers, lakes)
- temporary water (e.g. temporarily inundated areas)
- permanent wet areas (e.g. areas of permanently high soil moisture)
- temporary wet areas (e.g. areas of changing soil moisture)
- dry areas.

Table 1 below summarizes the detailed definitions for these classes.

**Table 1:** Definition of Water and Wetness classes

Code	Wetness/Water layer	Explanation	Examples
0	No water / no wet area	always <b>dry</b> (dry in at least 75% of all observations)	
1	Permanent water	always <b>water</b> (water in at least 80% of all observations)	<ul style="list-style-type: none"> <li>• Permanent inland lakes (natural)</li> <li>• Artificial ponds (permanent fish ponds, reservoir)</li> <li>• Natural ponds (permanent open water surfaces of inland or coastal wetlands)</li> <li>• Rivers</li> <li>• Channels (permanently with water)</li> <li>• Coastal water surfaces: lagoons, estuaries within the boundaries of the EEA coastline for analysis V2.</li> <li>• Liquid dump sites (permanent)</li> <li>• Water surfaces with floating vegetation where detectable with remote sensing techniques.</li> </ul>
2	Temporary water	alteration of <b>dry</b> and <b>water</b> or alteration of <b>wet</b> and <b>water</b> (water in >25% to 80% of all observations, with varying degrees of wet and dry; water dominates over wet)	<ul style="list-style-type: none"> <li>• Temporary water surfaces associated to permanent water bodies (e.g. oscillating shoreline areas of reservoirs)</li> <li>• Temporary natural (e.g. steppe) lakes and temporary artificial lakes (e.g. cassettes of fishponds)</li> <li>• Intermittent rivers and temporarily flooded river banks</li> <li>• Flood areas</li> <li>• Water-logged areas</li> <li>• Temporary flooded agricultural fields e.g. rice fields</li> <li>• Intertidal areas</li> <li>• Temporarily inundated areas (due to snow melt, floods or rain)</li> </ul>
3	Permanently wet areas (wetness)	always <b>wet</b> (wet in at least ~60% of all observations, region dependent)	<ul style="list-style-type: none"> <li>• Reeds</li> <li>• Peat land</li> <li>• Inland and coastal wetlands (incl. salt marshes)</li> </ul>
4	Temporary wet area (wetness)	alteration of <b>dry</b> and <b>wet</b> (wet in >25% to 60% of all observations, with varying degrees of wet and dry; wet dominates over dry)	<ul style="list-style-type: none"> <li>• Inland saline marshes</li> <li>• Intermittent wetlands</li> <li>• Temporary wet agricultural fields</li> <li>• Temporary wet meadows</li> </ul>
254	unclassifiable	No satellite image available, clouds, shadows, snow and glaciers	
255	Outside production unit	Sea and ocean, land area outside the production unit	



While, the 2015 class “permanent water” is largely comparable to the 2012 HRL on “permanent water bodies”, a direct comparison of the two layers is not possible, because the 2015 layer also includes the EO data that were used to produce the 2012 GIO water layer plus additional time steps (i.e. since 2009) and additional data within one year (i.e. seasonal information). Furthermore, the layer does not map “wetlands” according to their ecological concept, but areas of elevated soil moisture or water presence. The product therefore fully replaces the previous 2012 “water” and “wetland” products and should be understood as a baseline for future assessments and trends and may be used to derive probability / potential maps for “real wetlands”. It is available in full spatial resolution of 20m x 20m as well as aggregated to 100m x 100m spatial resolution in European projection ETRS LAEA, and in national projections.

Elements included and excluded from the production of the main HRL Water and Wetness product are listed in Table 2 as follows:

**Table 2:** Elements included or excluded from the production of the main HRL Water and Wetness

Elements to be included in the water & wetness product	Elements to be excluded from water & wetness product
<ul style="list-style-type: none"> <li>• Open water bodies (floating or emergent vegetation, only as far as possible) <ul style="list-style-type: none"> <li>○ permanent lakes, reservoirs, ponds</li> <li>○ rivers</li> </ul> </li> <li>• Temporary open water bodies (intermittent rivers, changing lake/reservoir levels)</li> <li>• Areas with a permanently high degree of soil moisture (no open water) as far as the vegetation cover permits. <ul style="list-style-type: none"> <li>○ inland wetlands (mires, bogs, fens, reed beds)</li> <li>○ coastal wetlands</li> </ul> </li> <li>• Areas with temporary high degree of soil moisture</li> <li>• Temporarily inundated areas (due to snow melt, floods or rain)</li> <li>• Wet agricultural fields, including rice fields and water-logged areas</li> <li>• Wet grasslands and pastures</li> <li>• Transitional coastal water bodies (lagoons, estuaries)</li> </ul>	<ul style="list-style-type: none"> <li>• Sea and ocean (border between sea water and fresh water in river estuaries and coastal lagoons is determined by “EEA Coastline for analysis V.2” dataset)</li> <li>• Permanent snow and glaciers</li> <li>• Small river channels and streams with widths less than approx. 30 to 40m (mixed pixel phenomenon)</li> <li>• Elements below the 20x20m MMU</li> </ul>

