Copernicus Initial Operations 2011-2013 - Land Monitoring Service Local Component: Riparian Zones

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Applicable Documents

ID	Document Name / Content
AD01	Tender Specifications "Copernicus Initial Operations 2011-2013 - Land Monitoring Service Local Component: riparian zones"; EEA/MDI/14/001
AD02	Framework Contract EEA/MDI/14/001 incl. Clarification to Tender Specifications of 12/08/2014
AD03	Specific Contract No. 3436/R0-GIO/B2014/EEA.55814 incl. Annex 1: Request for Service

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Abbreviations & Acronyms

AoI	Area of Interest
CLC	CORINE Land Cover
CSW	Catalogue Service for the Web
DEM	Digital Elevation Model
DWH	Data Warehouse of the European Space Agency
EC	European Commission
EEA	European Environment Agency
EO	Earth Observation
ESA	European Space Agency
EU	European Union
EU-DEM	European Digital Elevation Model
EU-HYDRO	European Hydrography Layer
EUNIS	European Natural Information System
GIO	GMES Initial Operations
HR	High Resolution
HRL	High Resolution Layer
IM.D	Imperviousness Density
JRC	Joint Research Centre of the European Commission
LC/LU	Land Cover/Land Use
LUCAS	Land Use/Cover area Frame Statistical Survey
LUZ	Large Urban Zone
MAES	Mapping and Assessment of Ecosystems and their Services
MMU	Minimum Mapping Unit
MMW	Minimum Mapping Width(s)
N/A	not applicable
NDVI	Normalised Difference Vegetation Index
OSM	Open Street Map
RZ	Riparian Zones
SPOT	Satellite Pour l´Observation de la Terre
T.C:D./TCD	Tree Cover Density
UA	Urban Atlas
VHR	Very High Resolution
WMS	Web Map Service

1. Introduction

This document provides a **comprehensive Riparian Zones LC/LU nomenclature guideline**, which is covering the detailed description of all MAES level 4 classes, their geographic characteristics, available input datasets and relevant methods to interpret the respective classes.

2. LC/LU product description

The Riparian LC/LU product is providing a detailed LC/LU dataset for areas along a buffer zone of selected rivers covering EEA39. The area to be mapped is approximately 525.000 km² and comprised of a merge of selected rivers with Strahler level 3 to 8 with different buffer sizes derived from the EU-HYDRO dataset and the area of the Pan-EU Flood Hazard Map produced by JRC for the 100-year return period (Alfieri et. al. 2013) with 100m grid size (see Figure 1).

The mapping of land cover and land use along a buffer zone of selected areas has as main objective to support the Mapping and Assessment of Ecosystems and their Services (MAES)[1], as part of the EU Biodiversity Strategy to 2020.
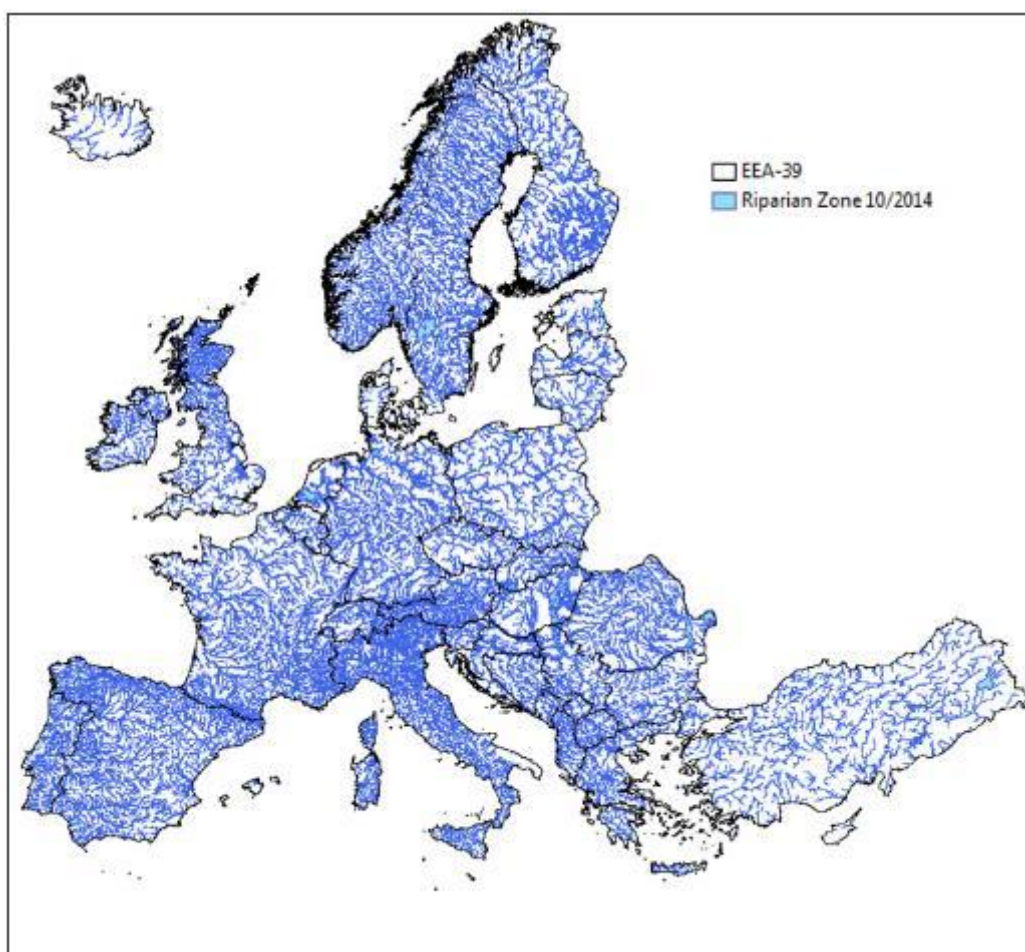

Figure 1: Riparian LC/LU AOI

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[1] European Union (2013, 2014): Mapping and Assessment of Ecosystems and their Services, An Analytical Framework for Ecosystems Assessment under Action 5 of the EU Biodiversity Strategy to 2020, Technical Report-2013-067 and Technical Report-2014-080

Table 1: Product specifications

Product Specifications of the Land Cover and Land Use Product
Product Title / Content
Riparian Zones: Land Cover and Land Use Classification within buffer zone of selected rivers.
Product Short Name
LCLU
Product Definition
The Riparian LC/LU product is providing a detailed LC/LU dataset for areas along a buffer zone of selected rivers covering EEA39.
Input Data Sources

1.) Final Riparian Zones AoI *rpz_europe_rz_aoi_v07.shp*
2.) DWH_MG2b_CORE_03 - Optical VHR2 coverage over EU 2011-2013 and Riparian zones
    • ca. 3,600x SPOT-5 HRG (2.5m) & ca. 400x SPOT-6 (1.5m)
    • Additional CORE_03 gap-filling VHR2 data as becoming available in the course of the project
Additional data:
    • CLC 2006/2012; Urban Atlas 2006/2012; GIO HR Layers Imperviousness Degree and Tree Cover Density; DWH_MG2_CORE_01 Coverage 1 (IRS 20m) & 2 (RapidEye, 5m); Landsat-8, National ortho-photo WMS, Google Earth Pro, Bing Maps; Numerous reference data sources (see chapter 4)

Methodology
Semi-automatic LC/LU classification of 1.5m SPOT-6, 2.0m Pléiades and 2.5m SPOT-5 HRG satellite data from the DWH_MG2b_CORE_03 dataset (Optical VHR2 coverage over EU 2011-2013 and Riparian zones) and computer assisted visual refinement. Visual interpretation of LC/LU classes follows the pre-defined nomenclature on the basis of MAES typology of ecosystems (Level 1 to Level 4) and Corine Land Cover. Subsequently intersection of classification results with additional data (CLC 2006/2012, GIO HRL Imperviousness Degree, GIO HRL Tree Cover Density, Urban Atlas 2006/2012).
Geographic Coverage
EEA-39 (without Azores, Canarias and French DOMs) plus Andorra and Vatican City: ca. 5,825,500 km²

Geographic Bounding Box

	North **71.185**	
West **-24.532**		East **44.819**
	South **34.562**	

Temporal Reference
2010 – 2013 (2014)
Geometric Resolution / Equivalent Scale
1:10.000
Minimum Mapping Unit
0.5 ha
Minimum Mapping Length
N/A
Minimum Mapping Width
10m

3. Riparian LC/LU legend (MAES legend)

The Nomenclature for the LC/LU dataset is in accordance with the MAES levels 1 to 3 legend (Annex 9 to the Tender Specifications – Nomenclature, Ref. EEA/MDI/14/001).

MAES L1	Description
1. Urban	The definition of urban areas in general is under the Urban Atlas guidelines. The MAES level 2 separates the urban fabric from transportation network, construction & dump sites and green urban areas (including sports facilities). On MAES level 3, the urban fabric is distinguished into density classes. The MAES level 4 further differentiates the urban fabric (continuous, urban dense, low dense, industrial or commercial) and transport infrastructures (road network, port areas and airports), extraction mine, dump and construction sites and land without current use.
2. Croplands	On MAES Level 2, classes are defined according to the CORINE nomenclature (CORINE Technical Addendum 2000). Three main classes are separated: • Arable Land: Land under a rotation system used for annually harvested plants and fallow lands, which are permanently or not irrigated. It includes flooded crops, such as rice fields and other inundated croplands. • Permanent crops: All surfaces occupied by permanent crops, not under a rotation system. It includes ligneous crops of standard cultures for fruit production, such as extensive fruit orchards, olive groves, chestnut groves, walnut groves, shrub orchards, vineyards and some other specific low-system orchard plantation, espaliers and climbers. • Heterogeneous agricultural areas: Areas of annual crops associated with permanent crops on the same parcel, annual crops cultivated under forest trees, areas of annual crops, meadows and/or permanent crops which are juxtaposed, landscapes in which crops and pastures are intimately mixed with natural vegetation or natural areas. Class definitions on Level 3 are CORINE level 3 classes extended by the class "Greenhouses" and T.C.D. values for class "Agro-forestry". The CLC classes "Rice fields" and "Irrigated arable land" are merged to one single class. On level 4, a distinction of orchards into "extensively managed high stem fruit trees" and "low stem plantations of fruit trees and berries" separates ecologically valuable, extensively cultivated fruit orchards from intensively used plantations.
3. Woodland and forest	MAES 2 differentiates main types of forests: • Broadleaved forest: Vegetation composed mainly of trees, including shrub and understoreys, where broadleaved species predominate and represent more than 75% of the pattern. • Coniferous forest: Vegetation composed mainly of trees, including shrub and understoreys, where coniferous species predominate and represent more than 75% of

	the pattern.
	• Mixed forest: Vegetation composed mainly of trees, including shrub and understoreys, where neither broadleaved nor coniferous species predominate. The share of coniferous or broadleaved species does not exceed 25% in the canopy closure.

Transitional woodlands scrub and damaged forest by fire are also included in MAES 2.

The differentiation of Woodland and Forest on Level 3-4 is mainly oriented along aggregated EUNIS habitat classes. Main classes are riparian and fluvial forest, swamp forest, other natural and semi-natural forest and highly artificial forest (e.g. plantations), following the EUNIS classification scheme.

Tree Cover density is included as an attribute. |
| **4. Grassland** | MAES level 2 differentiates managed grasslands and natural grasslands.

• Managed or agricultural grasslands are intensively managed areas (selection of grasses, intensive cutting and grazing, fertilization, etc.) for the production of grass. From a land use point of view, in this case, grass is a crop in the same way as cereals or others.
• Natural grasslands include alpine meadows and other semi-natural grasslands included in Habitat Directive (except mountain and lowland hay meadows).

Semi-natural grasslands are frequently associated with trees and scrubs (MAES 3 main differentiation).

A distinction between dry and mesic grasslands and alpine grasslands are included in MAES 4. |
| **5. Heathland and scrub** | The MAES level 2-3 separates Moors and Heathland from areas with sclerophyllous vegetation, following the CORINE Land Cover guidelines.

The MAES level 4 further distinguishes Heathlands and Moorlands from Other scrub land. |
| **6. Sparsely vegetated land** | Differentiation of MAES Level 2 into two categories: "Sparsely vegetated areas" and "Bare soil, rock, perennial snow & ice" in order to separate vegetation classes from non-vegetated surfaces.

On Level 3, a further split of non-vegetated surfaces into class 6.2.1 Beaches, dunes, sands and 6.2.2 Bare rocks, burnt areas, glaciers and perpetual snow is performed.

Further differentiation in MAES level 4 into the classes 6.2.2.1 Bare rocks & rock debris, 6.2.2.2 Burnt Areas (except burnt forest) and 6.2.2.3 Glaciers & perpetual snow. |
| **7.Wetland** | Inland marshes and peat bogs are included in MAES Level 2.

MAES Level 3 differentiates between inland freshwater marshes and inland saline marshes.

In MAES Level 4 peat bogs are divided in exploited and unexploited. |

8.Lagoons, coastal wetlands and estuaries	In MAES Level 2 Coastal waters are distinguished into maritime wetlands (coastal salt marshes according to the EUNIS habitat classification, salines and intertidal flats) and marine waters (coastal lagoons and estuaries).
	Maritime wetlands are divided in salt marshes and salines and intertidal flats in MAES level 3. Coastal lagoons and estuaries are also distinguished.
9.Rivers and lakes	Water courses (fresh running waters and constructed inland freshwater) and lakes and reservoir is the division of MAES Level 2.

Water courses are separated according to their morphology into the riparian systems in MAES Level 3: interconnected rivers, streams or springs and separated water bodies belonging to the river systems (oxbow lakes or dead side-arms, flood ponds, etc.)

MAES Level 4 is based on:

- Identification of highly artificial modified water courses (navigation, irrigation, water regulation, flood protection and land drainage)
- Identification of main artificial or highly transformed water bodies: ponds and lakes with completely man-made structure for irrigation and water supply, intensively managed fish ponds and pools associated with extractive sites. |
| 10. (Marine) Other | The coastal areas refer to coastal, shallow, marine systems that experience significant land-based influences (MAES Level 2, 3 and 4 Marine –other-) not included in lagoons, coastal wetlands or estuaries. |

4. Mapping rules

Object delineation
Object delineation is performed on VHR EO data (see Table 1) as primary data source. In areas, where two or more satellite scenes overlap, the most recent scene is chosen as primary data source. An exception of this rule is made in northern and southern European regions, where images acquired during summer season are preferred if a selection of data was available, in order to support an optimum object discrimination.

In cases where clouds or cloud shadows cover the area of interest, either overlapping neighboring SPOT-5/6 data or DWH_MG2b_CORE_03-Optical VHR2 SPOT images acquired outside the preferred acquisition window from May-September are used. But also DWH_MG2_CORE_01 Coverage 1 (IRS-P6, 25m) and Coverage 2 (RapidEye, 5m) scenes or Landsat-8 data are employed in case no other adequate data source is available.

Minimum Mapping Unit (MMU)/ Minimum Mapping Width (MMW)
The minimum mapping unit defined is ≥ 0.5 ha for all objects. A minimum width of ≥ 10m is required for all linear features.

MMU Exceptions:

- Objects located at the border of the riparian zone:
  If an object is cut but the riparian border and the portion lying inside the RZ therefore is < 0.5 ha, this feature is mapped, if the whole object (inside and outside the RZ) amounts to ≥ 0.5 ha. However, the

MMU of those divided features lying inside the RZ must have a MMU of at least ≥ 0.2 ha. Smaller objects will be generalized.