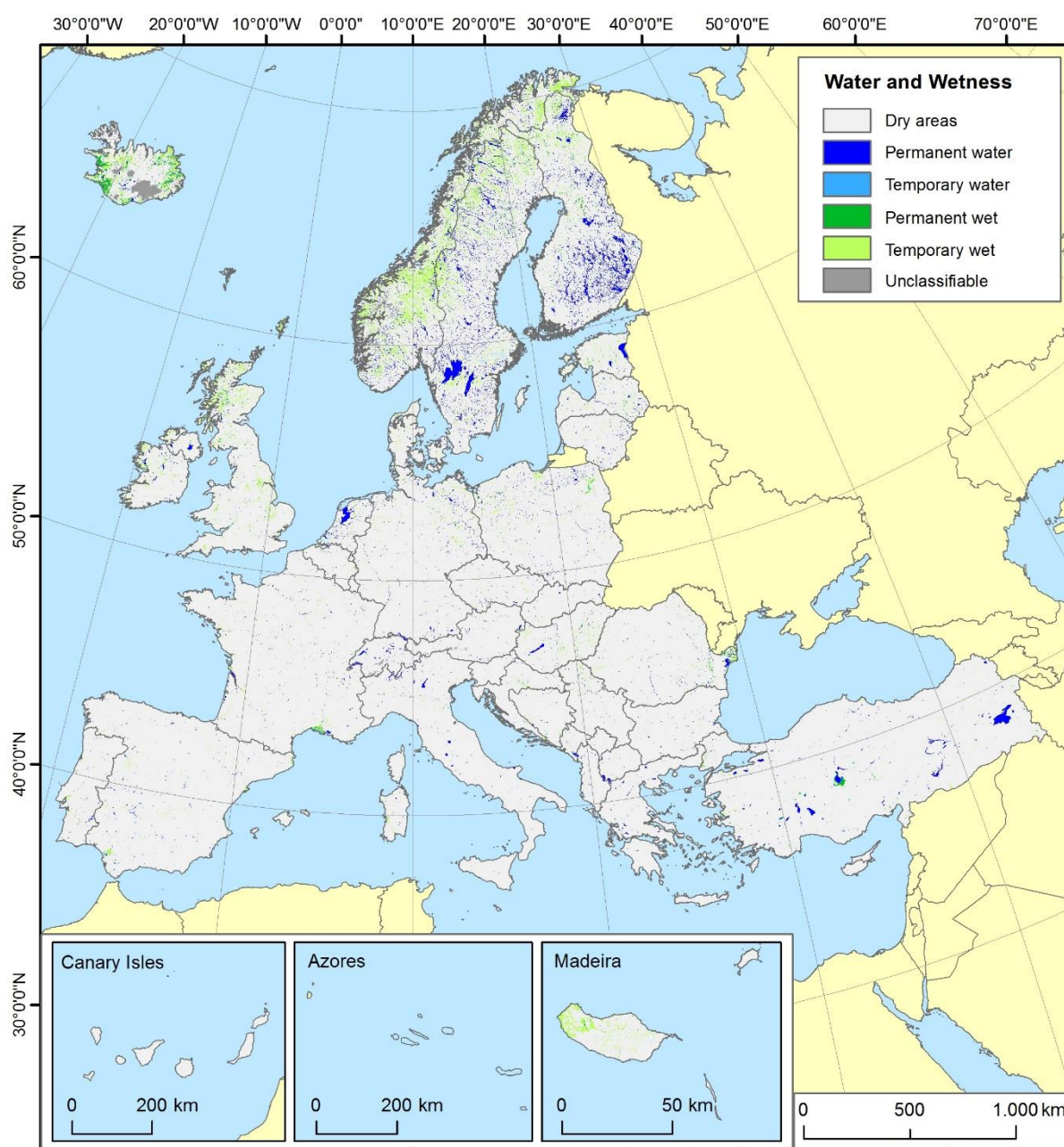
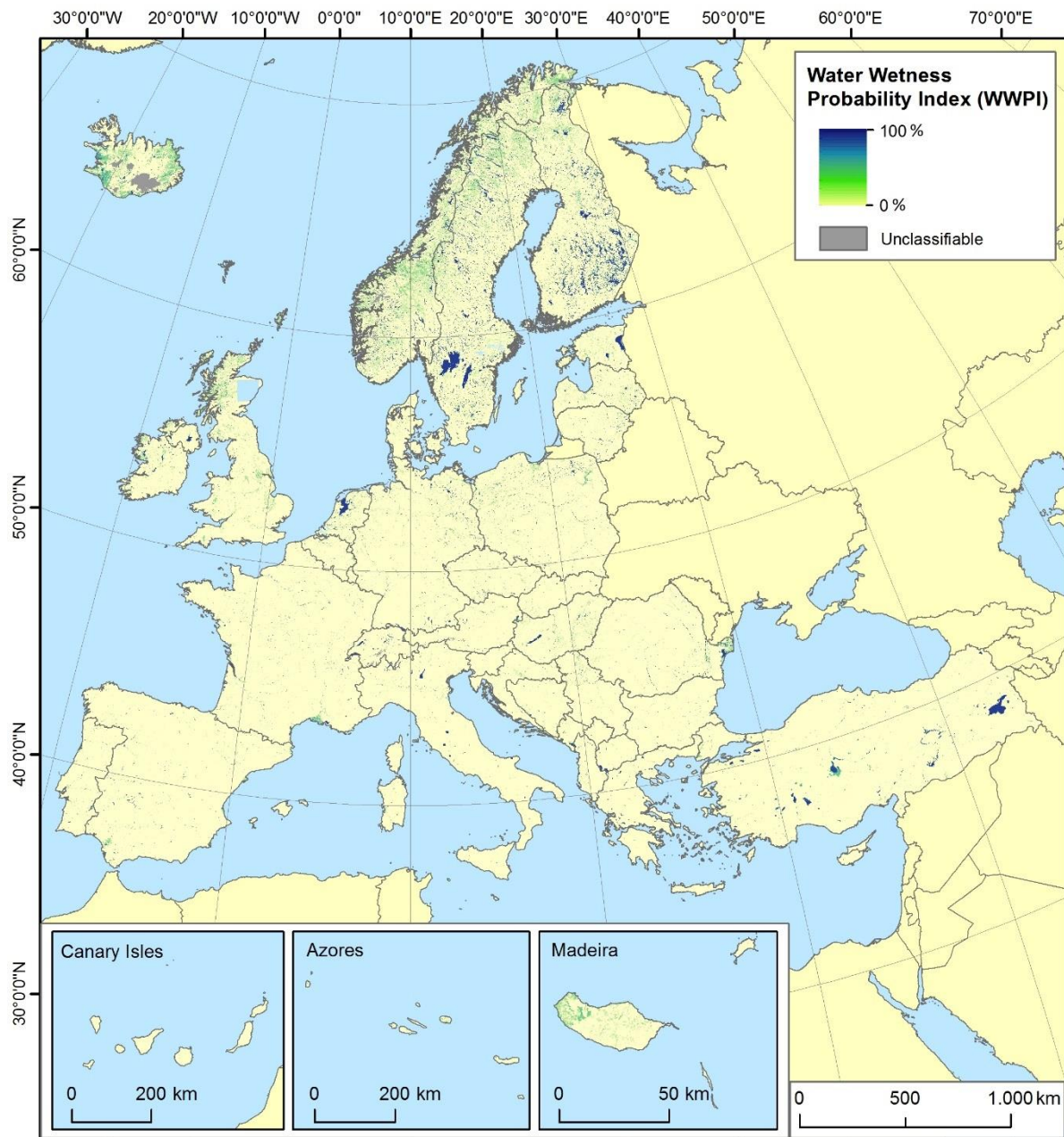