- Linear features (roads, railways, rivers) that are split in two or more polygons by other linear elements (e.g. the road/railway network) will be mapped even if the resulting segments are smaller than the MMU in order to preserve the network. However, features < 0.1 ha will be generalized.

- Objects inside Urban Atlas Core Regions keep their MMU of 0.25 ha and will not be generalized.

MMW exceptions:
- To maintain continuity of linear features, the MMW may fall below the limit of 10 m over a distance of up to 100m.

Good Practice for Data Display – Mapping Scale
On-screen mapping scale is 1:5.000 – 1:10.000 depending on the landscape and feature class. Large homogeneous objects like agricultural areas or woodland are mapped at scales 1:8.000 – 1:10.000. For all other features, 1:5.000 mapping scale is applied.

Delineation Rules
Object delineation should be as follows:
- Delineation shall be angular and not round
- Avoid to digitize too many vertices: Use vertices as few as possible and only as many as necessary to define the shape of an object
- Avoid to map sharp angles
- Use road centers (roads < 10m width) as border between two objects if roads separate two features. E.g. a forest and an agricultural area are separated by a road feature < 10m width. Map the border between forest and agriculture in the middle of the road.

Overlap Rules
Objects may not overlap. In case of real objects overlay, the following rules apply:
- If objects overlap on **different levels**, the top level is mapped.
  Example: if an artificial canal overlaps a river, the canal is mapped continuously.
- If objects overlap on **the same level**, the visually dominant object is mapped continuously. However, if roads and railways meet on the same level, railways are mapped continuously to maintain the railway network.

Priority Rules
The priority rules applied are defined as follows:
- Objects < 0.5 ha are added to the neighboring object with the next lesser number of the same sub-class.
- Objects < 0.5 ha are added to the neighboring object of the same upper class.
- Objects < 0.5 ha are added to the neighboring object with the longest common border line.
  Exception: Objects surrounded by railways or roads.
  If an object is below the MMU size and completely surrounded by a road or railway network, it shall be aggregated with that surrounding traffic line. However, an exception is made for urban objects.
  Please see respective definition with Class 1.x.x.x.

Thematic/positional product accuracy
Overall thematic accuracy demanded is 85%. Positional accuracy is defined as < 5m.

Application of additional data sources

For data interpretation, additional data sources like CORINE Land Cover (CLC) 2006/2012, Urban Atlas (UA) 2006/2012, topographic maps, national WMS services, COTS navigation data and auxiliary data including local expertise is used.

- UA2006/2012: UA data are integrated in the RZ data set, where UA Core regions are locate inside the RZ. In that case, MMU of all UA objects is kept; however class codes are recoded to MAES (as far as possible).
  Outside UA Core regions, UA data are used as important data source for class delineation and class interpretation. Thus, interpreting the same areas twice is avoided and data compatibility between UA and RZ is guaranteed.

- HRL Imperviousness Degree:
  HR Impervious Degree Layer is used to support impervious degree derivation of urban classes. IM.D. is determined by either visual interpretation based on EO data and Impervious Degree Layer or derived by an automatic routine based on IM.D. Layer and road segments.

- HRL Tree Cover Density:
  HR Forest Layer is applied to support Tree Cover Density classification. The classification is performed by either visual interpretation based on EO data and HR Forest Layer or derived by an automatic routine based on HR Forest Layer and forest segments.

- CLC2006/2012:
  CLC2006/2012 is used as important data source for class assignment. CLC data use ensure data compatibility between CLC and RZ.

- Landsat-8/5 data sets:
  For critical classes, Landsat-8/5 data are used as additional data source. They are primarily used to support cropland/grassland differentiations and to detect irrigated areas, as in those cases, mono-temporal data analysis will not provide reliable results. Landsat-8/5 time series of summer images are collected for irrigated areas and images acquired in late summer/autumn/spring are used for grassland identification.

- In-situ data:
  Diverse national in-situ data like WMS services, specific maps or classifications as well as descriptions and maps of N2000 or RAMSAR site are used to support the object interpretation.

5. Description of mapping features

The following chapters describe the content of all MAES Level 4 classes.

1. Urban

The urban classes contain land that are covered by building structures and transport network. Urban fabrics appear in blue and darkish blue-grey on satellite images. The boundary dense, medium dense and low density urban fabric can be difficult to distinguish between. The principal is to determine these classes are either by the presence and quantity of vegetation or use the HR Imperviousness layer.

From the UA Mapping Guide:

- Surfaces with dominant human influence but without agricultural land use. These areas include all artificial structures and their associated non-sealed and vegetated surfaces.
- Artificial structures are defined as buildings, roads, all constructions of infrastructure and other artificially sealed or paved areas.
- Associated non-sealed and vegetated surfaces are areas functionally related to human activities, except agriculture.
- Also, the areas where the natural surface is replaced by extraction and / or deposition or designed landscapes (such as urban parks or leisure parks) are mapped in this class.
- The land use is dominated by permanently population.

The delineation rules for urban classes will be taken from the UA Mapping Guide, adapted to the MMU outside UA Core areas.

For general generalization/delineation rules applied for all urban classes, please see Chapter "4. Mapping Rules". Additionally, specific rules for urban areas are defined:

- Urban objects confined by roads or railways ≥ 0.25 up to < 0.5ha. Smaller urban objects will be generalized.
- If an infrastructure line is crossing a river, the bridge has to be mapped if the bridge is wider than 10 meters.
- Specific generalization rules are applied to 1.1.2.1 Low density urban fabric class (see description below).

This category includes:

1.1 Urban fabric, industrial, commercial, public, military and private units
Urban fabric contains of land covered by structures and transport networks, the degree of vegetation separates the three urban fabric classes from each other. Industrial or commercial units are almost completely covered by artificial surface.

1.2 Transport infrastructure
Motorways, roads and railways with is associated land and installations are included in this class if with >10m. Airports and port areas with installations and associated land is included.

1.3 Mineral extraction, dump and construction sites, land without current use
Dump sites include public, industrial or mine dump sites. Construction development, soil and bedrock excavations and earthwork are included in this class. Land without current use is land that is s in a transitional phase. It is included in urban areas.

1.4 Green urban, sports and leisure facilities
A green urban area is areas with vegetation within the urban fabric and includes parks and cemeteries. In Sport and leisure facilities, camping grounds, sport grounds, leisure parks, golf courses, racecourses, etc. are included. It also comprises parks not surrounded by urban areas.

1.1.1.1 Continuous urban fabric (in-situ based or IM.D. >80-100%)

Definition:

Buildings and its associated land together with artificial surfaced areas covers more than 80% of the total surface. Non-linear areas of vegetation and bare soil are exceptional.
Average degree of soil sealing: > 80%.

Continuous Urban fabric IM.D. >80% (Tallinn, Estonia). Credit: K. Larsson

Continuous Urban fabric IM.D. >80% (Palermo, Italy). Credit: M. Escobar

This category includes:

- Built-up areas and their associated land with dominant residential use; mostly inner-city areas with central business district as long as there is partial residential use.
- Buildings, roads and sealed areas cover most of the area; non-linear areas of vegetation and bare soil.

This category excludes:

- Industrial, Commercial, public, military and private units → 1.1.1.3 *Industrial or commercial unit* or 1.1.1.2 *Dense urban fabric.*
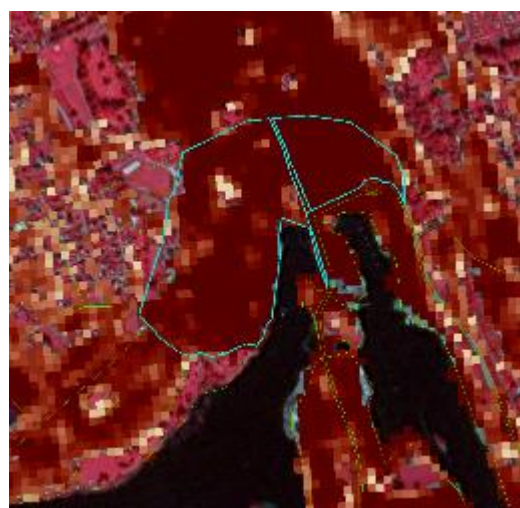
Attributes:

- UA

Appearance:

Urban fabric appears in blue or dark blue /grey colours on satellite images.
Distinguishing between different levels of urban fabric has to be done with help of IMD.

Class 1.1.1.1, City Drammen (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2013-07-20. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Class 1.1.1.1, City Skien (Norway). Left side: SPOT-5 (2.5 m); right side: SPOT-5 and HR I.MD. (1/2/3 Band Combination). Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
    - Core:
        - recode to MAES, but keep 0.25 ha MMU
        - no further differentiation according to MAES Level 4
        - flag such polygons with attribute "UA2012" or "UA2006"
    - LUZ:
        - full adaptation to MAES Level 4
        - MMU 0.5 ha
- If other local in-situ data available, use if suitable
- I.M.D has to be used outside UA Core, for delineation
- For interpretation of urban density: Use HR Imperviousness layer.

1.1.1.2 Dense urban fabric (IM.D. >30-80%)

Definition:

Predominant residential usage contains more than 20% non-sealed areas, independent of the housing scheme (single family houses or high-rise dwellings, city centre or suburb). The non-sealed areas might be private gardens or common green areas.

Average degree of soil sealing: >30-80%.

Dense Urban fabric (IM.D. 30-80%): City: Stockholm. Credits: European Union LUCAS 2009

Dense Urban fabric (IM.D. >30-80%): City: Stockholm. Credits: European Union LUCAS 2009

This category includes:

- Predominant residential usage. Contains more than 20% non-sealed areas, independent of their housing scheme (single family houses or high-rise dwellings, city centers or suburb).

This category excludes:

- Nurseries with dominant areas of greenhouses (no or only small fields) → class 2.1.2.1 *Greenhouses.*
- Allotment gardens → class 1.4.2.x *Sport and leisure facilities.*
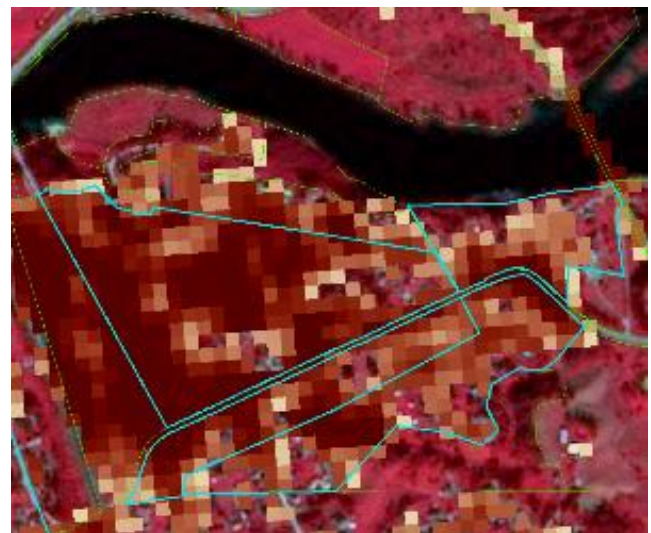- Isolated holiday villages → class 1.4.2.1 or 1.4.2.2 *Sport and leisure facilities.*

Attributes:

- UA

Appearance:

Class 1.1.1.2 City Larvik (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Class 1.1.1.2 City Lunde (Norway). Left side: SPOT-5 (2.5m); right side: SPOT-5 and HR I.MD. (1/2/3 Band Combination). Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
  - o   Core:
    - recode to MAES, but keep 0.25 ha MMU
    - no further differentiation according to MAES Level 4
    - flag such polygons with attribute "UA2012" or "UA2006"
  - o   LUZ:
    - full adaptation to MAES Level 4
    - MMU 0.5 ha
- If other local in-situ data available, use if suitable
- I.M.D has to be used outside UA Core, for delineation.
- For interpretation of urban density: Use HR Imperviousness layer

1.1.1.3 Industrial or commercial units

Definition

This category contains industrial or commercial units included. The administrative border and associated areas, such as roads, sealed areas and vegetated areas are included, if these areas are below the minimum mapping unit size. It also contains public, military and private services.

At least 30% of the ground is covered by artificial surfaces. More than 50% of those artificial surfaces are occupied by buildings and / or artificial structures with non-residential use, i.e. industrial, commercial or transport related uses are dominant.

The texture is homogenous with large buildings, car parks and sheds representing industrial or commercial complexes. Industrial or commercial units located in urban fabric are only taken into account if they are clearly distinguishable from residential areas.

Industrial or commercial units. (Riga, Latvia). Credits: K. Larsson

Industrial site (Madrid, Spain). Credits: M. Palacios

This category includes:

Industrial uses and related areas:
- Sites of industrial activities, including their related areas.
- Production sites.
- Energy plants: nuclear, solar, hydroelectric, thermal, electric and wind farms.
- Sewage treatment plants.
- Farming industries (farms with large buildings and / or greenhouses, not production fields).
- Antennas, even with predominant vegetated areas. The vegetated areas may be predominant, but the land is not dedicated to forestry or agriculture.
- Water treatment plants.
- Sewage plants.
- Seawater desalination plants.
- Bare soil / grassland used for storage of material.
- Water in industrial sites.
- Stud farms, agricultural facilities (cooperatives, state farm centers, livestock farms, living and exploitation buildings).
- Oil camps including administrative area.
- Abandoned industrial sites and by-products of industrial activities where buildings are still present.
- Water retention and hydro-electric stations.
- Telecommunication networks (relay stations for TV, telescopes, radars) including associated land.

Commercial uses, retail parks and related areas:
- Surfaces purely occupied by commercial activities, including their related areas (e.g. parking areas even larger than the MMU).
- High-rise office buildings.
- Petrol and service stations within built-up areas.
- Large shopping centers.

Public, military and private services not related to the transport system:
- Surfaces purely occupied by general government, public or private administrations including their related areas (access ways, lawns, parking areas).
- Schools and universities research and development establishments, including associated areas like sports fields, meadows also if > 0.5 ha.
- Hospitals and other health services or buildings.
- Places of worship (churches / cathedrals / religious buildings).
- Archaeological sites and museums, near to urban areas.
- Administration buildings, ministries.
- Penitentiaries.
- Military areas including bases and airports.
- Military exercise areas fenced and under current use.
- Castles, etc. not primarily used for residential purposes (building management, - etc.)
- Private storage areas without a residential component, such as compounds of garages.
- Company benefit schemes (old people's home, convalescent homes, orphanages, etc.).
- Exposition sites, fair sites.
- Military barracks, testing pistes, test fields, biological waste water treatment plants, water houses, transformers). The administrative boundary should be included and also associated land like storage space or meadows.
- Mine land areas.
- Cemeteries.
- Military areas including bases and airports.
- Military exercise areas fenced and under current use.
- Private storage areas without a residential component, such as compounds of garages.

Civil protection and supply infrastructure:
- Dams, dikes, irrigation and drainage canals and ponds and other technical public infrastructure, to be mapped with the roads, embankments and associated land included.
- Includes also breakwaters, piers and jetties, sea walls and flood defenses.
- (Ancient) city walls, other protecting walls, bunkers.
- Avalanche barriers.
- Security, law and order services (fire stations, penal establishments, etc.).

Water areas in industrial sites (ponds, settling basins, slurry tanks, etc.) will be mapped as industrial site even though they are larger than 0.5 ha, except water bodies related to the extractive industry (mines and gravel). These are mapped as class → 9.2.1.5 *Standing water bodies of extractive industrial sites.*

This category excludes:

- Petrol stations along fast transit and main roads with access only from these roads. They are mapped together with the road transport system → class 1.2.1.1 *Road network and associated land*.
- Public parks → class 1.4.1.1 or 1.4.1.2 *Green Urban areas*.
- Isolated holiday resorts including their hotels → class 1.4.2.1 or 1.4.2.2 *Green Urban areas*.
- Sport centers or bathing centers → class 1.4.2.1; 1.4.2.2 *Green Urban areas*.
- Noise barriers → class 1.2.1.1 *Road network and associated land* or 1.2.1.2. *Railways and associated land*.
- Water courses (within e.g. diked canals) if the water area is wider than 10 m → class 9 *Rivers and lakes*.
- Reservoirs along natural water courses → class 9 *Rivers and lakes*.
- Dockyards →1.2.1.3 *Port areas*.
- Greenhouse surfaces →2.1.2.1 *Greenhouses*.
- Dykes → grassland or other LC/LU.
- Non-active archaeological sites →1.3.2.1 *Land without current use*.
- Water bodies related to the extractive industry (mines and gravel) → 9.2.1.5 *Standing water bodies of extractive industrial sites*.
- Toxic lake, used for disposal → 9.2.1.5 *Standing water bodies of extractive industrial sites* (if additional information is available indicating that the lake is used for industrial purposes; if no information is available: 9211-*Natural water bodies*- or 9213 –*Ponds and lakes with completely man-made structure*-).

Attributes:

- UA

Appearance:

Industrial site of Skien (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Example of class 1.1.1.3 in Batman, Anatolia region (Turkey). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-07-16. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Active archeological site: Hosap castle – Guzelsu (Turkey). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-08-16. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
  - Core:
    - recode to MAES, but keep 0.25 ha MMU
    - no further differentiation according to MAES Level 4
    - flag such polygons with attribute "UA2012" or "UA2006"
  - LUZ:
    - full adaptation to MAES Level 4
    - MMU 0.5 ha
- If other local in-situ data available, use if suitable
- For interpretation of urban density: Use HR Imperviousness layer

Interpretation of dam and associated land:

Map dams as follows:

Dam and associated infrastructure: *Industrial or commercial unit* (1.1.1.3)
Channel*: Highly modified natural water courses and canals* (9.1.1.3)
Water: *Permanent interconnected running water courses* (9.1.1.1)

Ataturk dam, Sanliurfa region (Turkey). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-07-05. Source: CNES 2011©, Distribution Airbus DS/Spot Image

1.1.2.1 Low density urban fabric (IM.D. 0-30%)

Definition:

Low density urban fabric contains residential buildings, roads and other artificially surfaced areas. The vegetated areas are predominant, but the land is not dedicated to forestry or agriculture.

Average degree of soil sealing: 10-30%
The build-up areas on small farms will be included in this class.

Low density urban fabric (Täby, Sweden). Credits: K. Larsson

Low density urban fabric (Costa del Sol, Spain). Credits: M. Palacios

This category includes:

- Residential buildings, roads and other artificially surfaced areas. The vegetated areas are predominant, but the land is not dedicated to forestry or agriculture.
- Build-up areas on small farms.

This category excludes:

- Allotment gardens → 1.4.2.x *Sport and leisure facilities*
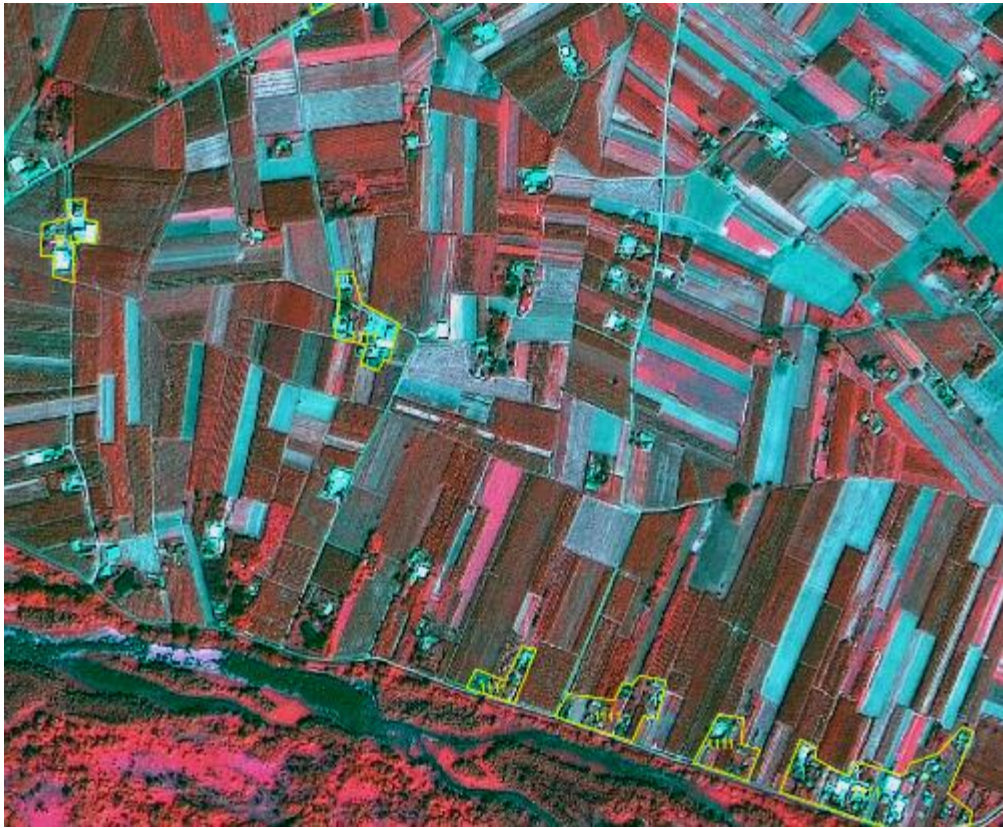
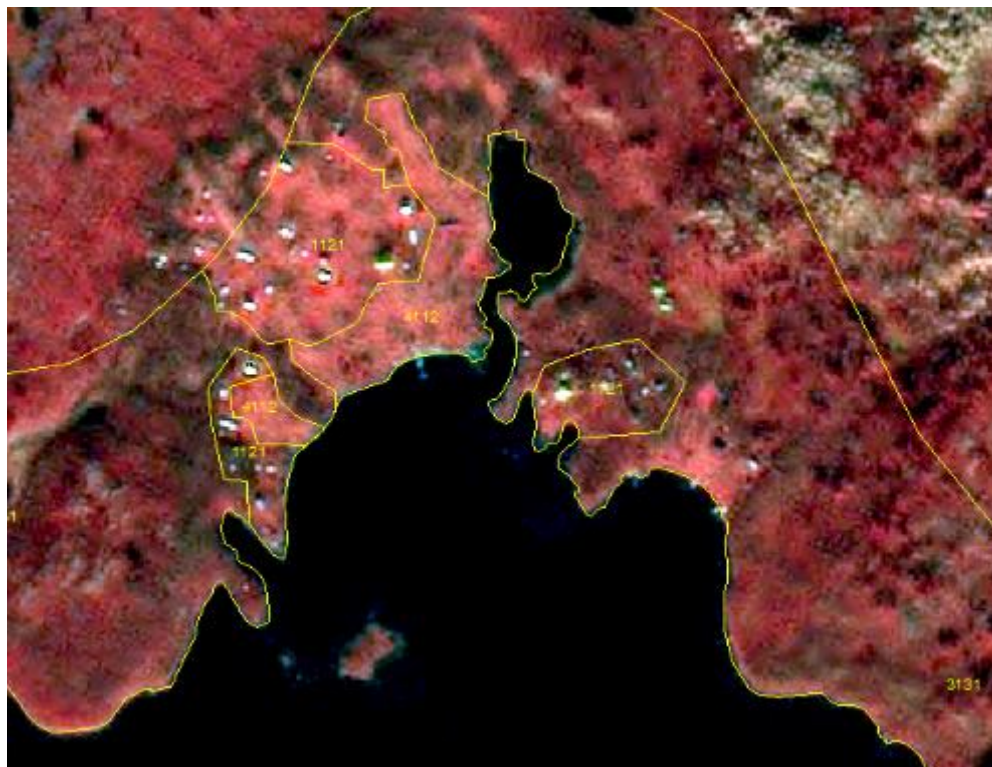**Attributes:**

- UA

Appearance:
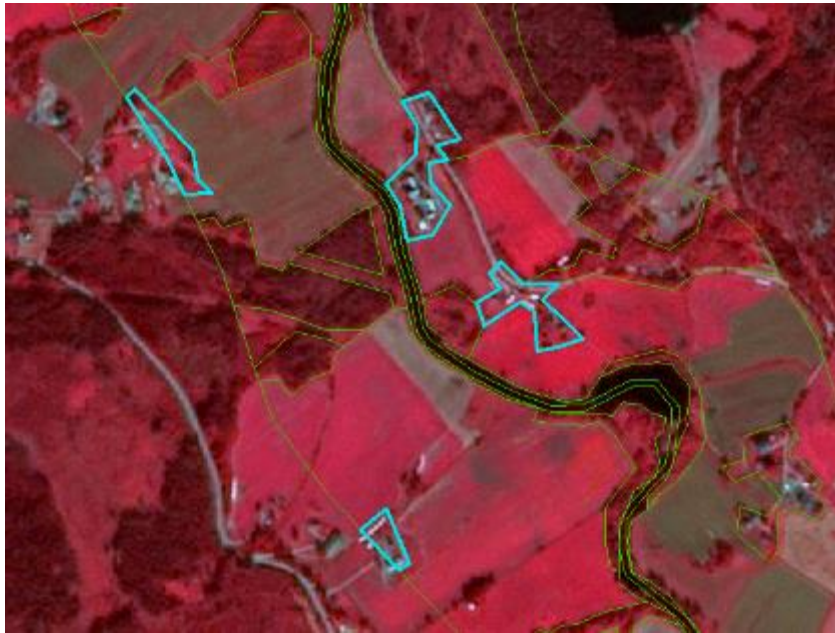
Class 1.1.2.1 Low Urban Density at Siljan region (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image
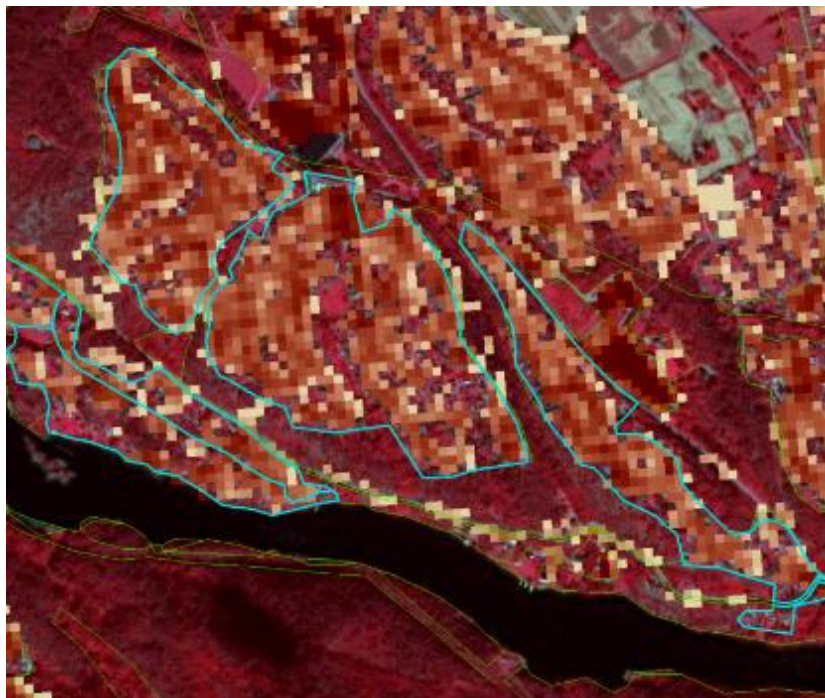
Class 1.1.2.1, City Skien (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination) together with HR I.M.D. Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

In regions with scattered houses, only large accumulations of houses are mapped (Example from Poland). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-07-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Village Åre (Sweden): Example of generalized delineation of low urban density area class 1.1.2.1. SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-07-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
    - Core:
        - recode to MAES, but keep 0.25 ha MMU
        - no further differentiation according to MAES Level 4
        - flag such polygons with attribute "UA2012" or "UA2006"
    - LUZ:
        - full adaptation to MAES Level 4
        - MMU 0.5 ha
- If other local in-situ data available, use if suitable
- I.M.D has to be used outside UA Core, for delineation.
- For interpretation of urban density: Use HR Imperviousness layer

Generalisation rules:

If a strict MMU >0.5 ha mapping of class 1.1.2.1 is applied, the low urban density areas would be underestimated. Therefore, to get a good representation of the area, the following generalisation rules will be adopted:

- Do not apply the 10 m MMW distance rule at the urban fringe but apply a < 50m MMW to generalize outline.
- Include private gardens.
- Avoid mapping of single urban segments
- Map the "whole structure".
- Close gaps at the urban fringe applying a maximum width of 50 m.