Figure 1: Overview on HRL 2015 Water and Wetness

### 3.2.2 Secondary product Water and Wetness Probability index (WWPI):

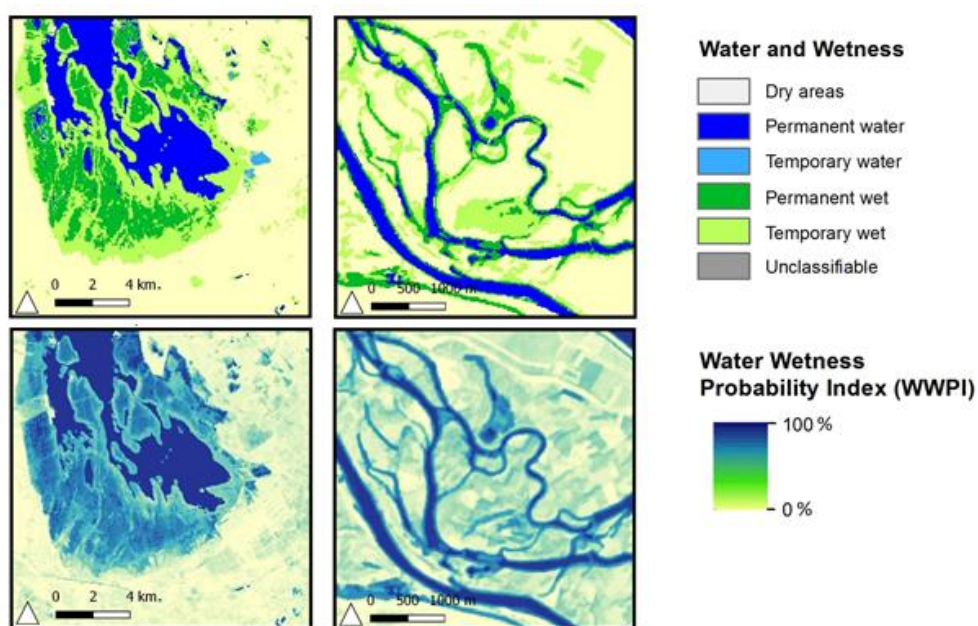
The “Water and Wetness Probability Index” (WWPI) layer is an additional product for expert users and indicates the occurrence of water and / or wet areas (with saturated soil moisture content) during a prolonged part of the year over a number of years. The index is derived from support layers calculated from seasonal composites in which each pixel in a given layer is classified as “dry”, “wet” or “(open) water”. Based on the same seasonal composites as applied for the classification of water and wetness, the WWPI is derived for each “column” of pixels in the stack. The WWPI is calculated according to the number of WATER and WET occurrences, the latter with a weighting factor of 0.75 (this value was confirmed after the analysis of the streamlining results), divided by the total number of valid observations (sum of WATER, WET and DRY occurrences). The resulting

product assembles the water and wet occurrence as an index on a scale between 0 (only dry observations) to 100 (only water observations).



**Figure 2:** Overview on the HRL 2015 Water and Wetness Probability Index  
Detailed examples from the Water and Wetness and the WWPI layers are shown below in Figure 3.





**Figure 3:** WWPI (left) and classified WAW product (right) at E048N27 (PAN streamlining site, Austria, Hungary, Slovakia, see also AD07).

### 3.2.3 Metadata

Metadata are provided together with the pan-European 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 interoperability of metadata. The standard for the metadata of EEA 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 at: <http://www.eionet.europa.eu/gis>.

INSPIRE mapping tables are provided for each product as Microsoft Excel tables specified Land Cover raster (Version 3) and Land Cover nomenclature application schemes (ISO 19123).

## 4. Methodology

The methodology applied for the production of the HRL Water and Wetness allows to derive water and wetness in a robust, reliable and reproducible way out of high resolution optical and SAR satellite images (Landsat-5, -7, -8 & Sentinel-1). The classification is performed for a time period of seven years from 2009 to 2015, applying 100 x 100 km tiles based on the EEA reference grid as production units.