In any case, real agricultural/grassland parcel contained within urban surroundings, will be mapped as agricultural/grassland.
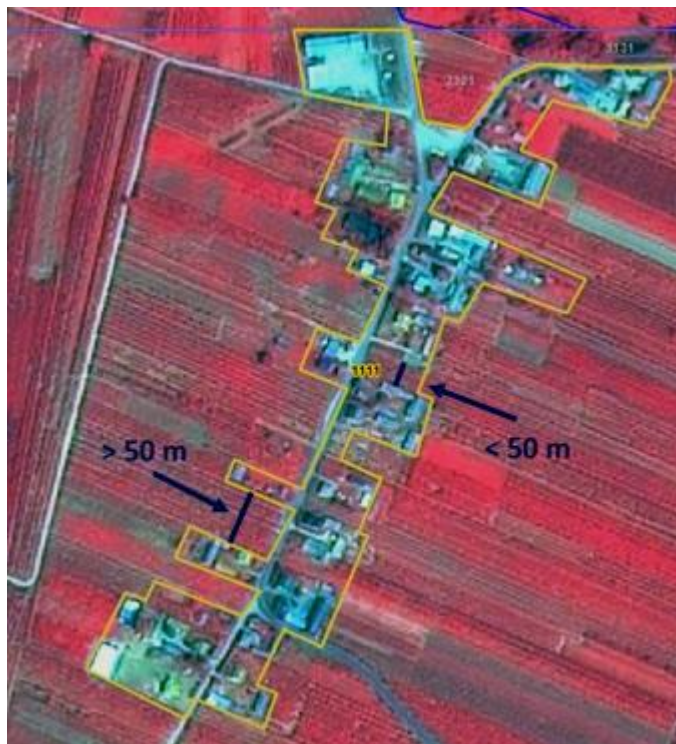
Example of generalized delineation of low urban density area, class 1.1.2.1 (Example from Poland). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-07-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image
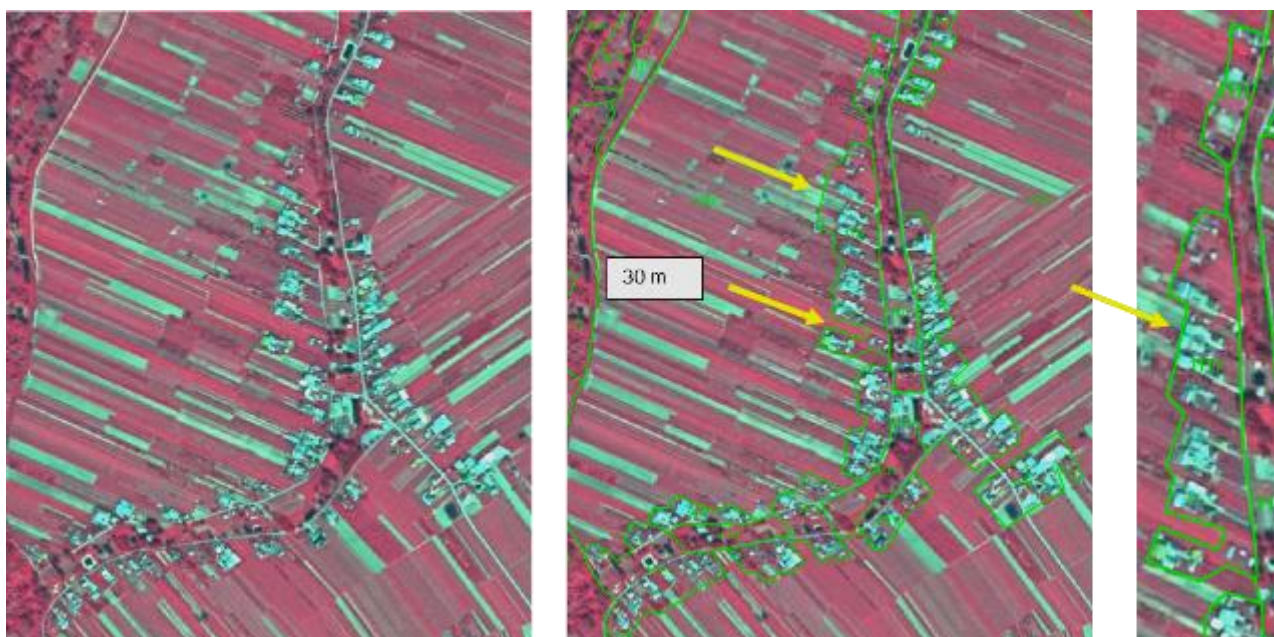
Generalized mapping of scattered urban areas. Gardens have to be included. Gaps of less than 50 meters are generalized and single blocks are connected. Large agricultural areas (width > 50 m) at the urban border should be excluded.
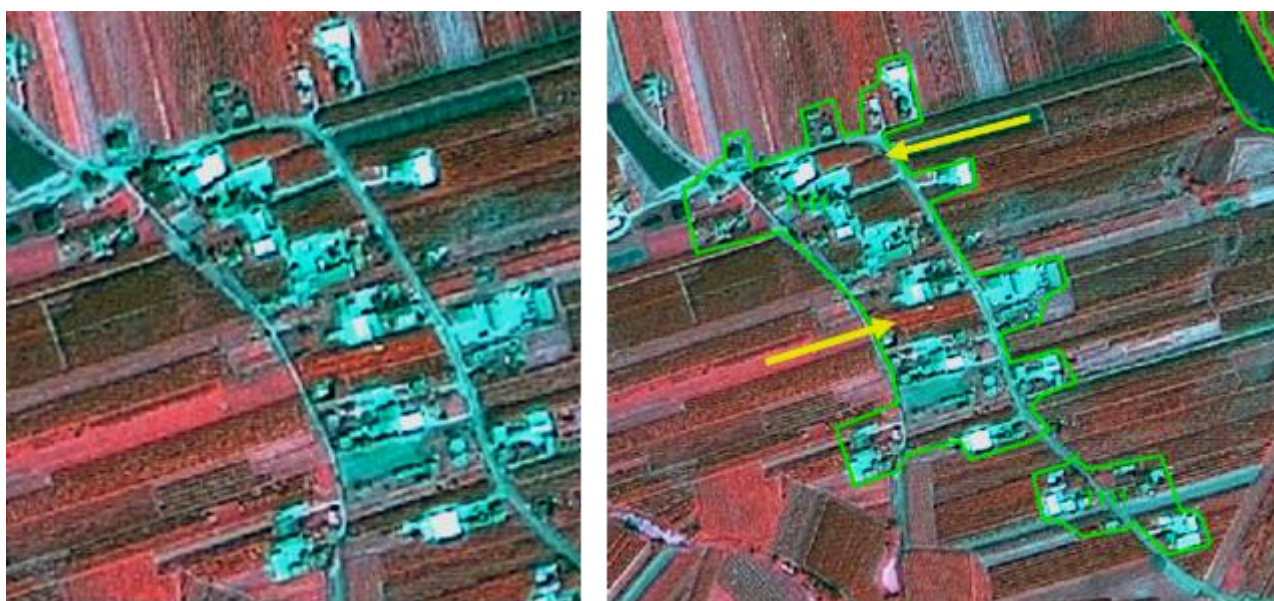
Gardens included, outline generalized to support a cartographic representation of urban areas. Otherwise urban areas will be underestimated and not presented correctly. Do not include too much agricultural area (Example from Poland). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-07-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image
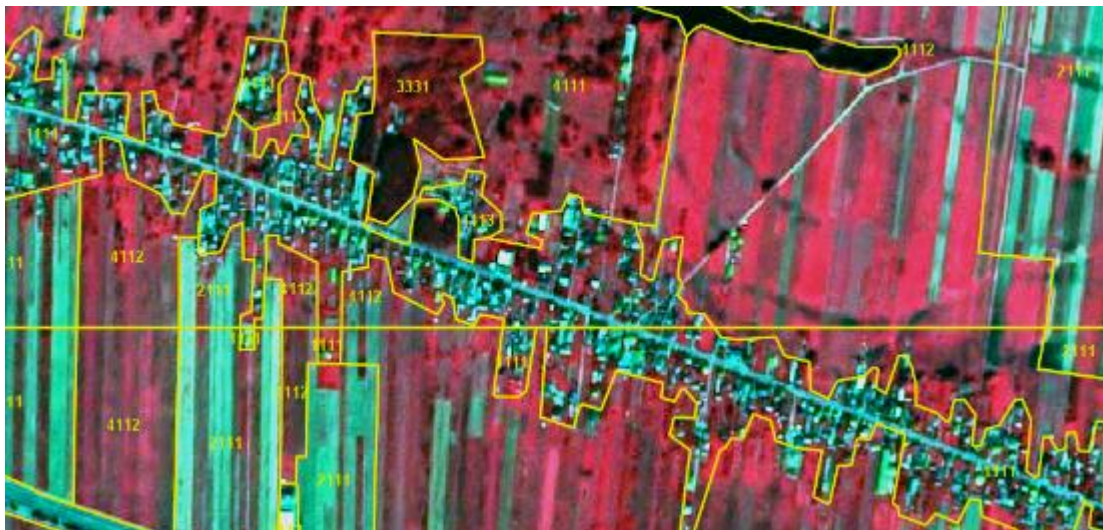
Urban mapping example from Poland: SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-07-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image
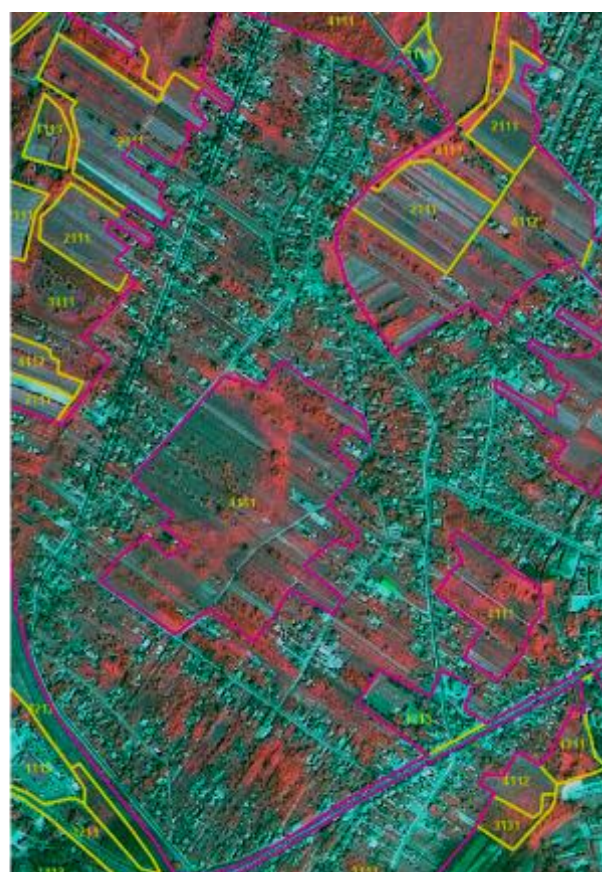

Generalize urban outline, include gardens, and use class 2.3.2.1 for complex areas (example from Poland). SPOT-5 (2.5m) (Poland) (1/2/3 Band Combination). Date: 2011-07-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image
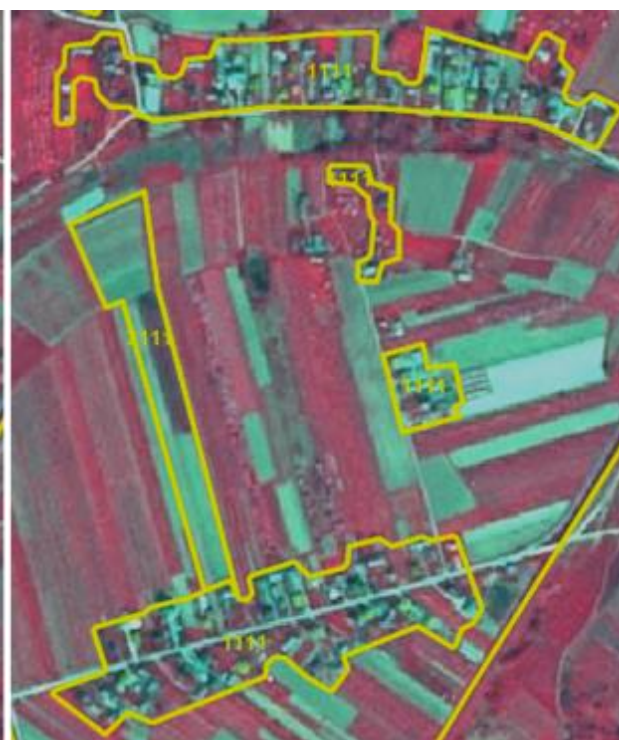
Use of auxiliary data:

If UA is available, keep the outline and just correct real errors. "Fine-tuning" of the class borders is not necessary.

UA delineation of a village in Poland presented on SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-07-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image
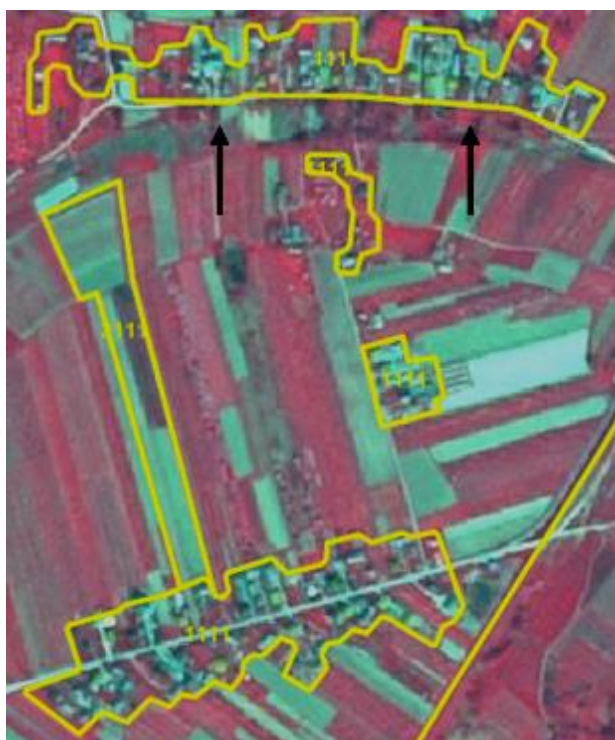
Left side. Very precise OSM delineation
Keep OSM, and just correct errors.
Right side: manual delineation – map urban outline generalized
Example from Poland. SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-07-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image

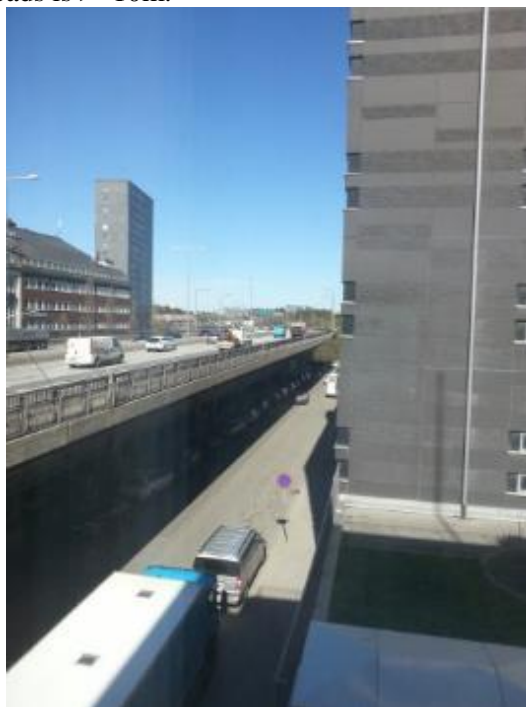# 1.2.1.1 Road network and associated land

Definition:

Road network and associated land.
Minimum mapping width for roads is >=10m.

Road network and associated land, (Stockholm, Sweden) Credit: K. Larsson

This category includes:

- Roads, crossings, intersections and parking areas, including roundabouts and sealed areas with "road surface".
- Slopes of embankments or cut sections.
- Areas enclosed by roads or railways, without direct access and without agricultural land use.
- Fenced areas along roads (e.g. as for protection against wild animals).
- Areas enclosed by motorways, exits or service roads with no detectable access.
- Noise barriers (fences, walls, earth walls).
- Rest areas, service stations and parking areas only accessible from the fast transit roads.
- Foot- or bicycle paths parallel to the traffic line.
- Green strips, alleys (with trees or bushes).
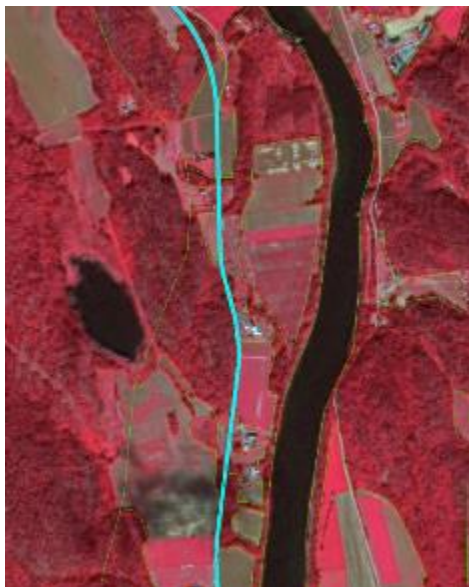- Closed-down roads.

This category excludes:

- Motorways under construction → 1.3.1.1 *Mineral extractions, dump and construction sites.*
- Closed-down roads (classified under the real appropriate land cover category) if MMW less than 10m.
- Land plots > 0.5 ha surrounded but roads and not considered as associated land → Current land cover category.