The production is based on an unsupervised classification with subsequent visual improvement of classification results and derivation of water frequencies based on seasonal spectral composites and different biophysical indices such as e.g. NDVI, NDWI and NMDI.

The final result is a raster dataset of permanent and temporary water as well as permanent and temporary wet surfaces with a spatial resolution of 20 x 20m.

The main steps of production are described in the following sub-chapters.

## **4.1 Main production steps**

1. EO data pre-processing
2. In-situ/ancillary data access and preparation
3. Thematic processing:
  - Preparation of 100 x 100 km tiles based on the EEA reference grid as production units.
  - Generation of multi-seasonal image composites (2009-2015) per 100 x 100 km tile.
  - Mosaicking of respective indices to mosaics per 100 x 100 km tile.
  - Automated thresholding-based unsupervised classification of Water and Wetness dependent on regional properties.
  - Fusion of optical and SAR water and wetness frequencies.
  - Visual correction and supplementation of derived classification.
  - Generation of the WWPI.
  - Plausibility checks.
  - INSPIRE-compliant metadata and mapping tables.
4. Internal validation

### **4.1.1 Optical HR Data**

All Landsat scenes were atmospherically, topographically and geometrically corrected. Cloud and shadow masks were (semi-)automatically generated. Up to 28 seasonal composites were computed for each EEA tile using a combination of approaches such as maximum NDVI (Gutman et al., 1994<sup>1</sup>) or Haze Optimized Transformation (HOT) (Zhang et al., 2002<sup>2</sup>).

The optical classification was applied on the composites for each EEA tile using a dynamical threshold-based classifier. Therefore, about 25 spectral indices were computed and stacked for each composite. For water detection, spectral indices such as the Normalised Difference Water Index (NDWI) and its modified version mNDWI, as well as the Normalised Difference Vegetation Index (NDVI) were used among others. For wetness extraction, individual indices and thresholds were chosen dynamically from the classifier for each site. The most chosen indices were the

<sup>1</sup> Gutman, G.G., Ignatov, A.M., Olson, S., 1994. Towards better quality of AVHRR composite images over land: reduction of cloud contamination. *Remote Sens. Environ.* 50 (2), 134–148.

<sup>2</sup> Zhang, Y., Guindon, B., Cihlar, J., 2002. An image transform to characterize and compensate for spatial variations in thin cloud contamination of Landsat images. *Remote Sens. Environ.* 82 (2–3), 173–187.

Normalised Multiband Drought Index (NMDI), Tasseled Cap Brightness Index (TCBI), mNDWI, Red and SWIR spectral bands.

Due to the lack of wetland occurrences on hillslope areas the Topographic Wetness Index (TWI) was applied to exclude steep surfaces from classification. From the achieved water-, wetness- and dry frequencies the classification into water and wetness classes were processed by thresholding water and wet occurrences as suggested in the technical proposal and listed in Table 1.

#### **4.1.2 Thresholding**

In the streamlining phase (initial test production) parameters and thresholds were re-considered. Thresholds between temporary water and temporary wet areas in the main product were optimized. Water and wetness were determined by dynamic thresholding dependent on different regions and under consideration of neighbouring tiles. It was made sure that the identified threshold lies within a plausible value range of spectral index that indicates water or wetness. The value ranges were determined based on the physical characteristics of the indices (e.g. NDVI < 0 for water and NDVI  $\approx 0.4 \pm 0.1$  for wetness, NDWI  $\approx 0.4 \pm 0.1$  for water and  $\approx 0.0 - 0.3$  for wetness, mNDWI  $\approx 0.7 \pm 0.1$  for water and mNDWI < 0 for wetness).

#### **4.1.3 SAR data (Sentinel-1/Envisat ASAR WS)**

The Water and Wetness classification from SAR data was applied on water-, wetness-, and dry frequencies derived from the SAR time series. The workflow implemented for the production is based on the TU Vienna method for soil moisture retrieval (Pathe et al., 2009). In this method, the backscatter measurements are scaled, after normalization to a reference incidence angle, between the backscatter values observed at the historically driest and wettest observed conditions as described in the technical proposal. Because of the variability of the number of SAR observations and noise occurrence for different areas, the water frequency threshold for permanent water extraction varies for each EEA tile (Table 3). A non-local mean filter was applied to each seasonal frequency image to reduce speckle noise. To avoid the above-mentioned frequency variations, seasonal water masks were extracted dynamically from the filtered images.

#### **4.1.4 Fusion factor of SAR and optical EO data**

After deriving separate water and wetness masks from optical and SAR data the results were fused to obtain the main water and wetness product. The fusion was applied on a seasonal basis to avoid an over-classification from SAR frequencies. Since the Sentinel-1 water and wet frequencies are based on more observations (~6 S-1 observations/pixel/season) than the seasonal optical composites (best observation/pixel/season), the fusions are applied with different weights. Therefore, masks are only fused at areas where a certain probability of water and wetness occurrence derived from optical imagery is given. Especially for wetness fusion different soil-type-

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<sup>3</sup> Pathe et al. (2009): Using ENVISAT ASAR GlobalMode Data for Surface Soil Moisture Retrieval Over Oklahoma, USA. IEEE Transactions on Geoscience and Remote Sensing, 47(2).

sensitive, optical-biophysical indices were considered in the weighting. The final classification was carried out based on thresholds as listed in Table 1.