Attributes:

- UA

Appearance:

Example of Class 1.2.1.1 from Siljan (Norway) presented on SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Example of class 1.2.1.1 city of Skien (Norway) presented on SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image


Example of class 1.2.1.1 Bismil (Turkey). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2013-07-13. Source: CNES 2013©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
    - Core:
        - recode to MAES, but keep 0.25 ha MMU
        - no further differentiation according to MAES Level 4
        - flag such polygons with attribute „UA2012/2006"
    - LUZ:
        - full adaptation to MAES Level 4
        - MMU 0.5 ha
- If other local in-situ data available, use if suitable
- Roads will be used from COTS navigation systems, where available. In case of geometrical differences between EO data and COTS navigation data, the COTS navigation data has to be corrected in line with the EO data.
- Roads do not necessarily have to form a closed network. Isolated traffic lines are possible, but they have to be mapped with regard to the MMU criterion.
- Associated land < 0.5 ha MMU is mapped with the roads as it is visible in the EO data and topographic maps.
- If a road is covered by a tunnel, the LU/LC over the tunnel has to be mapped.

Specific generalisation rule:
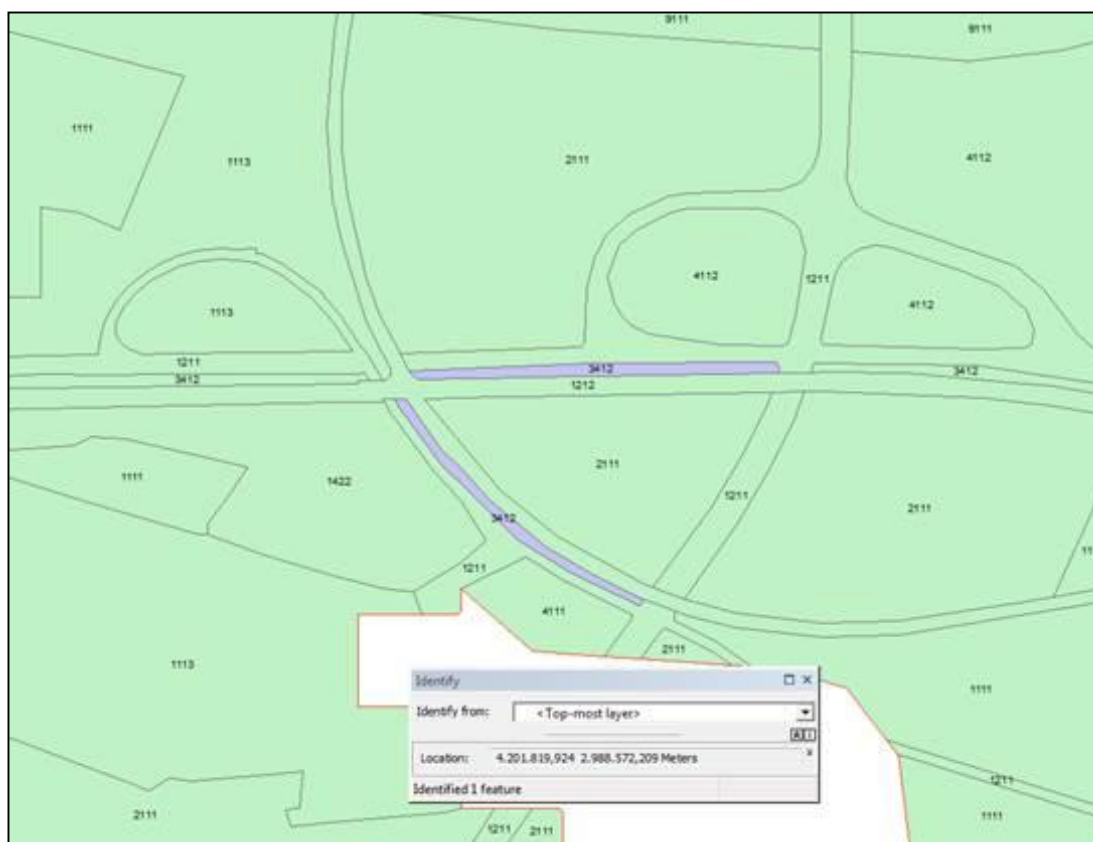
Class 3.4.1.2 surrounded by 1.2.1.1 and area < 0.5 ha: map as associated feature and generalize into road

1.2.1.2 Railways and associated land

Definition

Railways and associated land.
Minimum mapping width >=10m.

Railways and associated land (Täby, Sweden) Credit: K. Larsson

This category includes:

- Railway facilities including stations, cargo stations and service areas.
- Closed-down rails ≥ 10m MMW and where infrastructure is still visible.

This category excludes:

- Rails ending in industrial sites→ 1.1.1.3 *Industrial or commercial units.*
- Tramways → 1.2.1.1 *Road network and associated land.*
- Abandoned rails, mono-rails, funiculars→ 1.2.1.1 *Road network and associated land* or 1.3.2.1 *Land without current use.*
- Railways and high-speed train under construction → 1.3.1.1 *Mineral extractions, dump and construction sites.*
- Closed-down transport network (classified under the real appropriate land cover category) if MMW less than 10m.
- Railway under construction → 1.3.1.1 *Mineral extractions, dump and construction sites.*

Attributes:

- UA

Appearance:

Class 1.2.1.2 city of Lunde (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination) Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Class 1.2.1.2 city of Gvarv (Norway.) SPOT-5 (2.5m) (1/2/3 Band Combination) Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
    - Core:
        - recode to MAES, but keep 0.25 ha MMU
        - no further differentiation according to MAES Level 4
        - flag such polygons with attribute „UA2012" or „UA2006"
    - LUZ:
        - full adaptation to MAES Level 4
        - MMU 0.5 ha
- If other local in-situ data available, use if suitable
- Railways do not necessarily have to form a closed network. Isolated railway lines are possible, but they have to be mapped with regard to the MMU criterion.
- Associated land < 0.5 ha is mapped with the railways as it is visible in the EO data and topographic maps, also in industrial sites.
- Railways always form the top-level. They clip all other features.
- Minimum mapping width >=10m.
- If a railways is covered by a tunnel, the LU/LC over the tunnel has to be mapped.

Generalisation rules:

Secondary railway lines within urban context has to be mapped if they are visible in the images or if they can be supported by ancillary data.

Industrial site with railways from ancillary data in turquoise. Example from Stockholm (Sweden). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image.
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1.2.1.3 Port areas

Definition
Port areas contain the infrastructure of the port area, quays, dockyards and also the transport and storage area associated to the port.

Delineation of port areas must be taken from the geographical location, near the sea.

Port area of Stockholm (Sweden) Credit: European Union, LUCAS 2009

This category includes:
- Administrative area of inland harbors and sea ports.
- Infrastructure of port areas, including quays, dockyards, transport and storage areas and associated areas.
- Commercial and military ports.
- Shipyards.
- Fishing ports.
- Shipping and infrastructure port facilities.
- Harbour stations, dock houses.
- Oil terminals.

This category excludes:
- Marinas →class 1.4.2.1 or 1.4.2.2 *Sport and leisure facilities.*
- Yachts ports, sport and recreation ports → class 1.4.2.1/1.4.2.2 *Sport and leisure facilities.*
- Port area water, connected to open sea → 10.1.1.1 *Marine (other)*
- Port area water, connected to river or lakes → 9.x.x.x *Rivers and lakes*
- Port area water on marina or yachting ports (small area, not complying with MMU or MMW) →1.4.2.x *Sport and leisure facilities*

Attributes:
- UA

Appearance:
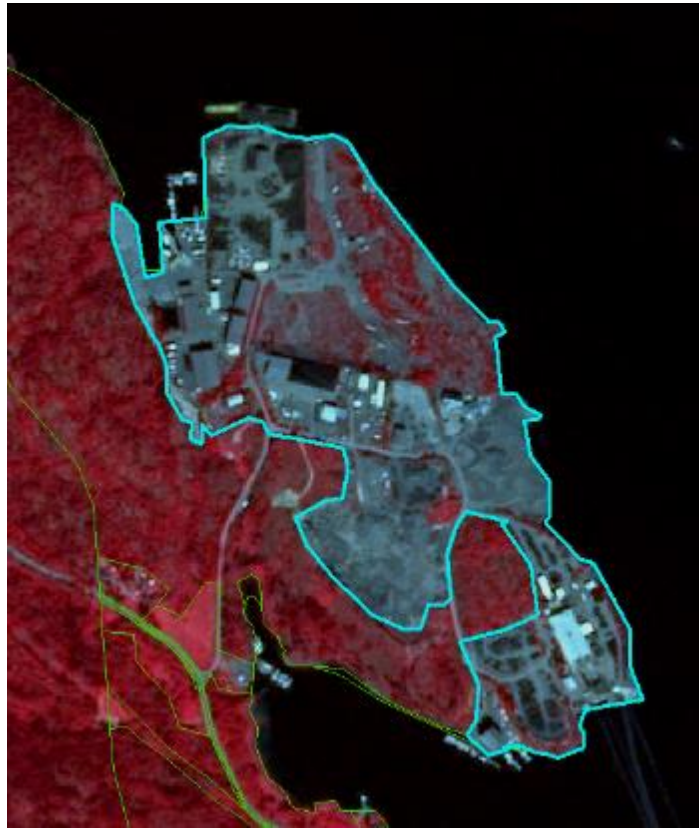
Delineation of a port area and associated land located at Surtebogen (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
    - Core:
        - recode to MAES, but keep 0.25 ha MMU
        - no further differentiation according to MAES Level 4
        - flag such polygons with attribute "UA2012" or "UA2006"
    - LUZ:
        - full adaptation to MAES Level 4
        - MMU 0.5 ha
- If other local in-situ data available, use if suitable

1.2.1.4 Airports

Definition:

Everything associated with the airport (runways, buildings, hangars, associated land) is included in this class, also all grassland areas, even if > 0.5 ha.

Artificial runways surrounded by grassed areas are easily distinguishable in satellite images.

Heliports (helicopters ports) are also included in this category if they are >0.5 ha.

Airport, (Arlanda Stockholm, Sweden). Credits: K. Larsson

This category includes:

- Administrative area of airports, mostly fenced.
- Included are all airport installations: runways, buildings and associated land (mainly grassland).
- Military airports.

This category excludes:
- Aerodromes without sealed runway → class 1.4.2.1 *Sport and leisure facilities.*
- Sport airfield → 1.4.2.2. *Sport and leisure facilities.*

Attributes:
- UA

Appearance:
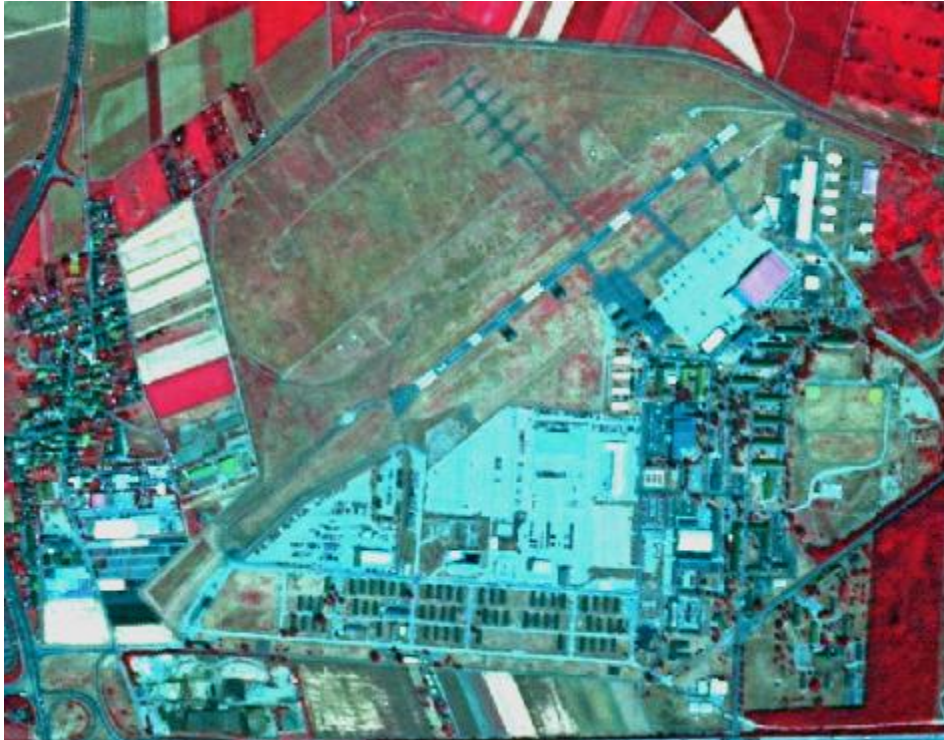
Military airport at Wilhelmswöerth (Germany). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-07-14. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Airport Worms (Germany). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-07-14. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Erzinkan airport (Turkey). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-09-16. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA201/20062 are available:
  - Core:
    - recode to MAES, but keep 0.25 ha MMU
    - no further differentiation according to MAES Level 4
    - flag such polygons with attribute "UA2012" or "UA2006"
  - LUZ:
    - full adaptation to MAES Level 4
    - MMU 0.5 ha
- If other local in-situ data available, use if suitable

1.3.1.1 Mineral extraction, dump and construction sites

Definition:

This class includes public, industrial or mine dump sites, areas with open pit extraction of construction material or other minerals but also spaces under construction, soil or bedrock excavations and earth work.

Quarries and open-cast mines are easily recognizable on satellite images (white patches) because they contrast with their surroundings. The same is true for working gravel pits.

Dump sites are often located near large towns or major industrial areas. Sites being exploited/in use or only recently abandoned, with no trace of vegetation, are comprised. Associated land, buildings and infrastructures are included.

Construction sites are easily identifiable on satellite images. Included are construction sites for buildings, dams and motorways.

Construction site (Cadiz, Spain). Credits: M. Palacios

Construction site (Malaga, Spain). Credits: M. Palacios

Dump site (Madrid, Spain). Credits: M. Palacios

Dump site (Madrid, Spain). Credits: M. Palacios

This category includes:

- Open pit extraction sites (sand, quarries) including water surface, if < MMU, open-cast mines, oil and gas fields; including infrastructure: buildings, roads, parking lots, etc.
- Their protecting dikes and / or vegetation belts and associated land such as service areas, storage depots.
- Public, industrial or mine dump sites, raw or liquid wastes, legal or illegal, their protecting dikes and / or vegetation belts and associated land such as service areas.
- Spaces under construction or development, soil or bedrock excavations for construction purposes or other earthworks visible in the image.
- Clear evidence of actual construction needs to be identifiable in the data, such as actual excavations and machinery on site, or ongoing construction of any stage, etc. In case of doubt → class 1.3.2.1. *Land without current use.*
- Active gravel pits.
- Inland salines (including water surface).