#### **4.1.5 Weighting factor**

The WWPI applied initially a weighting factor of 0.75 to wet instances for optical and SAR EO data, in order to account for the difference of open water and wet soils. This factor of 0.75 gave reasonable results for the streamlining sites and was applied for full production.

## **4.2 Boundary datasets**

### **4.2.1 Delineation of the production area**

For the Water and Wetness layer, a hybrid version of the EBM v11 and the GISCO boundaries was produced by the service providers and initially applied to define the mapping area. However, as considerable land mass would have been omitted, coastal land areas extending beyond this boundary were retained as good as possible, based on the 7-year multitemporal EO detection of land. Therefore, the land-sea boundary of the Water and Wetness layers is unique and differs from that of the other HRLs while the internal land boundary to non EEA39 member states is congruent with the other HRLs.

### **4.2.2 Delineation of sea water and fresh water**

While sea water is classified with the code 255 (outside the production unit), fresh water is classified as code 1 or 2 (permanent or temporary water). As there are significant areas where an unambiguous distinction of fresh water and sea water cannot be made (e.g. large river estuaries and coastal lagoons) a clear rule for delineation of these units had to be defined. In agreement with the EEA, the SP integrated the dataset “EEA coastline for analysis V2” to delineate sea water and fresh water. It is applied in the following way:

- At the mouth of rivers and within coastal inlets, water is classified with code 1 or 2 when located within the “EEA coastline for analysis V2” dataset. Beyond this limit all water is classified with code 255.
- The “EEA coastline for analysis V2” dataset is not meant to define the coastline itself (i.e. to delineate land and sea areas), since it would exclude land in some areas. Hence, this dataset has no effect on detected land areas located beyond the coastline boundary (codes 0, 3 and 4).

As the “EEA coastline for analysis V2” dataset does not cover the DOMs (French overseas territories), the EBM boundary V.11 was applied to delineate fresh water and sea water in estuaries and river mouths.

## 5. Detailed product description

**Table 3:** Table of Products

No	Name of product	Rfr. year	Abbreviation	Pixel size	Project ion	MMU	Re-projected	Aggregated	Classified feature	Raster coding
1	Water & Wetness Probability Index	2015	WWPI	20m	LAEA	20m	No	No	Water and wetness probability index	Water & Wetness Probability Index (0 – 100), 254: unclassifiable (no satellite image available, or clouds, shadows, or snow), 255: sea water/ outside the production unit
2	Water & Wetness product	2015	WAW	20m	LAEA	20m	No	No	Temporary and permanent wetness and water	0: no water/no wet areas 1: Permanent water 2 Temporary water 3 Permanently wet area 4 Temporary wet areas 254: unclassifiable (no satellite image available, or clouds, shadows, or snow), 255: sea water/outside the production unit
3	Water & Wetness product	2015	WAW	100m	LAEA		No	Yes		



## 6. Aggregation concept

The 20m classified Water and Wetness layer is aggregated to 100m for the complete European LAEA layer according to the procedure described in the following.

For the aggregation of the 20m classified product to a 100m raster in a concise way, all underlying 20m cells are considered. A majority rule is applied to ensure that the most appropriate class value is given to the 100m cell, considering all underlying 25 pixels that are covered by the 100m raster cell. The 100m cell receives the code of the majority of 20m pixels, under consideration of the fraction of valid and un-valid pixels and equality.

### Case 1: Majority of one pixel value:

The 100m cell receives the value of the 20m pixels that occurs the most within a 100m cell.

For example:

- 15 pixels have the value 3 (permanent wet)
- 7 pixels have the value 2 (temporary water)
- 3 pixels have the value 254 (unclassifiable)

The aggregated 100m cell is assigned the value 3 (permanent wet).

### Case 2: Equality of pixels values:

It is possible that the same amount of different pixel values occurs within one 100m cell. This may be true for two or more values concurrently. In case of equality (i.e. the same amount of 20m pixels values) the following rules shall be applied:

- In case of equality, the permanent water and wetness classes (class 1 and 3) shall be preferred over the temporary classes (class 2 and 4).
- In case of equality between permanent classes (class 1 and 3) or equality between temporary classes (class 2 and 4) water shall be preferred over wetness.
- In case of equality all water and wetness classes (class 1-4) shall be preferred over dry (class 0).
- In case of equality all water and wetness classes shall be preferred over classes 254 (unclassifiable) and 255 (no data).
- In case of equality class 0 (dry) shall be preferred over 254 (unclassifiable) and 255 (no data).
- These rules also apply in case of equality of 3 or 4 classes (e.g. 6 pixels of class 1, 6 pixels of class 2, 6 pixels of class 4 and 1 pixel of class 255).

Justification for these rules in case of equality of pixel values:

- According to the ETC quality checks, the most reliable classifications (i.e. the classes with the highest users accuracy = lowest commission errors) are preferred.
- To avoid that omissions in the 20m layer, which are a known limitation of the layer, are reproduced or multiplied in the aggregated layers, all water and wetness classifications are preferred over dry (class 0) or the classes 254 (unclassifiable) and 255 (no data).

The following matrix (Figure 4) shows the rules defined in case of equality of 20m pixel values within a 100m cell in a structured way.

		class						
		0	1	2	3	4	254	255
class	0		1	2	3	4	0	0
	1			1	1	1	1	1
	2				3	2	2	2
	3					3	3	3
	4						4	4
	254							255
	255							

**Figure 4:** Matrix of aggregation rules in case of equality of 20m pixel values within a 100m cell

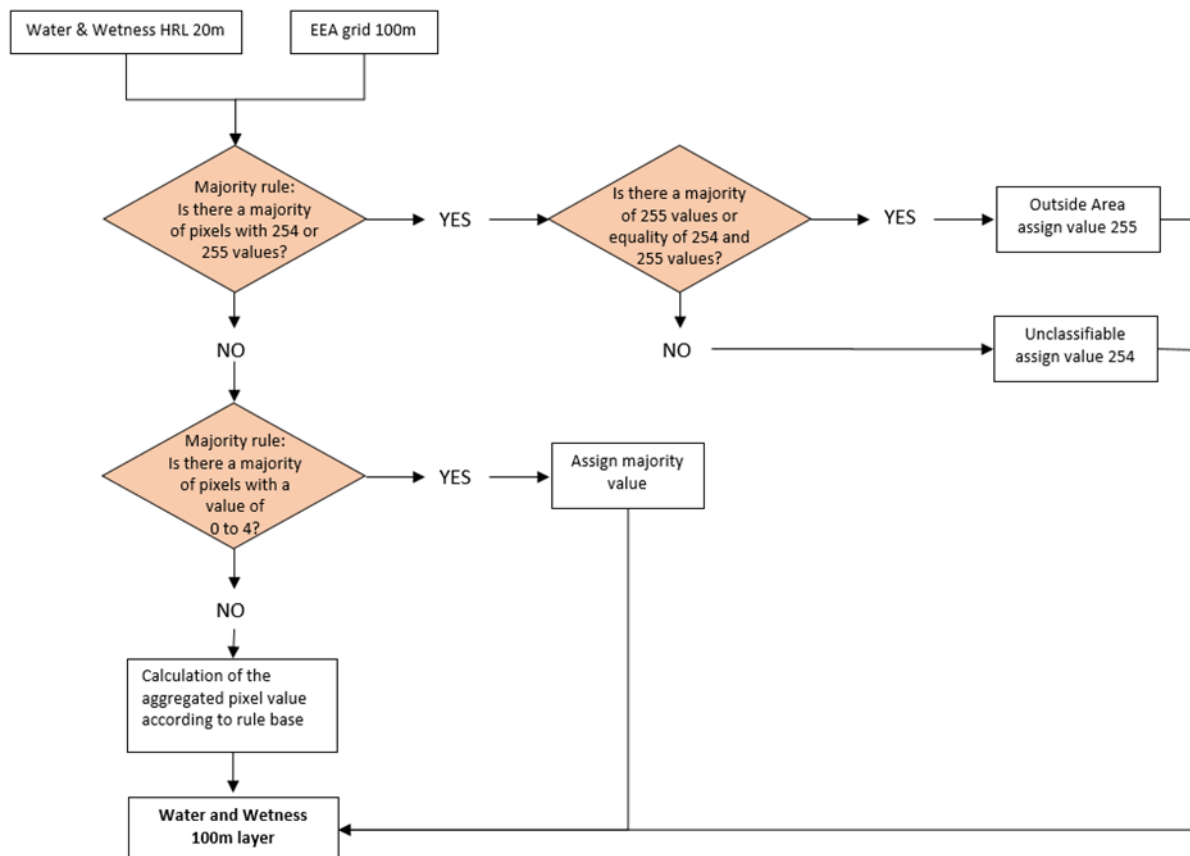
To apply the matrix one have to select the two class codes of equal number of pixels, one from the vertical and one from the horizontal row/column. The cell where the row/column lines cross each other indicates the class code (pixel value) of the corresponding 100m cell.

### Workflow:

The 20m Water and Wetness Probability Index layer (WWPI) is also aggregated to 100m for the complete European LAEA layer. For the aggregation of this product to a 100m raster in a concise way, all underlying 20m cells are considered. First a majority rule is applied for the non-valid value 255, meaning that if a majority of 20m cells have the code 255, then this value is used for the aggregated 100m cell. Should secondly the majority be 254, then this value is given to the 100m cell. In all other cases the 100m cell values are calculated by applying the mean value from all underlying 20m cells with values reaching from 0 to 100.

For the national products, the reprojection from LAEA to the individual national projections is performed first, followed by the subsequent aggregation of the 20m layers according to the above described methodology.

An overview of the technical workflow is illustrated in Figure 5:



**Figure 5:** Technical workflow of the aggregation process

## 7. Product Accuracy

### 7.1 Thematic accuracy

The thematic accuracy assessment is carried out for the main HRL Water and Wetness product. The target is class specific as shown below and the expected thematic accuracy depends on the class:

- Permanent water: target accuracy 85%
- Temporary water: target accuracy 80%
- Permanent wet areas: target accuracy 80%
- Temporary wet areas: target accuracy 80%
- Dry areas: target accuracy 85%

These thematic accuracies are to be achieved within each biogeographic region of Europe. A quantitative approach was used based on a set of stratified systematic point samples

The accuracy assessment took place on three levels:

- Internal validation by Service Providers as part of the delivery report.
- External assessments on samples of the 20m products in European Projection by ETC after each intermediate delivery (Streamlining phase and first 60%)
- Full independent validation of the European product after production end (final 100%).

While the additional products are not part of the thematic accuracy assessment, at least technical checks are applied on the additional products (see next section).

As the validated product is derived from multi-temporal and multi-sensor EO-data a single HR/VHR scene for checking the thematic accuracy was not sufficient. Hence, the ETC combined the temporary and permanent water classes to one water class and the temporary and permanent wet areas to one wet class to quantify possible omission errors in the product.

## 7.2 Technical checks

The delivered HRL products were subject to a number of internal and external technical checks. The following table shows the controls that were made for each dataset.