This category excludes:

- Water bodies > MMU → class 9 *Rivers and lakes.*
- Exploited peat bogs → class 7.2.1.1 *Exploited peat bog.*
- Coastal salines → class 8.1.1 *Salt marshes & salines*.
- Re-cultivated areas (mapped according to their actual land cover).
- Decanting basins of biological water treatment plants → 1.1.1.3 *Industrial or commercial units*
- River bed extraction → class 2 Croplands.
- Non-active gravel pits → if bushes are visible: 3.4.1.1 *Transitional woodland scrub*, without or with few vegetation: 6.2.1.3 *River banks.*

Attributes:

- UA

Appearance:
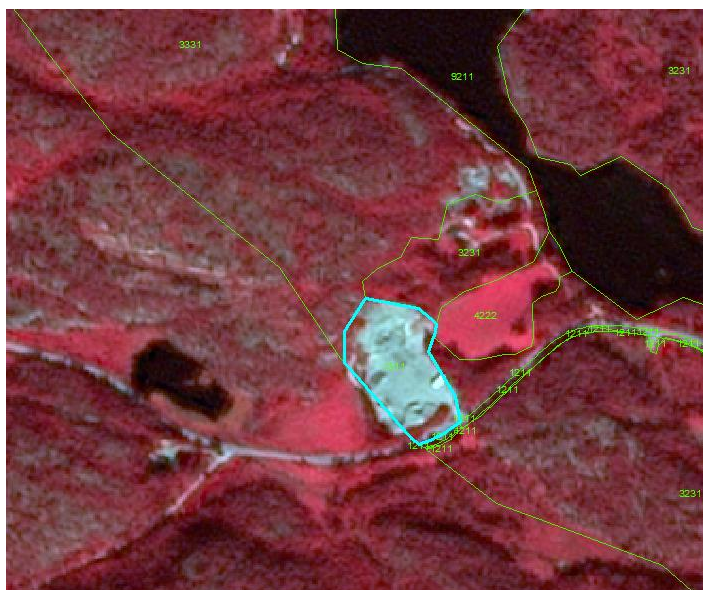
Delineation of mineral extraction site at Bostrac (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Delineation of construction site at Skien (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Gravel pit (Turkey). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2013-08-07. Source: CNES 2013©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
    - Core:
        - recode to MAES, but keep 0.25 ha MMU
        - no further differentiation according to MAES Level 4
        - flag such polygons with attribute „UA2012" or "UA2006"
    - LUZ:
        - full adaptation to MAES Level 4
        - MMU 0.5 ha
- If other local in-situ data available, use if suitable

Specific delineation rules for gravel pits:

If the gravel pit is active: map as 1.3.1.1 *Mineral extraction, dump and construction* sites. If it is not-active, map as 3.4.1.1 *Transitional woodland scrub* (in case bushes are visible). For all areas without or with little vegetation: map as 6.2.1.3 *River banks*

1.3.2.1 Land without current use

Definition:

Areas in the close to artificial surfaces, still waiting to be used or re-used, is obviously in a transitional position, "waiting to be used" and will be mapped as *Land without current use*.

"Land without current use" located outside urban areas will be classified according to their land cover – mostly grassland or transitional (bushes have to be visible).

Land without current use (Malaga, Spain). Credits: M. Palacios

This category includes:

- Waste land, removed former industry areas, ("brown fields") gaps in between new construction areas or leftover land in the urban context ("green fields").
- No actual agricultural or recreational use.
- No construction is visible, without maintenance, but no undisturbed fully natural or semi-natural vegetation (secondary rural vegetation).
- Also areas where the street network is already finished, but actual erection of buildings is still not visible
- Non-active archaeological sites, archaeological sites without infrastructure, (like e.g. museum, parking places, access roads) if inside urban continuum

This category excludes:

- "Leftover areas", areas too small / narrow for any construction with regard to the MMU size → map to the appropriate neighbor class as associated land.
- Active archaeological sites → *1.1.1.3 Industrial or commercial units*

Attributes:

- UA

Appearance:

Land without current use near Porsgun (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Land without current use near Porsgun (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Ruins near Caykoy (Turkey). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-06-30. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
    - Core:
      - recode to MAES, but keep 0.25 ha MMU
      - no further differentiation according to MAES Level 4
      - flag such polygons with attribute "UA2012" or "UA2006"
    - LUZ:
      - full adaptation to MAES Level 4
      - MMU 0.5 ha
- If other local in-situ data available, use if suitable

1.4.1.1 Green urban areas T.C.D. >= 30%

Definition

Public green areas such as gardens, zoos, parks, castle parks with predominantly recreational use and more than 30% tree cover. Vegetation is often planted and regularly worked by humans; strongly human-influenced.

HR T.C.D Layer can to be used as a support layer, but due to the coarse resolution also visual interpretation is necessary. T.C.D has to be >= 30%

Green urban areas T.C.D. >= 30% (Täby, Sweden). Credits: K. Larsson

This category includes:

- Public green areas for predominantly recreational use such as gardens, zoos, parks, castle parks.
- Suburban natural areas that have become and are managed as urban parks.
- Forests or green areas extending from the surroundings into urban areas are mapped as green when at least two sides are bordered by urban areas and structures, and traces of recreational use are visible.

This category excludes:
- Private gardens within housing areas → 1.1 *Urban fabric*.
- Cemeteries → 1.1.1.3 *Industrial or commercial units*.
- Buildings within parks, such as castles or museums → 1.1.1.3 *Industrial or commercial units*.
- Patches of natural vegetation or agricultural areas enclosed by built-up areas without being managed as green urban areas → class 2.1.1.1 *Non- irrigated arable land* or 4.1.1.x *Managed grassland*.

Attributes:

- UA

Appearance
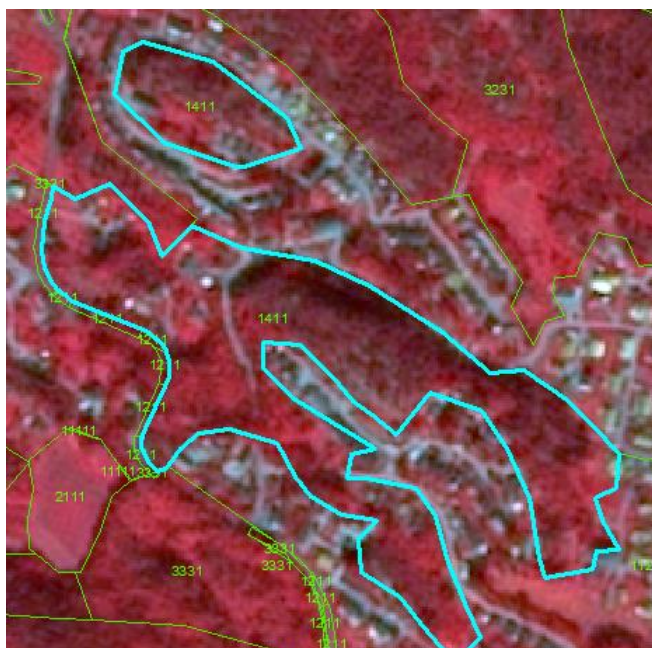
Green urban area with T.C.D. >= 30% in Skien (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Green urban area with T.C.D. >= 30% in Uleforss (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:
- If UA2012/2006 are available:
  - Core:
    - recode to MAES, but keep 0.25 ha MMU
    - no further differentiation according to MAES Level 4
    - flag such polygons with attribute "UA2012" or "UA2006"
  - LUZ:
    - full adaptation to MAES Level 4
    - MMU 0.5 ha
- If other local in-situ data available, use if suitable
- Apply T.C.D. from HR Forest Layer for T.C.D. discrimination

1.4.1.2 Green urban areas T.C.D. <30%

Definition

Public green areas such as gardens, zoos, parks, castle parks with predominantly recreational use and more than 30% tree cover. Vegetation is often planted and regularly worked by humans; strongly human-influenced.

HR T.C.D Layer can to be used as a support layer, but due to the coarse resolution also visual interpretation is necessary. T.C.D has to be >= 30%

Green urban areas T.C.D: <30% (Täby, Sweden). Credits: K. Larsson

Green urban areas T.C.D: <30% (Marbella, Spain). Credits: M. Palacios

This category includes:

- Public green areas for predominantly recreational use such as gardens, zoos, parks, castle parks.
- Suburban natural areas that have become and are managed as urban parks.
- Forests or green areas extending from the surroundings into urban areas are mapped as green.
- Urban areas when at least two sides are bordered by urban areas and structures, and traces of recreational use are visible.

This category excludes:

- Private gardens within housing areas → 1.1 *Urban fabric.*
- Cemeteries → 1.1.1.3 *Industrial or commercial units.*
- Buildings within parks, such as castles or museums → 1.1.1.3 *Industrial or commercial units.*
- Patches of natural vegetation or agricultural areas enclosed by built-up areas without being managed as green urban areas → class 2.1.1.1 *Non- irrigated arable land* or 4.1.1.x *Managed grassland.*

Attributes:

- UA

Appearance

Green urban area with T.C.D. <30% in Brevik (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Green urban area with T.C.D. <30% in Drangedal (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
    - Core:
        - recode to MAES, but keep 0.25 ha MMU
        - no further differentiation according to MAES Level 4
        - flag such polygons with attribute "UA2012" or UA2006"
    - LUZ:
        - full adaptation to MAES Level 4
        - MMU 0.5 ha
- If other local in-situ data available, use if suitable
- Apply T.C.D. from HR Forest Layer for T.C.D. discrimination

1.4.2.1 Sport and leisure facilities T.C.D >= 30%

Definition
All sports and leisure facilities including associated land, whether public or commercially managed.
Sporting facilities is functional units independent of being non-sealed, sealed or built-up.
Public arenas for any kind of sports including associated green areas, parking places, etc.
T.C.D can to be used as a support layer, but due to the coarse resolution also visual interpretation is necessary.
T.C.D has to be >= 30%.

Golf course. Credits:
M. Palacios

Sports and leisure facilities (Göteborg, Sweden). Credits:
European Union LUCAS 2009

This category includes:

- Golf courses.
- Sports fields (also outside the settlement area).
- Camp grounds.
- Leisure parks.
- Riding grounds.
- Racecourses.
- Amusement parks.
- Swimming resorts etc.
- Isolated holiday villages.
- Allotment gardens.
- Glider or sports airports, aerodromes without sealed runway.
- Marinas.

This category excludes:

- Private gardens within housing areas → 1.1 *Urban fabric.*
- Motor racing courses within industrial zone used for test purposes → 1.1.1.3 *Industrial or commercial unit.*
- Caravan parking used for commercial activities → 1.1.1.3 *Industrial or commercial unit.*
- Soccer fields, etc. within e.g. military bases or within university campuses → 1.1.1.3 *Industrial or commercial unit.*

Attributes:
- UA

1.4.2.2 Sport and leisure facilities T.C.D < 30%

Definition

All sports and leisure facilities including associated land, whether public or commercially managed.
Sporting facilities is functional units independent of being non-sealed, sealed or built-up.
Public arenas for any kind of sports including associated green areas, parking places, etc.
T.C.D has to be < 30%.

Sports and leisure facilities (playground), (Täby Sweden) Credits: K. Larsson

Sports and leisure facilities (artificial football field) (Täby Sweden). Credits: K. Larsson

This category includes:

- Golf courses.
- Sports fields (also outside the settlement area).
- Camp grounds.
- Leisure parks.
- Riding grounds.
- Racecourses.
- Amusement parks.
- Swimming resorts etc.
- Isolated holiday villages .
- Allotment gardens.
- Glider or sports airports, aerodromes without sealed runway.
- Marinas.

This category excludes:

- Private gardens within housing areas → 1.1 *Urban fabric.*
- Motor racing courses within industrial zone used for test purposes → 1.1.1.3 *Industrial or commercial unit.*
- Caravan parking used for commercial activities → 1.1.1.3 *Industrial or commercial unit.*
- Soccer fields, etc. within e.g. military bases or within university campuses → 1.1.1.3 *Industrial or commercial unit.*

Attributes:

- UA

Appearance:

Golf course at Uleforss (Norway). SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2010-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If UA2012/2006 are available:
    - Core:
    - - recode to MAES, but keep 0.25 ha MMU
      - no further differentiation according to MAES Level 4
      - flag such polygons with attribute "UA2012" or "UA2006"
    - LUZ:
      - full adaptation to MAES Level 4
      - MMU 0.5 ha
- If other local in-situ data available, use if suitable
- Applying T.C.D. from HR Forest Layer for T.C.D. discrimination

Isolated holiday villages delineation criteria:
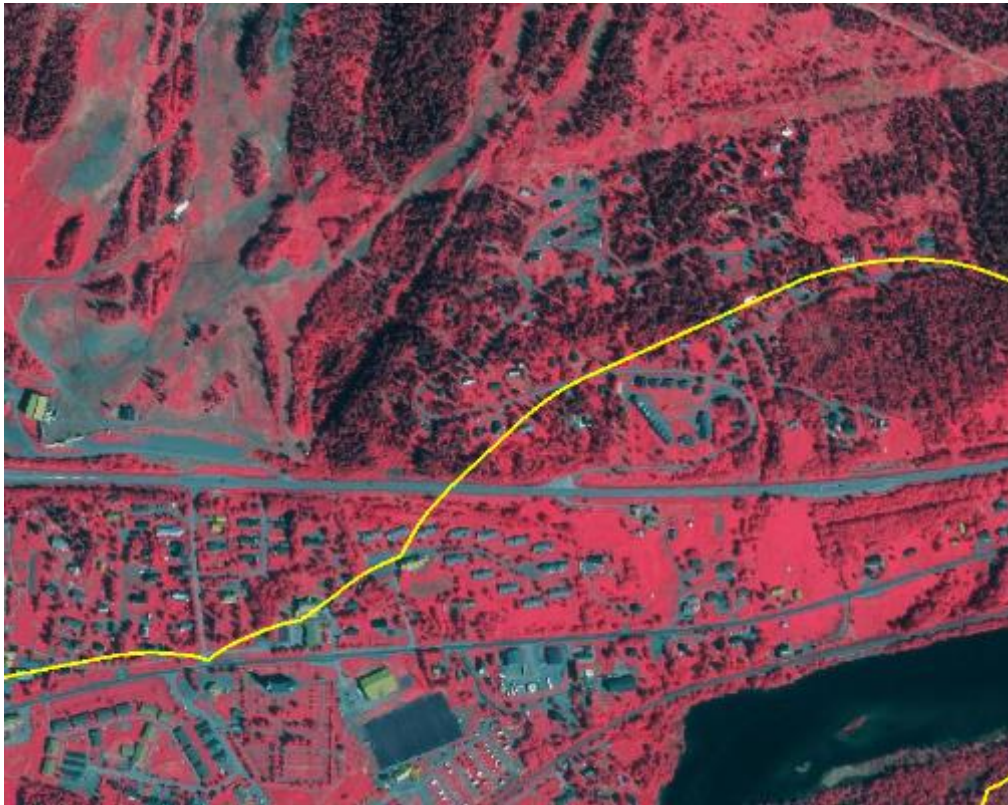
Example of low urban density area, class 1.1.2.1. Village Åre (Sweden). Map only distinct "holiday and leisure infrastructure" (e. g. camping grounds) as 1.4.2.x. SPOT-5 (2.5m) (1/2/3 Band Combination). Date: 2011-07-27. Source: CNES 2011©, Distribution Airbus DS/Spot Image

2. Croplands

Cropland is the main food production area. It includes both, intensively managed ecosystems and multifunctional areas supporting many semi-natural and natural species along with food production (lower intensity management). It comprises regularly or recently cultivated agricultural, horticultural and domestic habitats and agro-ecosystems with significant coverage of natural vegetation (agricultural mosaics) (Maes et. al., 2013).

MAES categorizes croplands in three main groups:

- Arable Land
- Permanent Crops
- Heterogeneous agricultural areas

Arable Land is land under a rotation system used for annually harvested plants and fallow lands. The land is permanently or not irrigated. It includes cereals, oil seed plants, vegetables, beets, fodder and flooded crops such as rice and other inundated croplands.