**Table 4:** List of internal technical checks made before delivery of the products

Control	Description
Readability of dataset	Dataset opened in an appropriate GIS
Nomenclature	File naming in accordance with specifications
Completeness of delivered files	Files to be provided: <ul style="list-style-type: none"> <li>- .tif (raster file)</li> <li>- .tfw (GeoTIFF world file)</li> <li>- .ovr (pyramids file)</li> <li>- .dbf (raster attribute table)</li> <li>- .aux.xml (raster statistics)</li> <li>- .xml (metadata)</li> <li>- .clr (ArcGIS colormap)</li> </ul>
INSPIRE compatible metadata	Check INSPIRE consistency of metadata file
No gaps	Check that no gaps (e.g. NoData values are within the land area)
Projection	Check correct projection and datum: EPSG:3035 ETRS89 Lambert Azimuthal Equal-Area projection coordinate reference system
Pixel type	Check pixel type: 8bit Unsigned
Compression	LZW compression
Pixel size	20m pixel size

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Raster values	Only valid raster values: 0;1;2;3;4;254;255
Completeness	Check that all tiles have been merged to the mosaic
Look and feel	Check the overall appearance of the raster layer

## **Annex I: File naming convention**

### **File naming for HRL raster products and associated reports**

All letters are in small (not capital) letters, and no points (".") and/or minus ("-") within file names.

The proposed file name convention is applied both to raster HRLs and associated reports throughout the processing chain. It is based on the following HRL descriptors:

#### **File naming for HRL products (raster and vector)**

The proposed file naming convention is applied both to raster and vector (no difference in file name, only "SWF" product is vector) HRLs and associated reports throughout the processing chain. The file naming is slightly different for internal deliveries during the production phase, and for final products.

All letters are in small (not capital) letters, and no points (".") and/or minus ("-") within file names.

The file naming convention is based on the following descriptors:

THEME	YEAR	RESOLUTION	EXTENT	EPSG	VERSION	
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#### **THEME:**

- 3 letter abbreviation for main products (green)
- 5 letter abbreviation for additional and expert products (orange)

#### **REFERENCE YEAR**

- in four digits (e.g. 2015)
- Change products in four digits (e.g. 0609)

#### **RESOLUTION**

- Four-digit (020m and 100m)

#### **EXTENT**

- 2-digit country code for country deliveries in national projection
- "eu" for all deliveries in European Projection (partial and full lot mosaics)

#### **EPSG**

- 5-digit EPSG code (geodetic parameter dataset code by the European Petroleum Survey Group)
- "03035" for the European LAEA projection

#### **VERSION (only for final deliveries)**

- 4-digit qualifier of the version number, starting with "V1\_1" for a first full final version, and allowing to capture re-processing/calculation of small changes as

("V1\_2", "V1\_3" etc.). In case of major changes, a second version should be used ("V2\_1")

**Table 5:** Table of file naming conventions

Descriptor	To be written as	Meaning	Comments
THEME	WAW	Wetness and Water product	Main HRL Lot 4 product
	WWPI	Wetness and Water Probability Index	Additional HRL Lot 4 product
REFERENCE YEAR	2012	Reference year 2012 (+/- 1 year)	
	2015	Reference year 2015 (+/- 1 year)	
RESOLUTION	020m	20m spatial (pixel) resolution	
	100m	100m spatial (pixel) resolution	
EXTENT	al	Albania	2-letter abbreviation for the country (in national projections), and "eu" for deliveries in European projection
	at	Austria	
	ba	Bosnia and Herzegovina	
	be	Belgium	
	bg	Bulgaria	
	ch	Switzerland	
	cy	Cyprus	
	cz	Czech Republic	
	de	Germany	
	dk	Denmark	
	ee	Estonia	
	es	Spain (including Andorra)	
	eu	European Projection mosaic deliver	
	fi	Finland	
	fr	France	
	gb	United Kingdom	
	gf	French Guiana	
	gp	Guadeloupe	
	gr	Greece	
	hr	Croatia	
	hu	Hungary	
	ie	Ireland	
	im	Isle of Man	
	is	Iceland	

Descriptor	To be written as	Meaning	Comments
	it	Italy	
	li	Liechtenstein	
	lt	Lithuania	
	lu	Luxembourg	
	lv	Latvia	
	me	Montenegro	
	mk	Macedonia, FYR of	
	mq	Martinique	
	mt	Malta	
	nl	Netherlands	
	no	Norway	
	pl	Poland	
	pt	Portugal	
	re	Réunion	
	ro	Romania	
	rs	Serbia	
	se	Sweden	
	si	Slovenia	
	sk	Slovakia	
	tr	Turkey	
	xk	Kosovo	
	yt	Mayotte	
EPSG	e.g. 03035	LAEA (European Projection)	5-digit EPSG code (geodetic parameter dataset code by the European Petroleum Survey Group) <a href="http://www.epsg-registry.org/">http://www.epsg-registry.org/</a>
VERSION (only for final delivery)	V1_1	First full final version	4-digit qualifier of the version number, starting with "V1_1" for a first full final version, and allowing to capture re-processing/calculation of small changes as ("V1_2", "V1_3" etc.). In case of major changes a second version should be used ("V2_1")
	V1_2	Re-delivery of first full final version with small changes	
	V2_1	Second full final version	
	etc	etc	



## Annex II: File format specification

Raster products are delivered as GeoTIFF (\*.tif) with world file (\*.tfw), pyramids (\*.ovr), attribute table (\*.dbf) and statistics (\*.aux.xml). Each product is accompanied with INSPIRE-compliant metadata in XML format and an INSPIRE Mapping Table.