Permanent crops are surfaces that are not under a rotation system but last for many seasons and need not to be replanted after harvest. Included are ligneous crops of standard cultures for fruit production such as extensive fruit orchards, olive groves, chestnut groves, walnut groves, shrub orchards such as vineyards and some specific low-system orchard plantation, espaliers and climbers. In the case of irrigated permanent crops, the qualification of irrigation prevails over permanent, thus, all the irrigated permanent crops are classified as 2.1.3 *Irrigated arable land and rice fields*.

Heterogeneous agricultural areas comprise surfaces where several categories are mixed. This may be either annual crops associated with permanent crops on the same parcel or annual crops cultivated under forest trees. Moreover, also combinations of annual crops, meadows and/or permanent crops mixed with natural vegetation or natural areas belong to this class.

Specific decision rules have been stabilised to distinct different types of heterogeneous agricultural areas:

- Non-irrigated annual crops associated or in mosaic with permanent crops (vineyards, olives groves and non-irrigated fruits trees) in parcels < 0.5 has. → 2.3.1.1 *Annual crops associated with permanent crops*.
- Mosaic or association of non-irrigated permanents crops in parcels < 0.5 has. → 2.3.2.1 *Complex cultivation patterns*.
- Mosaic or association of irrigated and non-irrigated crops (annual and/or permanent) in parcels < 0.5 has. → 2.1.4.1 *Complex patterns of irrigated and non-irrigated arable land*.
- Mix of non-irrigated crops (annual and/or permanent) and pastures → 2.3.2.1 *Complex cultivation patterns*.
- Mix of irrigated crops (annual and/or permanent) and pastures → 2.3.2.1 *Complex cultivation patterns.*
- Crops (annual/permanent/irrigated/non-irrigated) and mosaic of crops and pastures in mosaic or invaded by natural vegetation (agricultural area > 75% and presence of parcels) → 2.3.3.1 *Land principally occupied by agriculture with significant areas of natural vegetation.*
- Agro-forestry landscapes in specific locations → 2.3.4/2.3.5 Agro-forestry.

This category includes:

2.1 Arable land
    2.1.1 Non-irrigated arable land
        2.1.1.1 Non-irrigated arable land
    2.1.2 Greenhouses
        2.1.2.1 Greenhouses
    2.1.3 Irrigated arable land and rice fields
        2.1.3.1 Irrigated arable land and rice fields
    2.1.4 Complex patterns of irrigated and non-irrigated arable land
        2.1.4.1 Complex patterns of irrigated and non-irrigated arable land

2.2 Permanent crops
    2.2.1 Vineyards
        2.2.1.1 Vineyards
    2.2.2 Fruit trees and berry plantations
        2.2.2.1 High stem fruit trees (extensively managed)
        2.2.2.2 Low stem fruit trees and berry plantations
    2.2.3 Olive groves
        2.2.3.1 Olive groves

2.3 Heterogeneous agricultural area
    2.3.1 Annual crops associated with permanent crops
        2.3.1.1 Annual crops associated with permanent crops
    2.3.2 Complex cultivation patterns
        2.3.2.1 Complex cultivation patterns
    2.3.3 Land principally occupied by agriculture with significant areas of natural vegetation
        2.3.3.1 Land principally occupied by agriculture with significant areas of natural vegetation
    2.3.4 Agro-forestry T.C.D. > 30%
        2.3.4.1 Agro-forestry T.C.D. > 30%
    2.3.5 Agro-forestry T.C.D. < 30%
        2.3.4.2 Agro-forestry T.C.D. < 30%

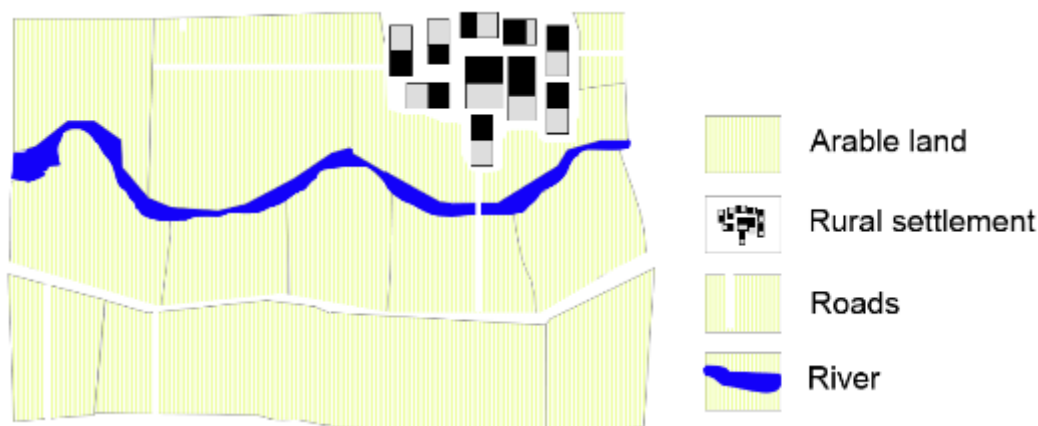## 2.1.1.1 Non-irrigated arable land

Definition

All kind of crops like cereals, legumes, fodder crops, root crops and fallow land. Includes flower and tree (nurseries) cultivation and vegetables (e.g. asparagus), whether open field or under plastic sheets. Includes market gardening and aromatic, medicinal and culinary plants.

Non-irrigated arable land: Rapeseed in Germany. Credits: M. Probeck

Non-irrigated arable land: Parcel of cereal harvested in Central Spain. Credits: M. Palacios

Schematic representation of managed non-irrigated arable land.

This category includes:

- All kinds of non-irrigated, arable land excluding permanent crops.
- Includes „hop plantations".
- Multi-year crops as asparagus and chicory – also if planted under plastic sheets.
- Semi-permanent crops as strawberries.
- Temporary fallow land (land under three yearly rotation systems).
- Drained arable land.
- Non-permanent industrial crops as textile plants (e.g. cotton, flax), oleaginous plants (e.g. rapeseed, sunflower).
- Tobacco.
- Condiment plants.
- Sugar cane.
- Flowers under rotation system.
- Industrial flower crops as lavender species.
- Nurseries-garden (seedlings of fruit trees and shrubs).

- Abandoned irrigated arable land even the irrigation channel network is still visible in the satellite image.
- Strawberries not irrigated.
- Cereals burnt after harvesting (usual practice in Anatolia, Turkey).
- Arable fields using for growing hay.

This category excludes:

- Permanent crops → 2.2.x.x *Permanent crops*.
- Managed and natural grassland → 4.x.x.x *Grassland*.
- Allotment gardens, city gardens → 1.4.1 *Green urban areas*/1.4.2 *Sports and leisure facilities*.
- Land that lies fallow for at least three years and which looks like grassland → 4.2.x.x *Natural grassland*.
- Rice fields → 2.1.3.1 *Irrigated arable land and rice fields*.
- Forest tree nurseries with non-commercial purposes located in forest areas → 3.x.x.x. *Woodland and forest*.
- Fruit and berry plantation under greenhouses → 2.1.2.1 *Greenhouses*.
- Osier trees for wicker production → 2.2.2.1 *High stem fruit trees (extensively managed)*.
- Permanent plantations of roses → 2.2.2.2 *Low stem fruit trees and berry plantations*.
- Wine-growing nurseries → 2.2.1.1 *Vineyards*.

Attributes:

- N/A

Appearance:

Non-irrigated agricultural fields in Northern Germany. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2012-07-27. Source: CNES 2012©, Distribution Airbus DS/Spot Image

- Landscape structured by fields of rectangular size
- Mix of diverse crops resulting in a heterogeneous pattern of different image colours and image textures
- Located on fertile grounds and in vicinity to settlements
- Mix of red, green and blue colours. Red colours indicate vital green whereas green and light blue colours are an evidence for open soil of fields which already have been harvested
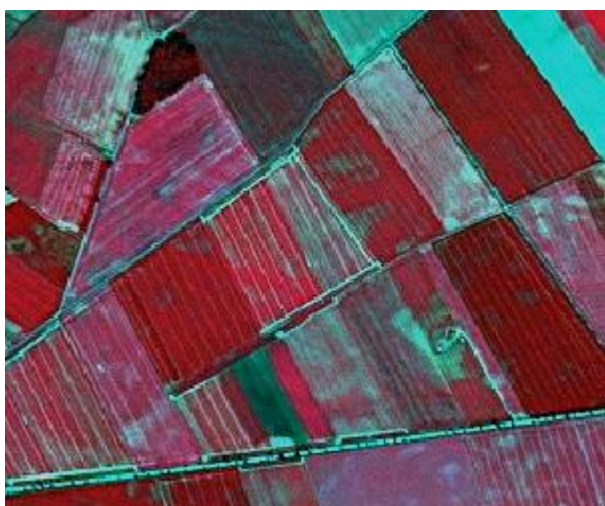
Non-irrigated arable land in central Europe (Germany). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2010-06-28. Source: CNES 2010©, Distribution Airbus DS/Spot Image

- Plough furrows are a typical characteristic of crops

Non irrigated arable land in Altnkusak (Anatolia, Turkey) SPOT-5 (2,5 m.) (NIR/R/G Band Combination). Date: 2011-08-05.Source: CNES 2011© Distribution Airbus DS/Spot Image

- Yellow/white colours in summer-time

Non-irrigated arable land in northern Sweden. (1/2/3 Band Combination). SPOT-5 image. Date: 2013-08-05. Source: CNES 2013©, Distribution Airbus DS/Spot.

- Square allotments, flat surface. Occasionally plowing furrows can be seen.

Methodological approach:

- Computer assisted visual interpretation of DWH CORE_03 data
- Use of additional data sources like e.g. AWiFS imagery of DWH CORE_08, Core_01 EO data, Landsat Archive, HR Grassland layer or any other additional data source available on national/local level for effective differentiation between arable land and grassland
- EO data acquired outside the vegetation period may also support the discrimination between arable land and grassland
- Ancillary data in specific cases (LPIS - Land Parcel Identification System -Swedish Board of Agriculture- / Topographic map –Lantmäteriet- in the case of Sweden)

2.1.2.1 Greenhouses

Definition:

All types of greenhouses regardless of whether they have solid glass or plastic roofs. The greenhouses are used to breed plants, vegetables or flowers.

This category includes:

- All kinds of greenhouses used to breed trees, plants, vegetables or flowers.
- Greenhouses not covered during EO data date and with presence of infrastructure.

Greenhouse in Almeria (Andalusia, Spain). Credit: Eurostat Lucas 2009.

Greenhouses structure in Almeria (Andalusia, Spain). Credit: Eurostat Lucas 2009.

This category excludes:

- Crops grown under plastic sheets (e.g. asparagus, strawberries plantations and other vegetables) → Other types of crops.

Attributes:

- o   N/A

Appearance:

Nursery with greenhouses, Lampertheim, (Germany).SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2010-07-14 Source: CNES 2010©, Distribution Airbus DS/Spot Image

- Mostly located in rural areas at the outer border of settlements, but near cities.

- High reflection of buildings due to the plastic or glass roofs. This may lead to confusions with industrial or commercial buildings. It is therefore recommended to check the objects with high-resolution data sources or other data sources like e.g. topographic maps.

- Oftentimes surrounded by small fields where vegetables or flowers are grown.
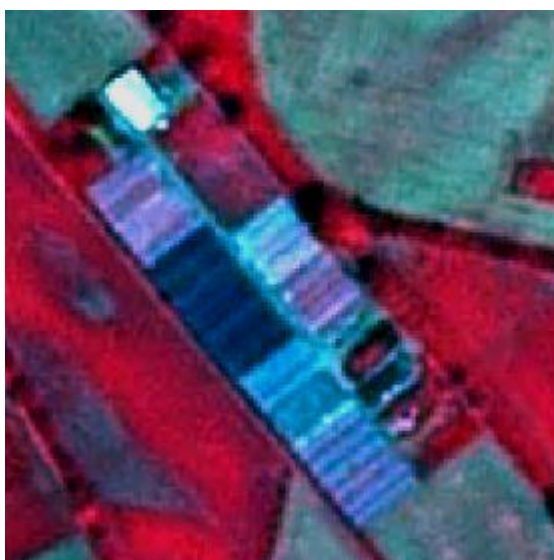
Nursery with greenhouses, Lampertheim, (Germany).SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2010-07-14 Source: CNES 2010©, Distribution Airbus DS/Spot Image

- Typical characteristic: long but very small narrow, parallel buildings.

- Certain types of greenhouses can open their roofs. In this case, the greenhouse may appear as a normal field.

Greenhouses in Koru (Turkey). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-06-29. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

- Typical characteristic: long but very small narrow, parallel buildings.
- In Mediterranean areas, located in very intensive agricultural areas and in many cases mixed with irrigated parcels.

Methodological approach:

- Computer assisted visual interpretation of DWH CORE_03 data
- Use VHR data sources like e.g. aerial orthophotos from national data bases or any other adequate VHR images to verify the interpretation.

2.1.3.1 Irrigated arable land and rice fields

Definition:

Crops irrigated permanently or periodically. Most of the crops cannot be cultivated without an artificial water supply.

Use of permanent irrigation infrastructure (irrigation channels, drainage network, irrigation ponds).This class includes also rice fields and irrigated fruits trees and vineyards in Mediterranean region. Irrigated arable land are restricted to Mediterranean areas, except clear areas with irrigated permanent infrastructures in other regions (such as Po river valley or Danube plain in Romania). The delimitation of Mediterranean will be based on biogeographic regions cartography.

This category includes:

- **Traditional irrigated arable land with permanent irrigation infrastructure**. Traditional irrigation areas located in fertile alluvial soils alongside the main Mediterranean rivers. These areas also include intensively or extensively managed fruit trees.

Irrigation channel in Osmaniye (Turkey). Credits:"Osmaniye irrigation" by Ozgurmulazimoglu - Own work. Licensed under Creative Commons Attribution-Share Alike 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Osmaniye_irrigation.JPG#mediaviewer/File:Osmaniye_irrigation.JPG
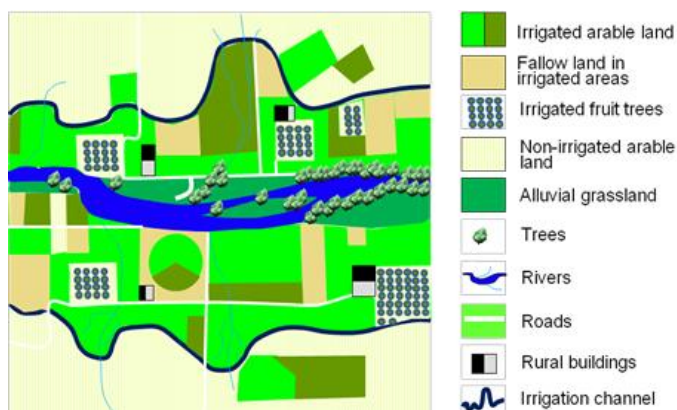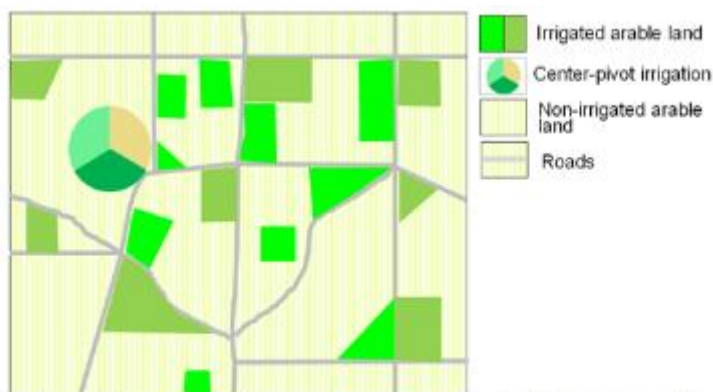

Schematic representation of a permanent irrigated area with irrigation channels.