In addition, for national products a PDF is to be delivered providing CRS information, including details of parameters used to transform to ETRS89 LAEA projection as in the following example from Hungary. The pdf should be named as follows: CRS\_Information\_Sheet\_<country 2-letter ISO code>, e.g. CRS\_Information\_Sheet\_BG.pdf.

**Table 6:** CRS Information Sheet Structure

<b>National</b>		
Datum		HD72 (EOV - Egységes Országos Vetületi rendszer)
	type	geodetic
	valid area	Hungary
Prime meridian		Greenwich
	longitude	0°
Ellipsoid		IUGG GRS 1967 (International 1967)
	semi major axis	6 378 160.0 m
	inverse flattening	298.2471674
Projection		Hotine Oblique Mercator (EOV proxy)
	latitude of projection center	47°08'39.817392"
	longitude of projection center	19°02'54.858408"
	azimuth of initial line	90°00'00"
	scale factor on initial line	0.99993
	false easting	650 000 m
	false northing	200 000 m
<b>European</b>		
Datum		ETRS89 (European Terrestrial Reference System 1989)
	type	geodetic
	valid area	Europe / EUREF
Prime meridian		Greenwich
	longitude	0°
Ellipsoid		GRS 80 (New International)
	semi major axis	6 378 137 m
	inverse flattening	298.257222101
Projection		Geographic (Ellipsoidal Coordinate System)
<b>Datum shift parameters used</b>		
Operation method		Bursa-Wolf (PositionVector)
	geocentric X translation	+52.684 m
	geocentric Y translation	-71.194 m
	geocentric Z translation	-13.975 m
	rotation X-axis -	0.312"
	rotation Y-axis -	0.1063"
	rotation Z-axis -	0.3729"
	correction of scale -	1.0191 ppm

### Annex III: Detailed product tables

**Table 7:** Detailed specifications for HRL Water and Wetness main product

<b>Product:</b> Water and Wetness product
<b>Geometric resolution (Scale)</b> Pixel resolution 20m x 20m and 100m x 100m
<b>Geographic projection / Reference system</b> European Terrestrial Reference System 1989 (ETRS89)
<b>Geometric accuracy (positioning accuracy)</b> Less than half a pixel. According to ortho-rectified satellite image base delivered by ESA (IMAGE2015).
<b>Thematic accuracy (in %) / quality method</b> Quantitative (stratified random points sample compared to external datasets) The thematic accuracy expected depends on the class: <ul style="list-style-type: none"> <li>○ Permanent water: target accuracy 85%</li> <li>○ Temporary water: target accuracy 80%</li> <li>○ Permanent wet areas: target accuracy 80%</li> <li>○ Temporary wet areas: target accuracy 80%</li> <li>○ Dry areas: target accuracy 85%</li> </ul> The thematic accuracy will be assessed by using the inclusion / exclusion list (i.e. land cover classes) as a proxy for each of the 5 classes.
<b>Data Type</b> 8 bit unsigned Raster, compressed with LZW
<b>Minimum Mapping Unit (MMU)</b> 400 m <sup>2</sup>
<b>Raster coding (Thematic pixel values)</b> <ul style="list-style-type: none"> <li>• 0 no water/no wet areas</li> <li>• 1 Permanent water</li> <li>• 2 Temporary water</li> <li>• 3 Permanently wet area</li> <li>• 4 Temporary wet areas</li> <li>• 254: unclassifiable (no satellite image available, or clouds, shadows, or snow),</li> <li>• 255: Sea water and area outside the production unit</li> </ul>
<b>Metadata:</b> XML metadata files are to be produced according to INSPIRE metadata standards
<b>Delivery format</b> Geo-Tiff accompanied by INSPIRE Mapping tables in .xlsx format








**Table 8:** Detailed specifications for HRL Water and Wetness Probability Index 2015

<b>Product:</b>	HRL Water and Wetness Probability Index 2015 (used for production of the main product, and provided as additional product for expert users)
<b>Geometric resolution (Scale)</b>	Pixel resolution 20m x 20m
<b>Geographic projection / Reference system</b>	European Terrestrial Reference System 1989 (ETRS89)
<b>Geometric accuracy (positioning accuracy)</b>	Less than half a pixel. According to ortho-rectified satellite image base delivered by ESA (IMAGE2015).
<b>Thematic accuracy (in %) / quality method</b>	The thematic accuracy assessment will be made on the main Water & Wetness product, while the WWPI is only an additional product for expert users.
<b>Data Type</b>	8 bit unsigned Raster, compressed with LZW
<b>Minimum Mapping Unit (MMU)</b>	20 m
<b>Raster coding</b>	WWPI: Water & Wetness Probability Index (0 – 100), 254: unclassifiable (no satellite image available, or clouds, shadows, or snow), 255: sea water and area outside the production unit
<b>Metadata:</b>	XML metadata files are to be produced according to INSPIRE metadata standards
<b>Delivery format</b>	GeoTIFF accompanied by INSPIRE Mapping tables in .xlsx format

## Annex IV: Color palette & attribute fields

The RGB color palettes were used as defined in the tender phase.

**Table 9:** Defined RGB colors for the depiction of the Water and wetness classes.

Class Code	Class Name	Red	Green	Blue	
0	no water/no wet areas	255	255	255	
1	Permanent water	0	77	168	
2	Temporary water	0	112	255	
3	Permanently wet	0	197	255	
4	Temporary wet	115	255	223	
254	unclassifiable	153	153	153	
255	Sea water and area outside the production unit	0	0	0	

Both the GIS files specifying the color palettes (.clr file), and a table (.txt file) listing the RGB values for possible non-GIS products and material are provided.

Formats provided:

- \*.clr for GIS color palettes
- \*.txt for other purpose