- **Rice fields** in Italy, Spain, Portugal or France (e.g. Camargue). Rice fields can be periodically flooded.

- **Irrigated land using underground water** when parcels > 0.5 ha (regardless of the irrigation system). In many cases, parcels occupied with crops under sprinkling irrigation systems are mixed with parcels occupied by non-irrigated crops. The location of irrigated parcels can vary from an agricultural year to another within de same area.

Sprinkler irrigation. Credit: M. Palacios

Schematic representation of an area irrigated in summer-time using underground water

Legend:
- Irrigated arable land
- Center-pivot irrigation
- Non-irrigated arable land
- Roads

- **Areas predominantly irrigated using center-pivots irrigation systems**. Main areas are located in Turkey (Tigris-Euphrates basins), Central Spain (La Mancha and Ebro Valley) or Portugal (Alentejo).

Center-pivot irrigation system. Credit: J. Pecci
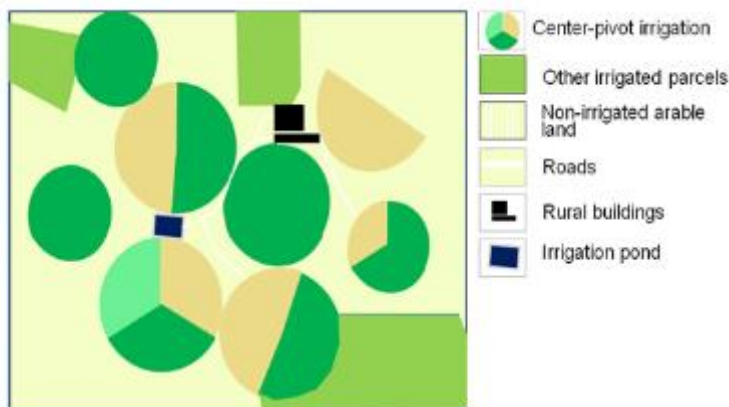
Schematic representation of an area irrigated using center-pivot irrigation systems

Legend:
- Center-pivot irrigation
- Other irrigated parcels
- Non-irrigated arable land
- Roads
- Rural buildings
- Irrigation pond

The location of the center-pivot systems can vary from an agricultural year to another within the same area.


Examples of center-pivot irrigation system not used to irrigate parcels in summer-time. Credits: M. Palacios

- **Fruit trees irrigated permanently and intensively managed**. Full irrigation is needed to maintain these crops (e.g. orange trees, lemon trees, peach trees, etc.). Irrigated strawberries fields intensively managed. Intensively irrigated vineyards in Mediterranean region. In many cases associated to artificial irrigations ponds. Well represented in Southern Spain. Parcel with young tree plantations are also included (identifiable by soil removal, big parcels, presence of irrigation ponds, etc.).

Irrigation pond and fruits trees in South-East Spain. Credit: M. Palacios
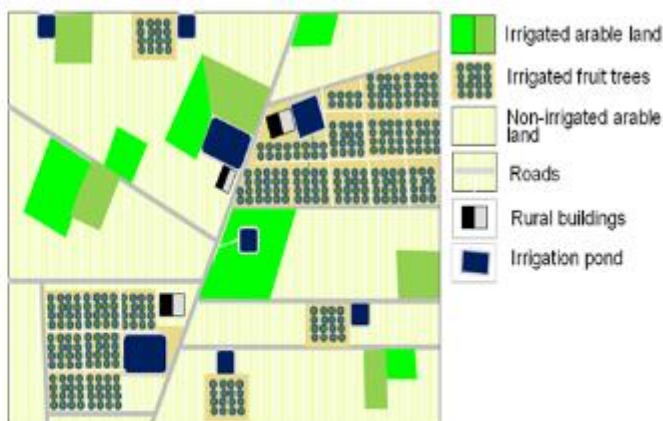
Schematic representation of irrigated fruits trees parcels with irrigation ponds

This category excludes:

- Drainage network intended to clean up wet soils → Classification according to their actual land cover.
- Crops under greenhouses → 2.1.2.1 *Greenhouses*.
- In specific locations across Europe, crops could be sporadically irrigated using sprinkler systems (e.g. improvement of production of potatoes or maize in dry summers in Central and Western Europe or irrigation of winter cereals in Southern Europe). Olive-trees, other fruit trees and vineyards could be also sporadically irrigated using localization irrigation systems. These categories are not included in this class → other arable land categories.
- Ancient rice fields with irrigation channels should be mapped according to their actual land cover.

Attributes:

o N/A

Appearance:

Traditional irrigated area in Saka (Anatolia, Turkey) SPOT-5 (2.5 m.) (NIR/R/G Band Combination). Date: 2011-09-06.Source: CNES 2011© Distribution Airbus DS/Spot Image.

Rice fields at Rosayenda, Italy. SPOT-5 (2.5 m) (1/2/3 band combination). Date: 2011-07-29. Source: CNES 20011©, Distribution Airbus DS / Spot Image

Traditional irrigated arable land with permanent irrigation infrastructure

- Red colours in summer-time
- Regular and small-medium parcels
- Irrigation channels visible.
- Villages and farms.

Rice fields

- In specific locations as deltas o near big rivers. Other locations are also possible.
- Red colours in summer-time. Presence of water in spring and soil in winter.
- Regular and small-medium parcels
- Clear presence of irrigation channels visible.
- Presence of buildings.

Irrigated land using underground water

- Regular medium and big parcels.
- Red colour in infrared bands combinations in summer time.
- Mixed with not irrigated parcels.

Viransehir, Turkey. Source: SPOT-5 (2.5 m) Natural colour combination. Date: 2006-09-16. CNES 2006 ©, Distribution Airbus DS / Spot Image

Center-pivot irrigation landscape

- Typical round shape of center-pivot irrigation systems.
- Red colour in infrared bands combinations in summer time.
- Mixed with not irrigated parcels.

Zaragoza (Ebro valley), Spain. Source: SPOT-5 (2.5 m) Natural colour combination. Date: 2006-08-27.CNES 2006 ©, Distribution Airbus DS / Spot Image

Intensively managed fruit trees plantations

- Identification of lines of trees.
- Red colour in infrared bands combinations in summer time.
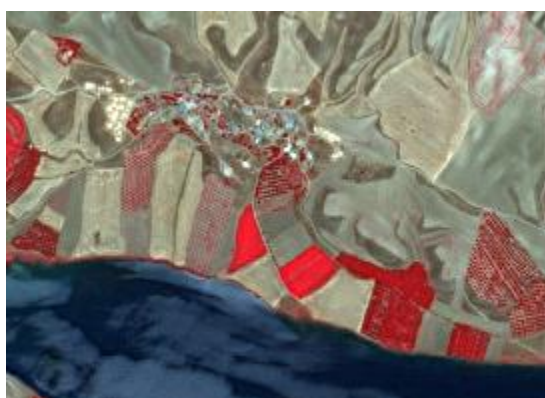
Irrigated fruits trees plantation in Morhamam (Anatolia, Turkey) SPOT-5 (2.5 m.) (NIR/R/G Band Combination). Date: 2011-06-29.Source: CNES 2011© Distribution Airbus DS/Spot Image.

Methodological approach:

- **Traditional irrigated land with permanent infrastructures**:

  o Extraction or irrigated land based on spectral signature of summer-time imagery.
  o Delineation of permanent irrigable land.
  o Non-irrigated land in the date of the image, fallow land and parcels presumably irrigated in spring-time within irrigable areas are included in 2.1.3.
  o Irrigated fruit-trees within these traditional irrigated areas are included in 2.1.3.1.
  o Center-pivot irrigation parcels within these traditional irrigated areas are included in 2.1.3.1.
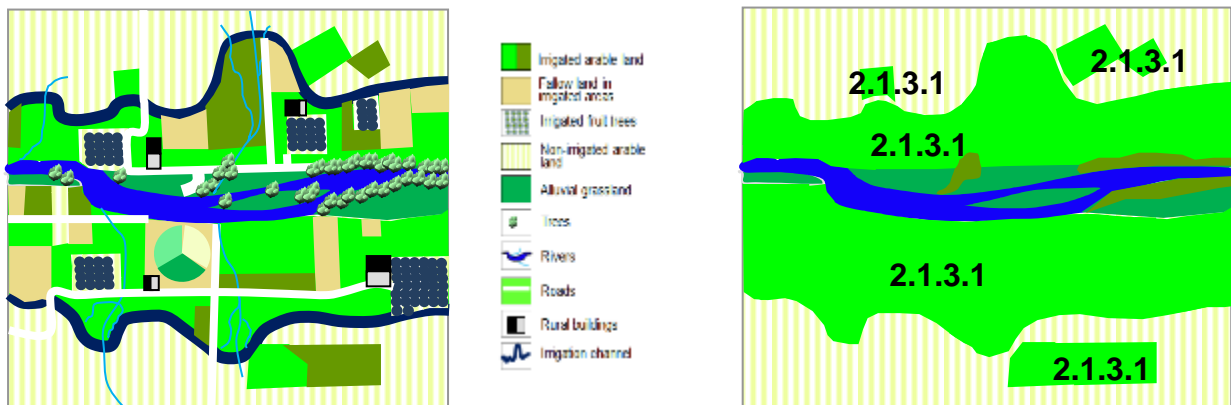
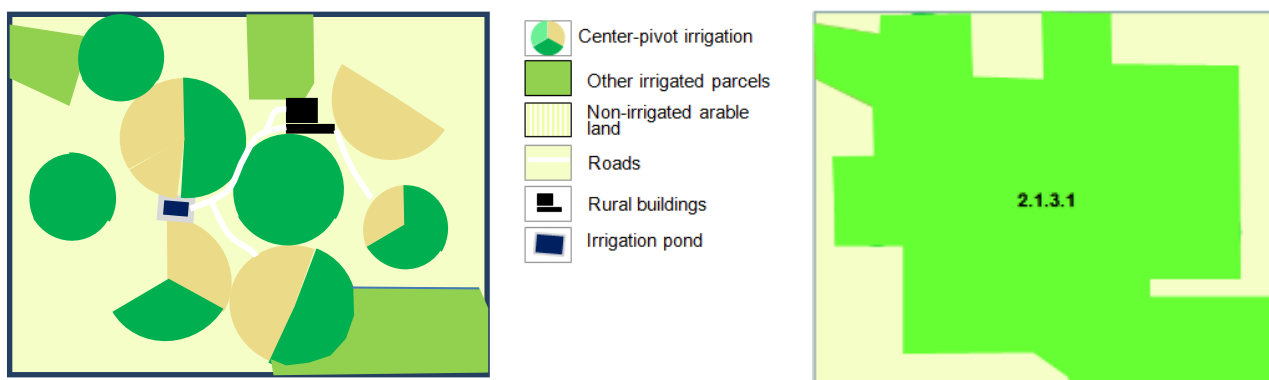*Example of final result of classification of traditional irrigated land with traditional infrastructures*

- **Irrigated land using underground water**:

  o Extraction or irrigated land based on spectral signature of summer-time imagery of use of series of images (as Landsat).
  o Parcels with the accurate spectral signature and > 0.5 ha will be considered as 2.1.3.1.
  o Only it will be considered parcels irrigated at the date of the image. If summer-time imagery are not available Landsat time series will be used.
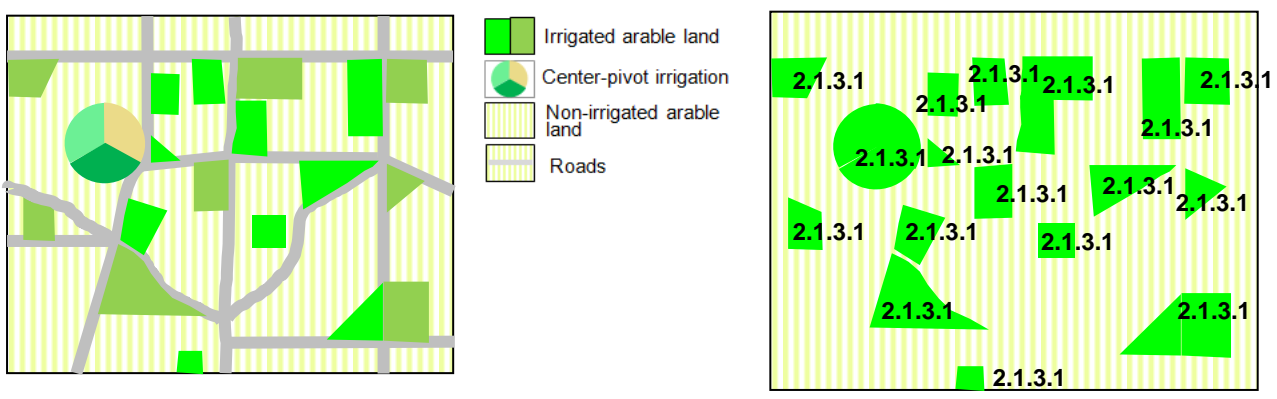
Example of final result of classification of irrigated land using underground water

- **Center pivot irrigation systems**

  o These type of irrigated landscapes are considered in the same way that other areas irrigated by underground water
  o Extraction or irrigated land based on spectral signature of summer-time imagery.
  o Parcels with the accurate spectral signature and > 0.5 ha will be considered as 2.1.3.1.
  o Only it will be considered parcels irrigated at the date of the image. If summer-time imagery are not available Landsat time series will be used.
  o Generalization rules will be applied grouping parcels where center pivots irrigation systems are included.

Example of final result of classification of center pivot irrigation systems

- **Intensively managed fruit trees plantations**:

  o Basically the identification will be carried out using visual interpretation.
  o All intensively managed irrigated fruit trees parcels are considered as irrigated land.
  o Young tree-plantations (e.g. visible due to the presence of ponds and soil removal) will be also included.
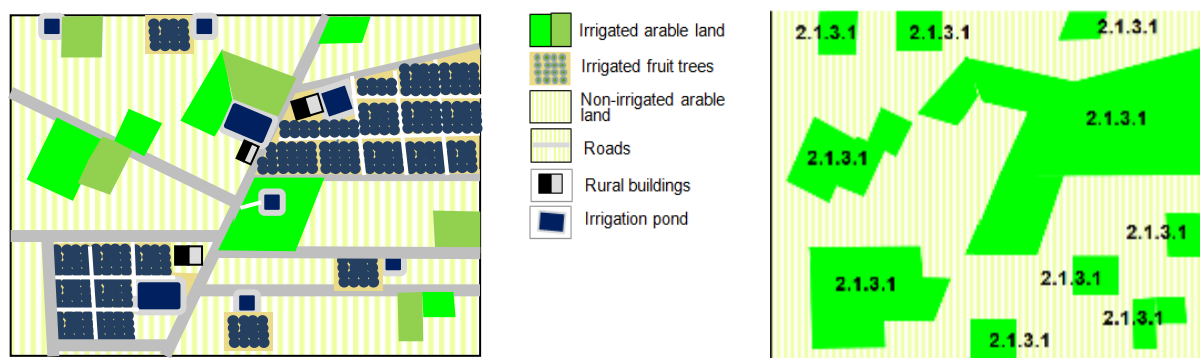
Example of final result of classification of intensively managed fruit trees plantations

Distinction irrigated/non irrigated land in Mediterranean region:

In order to extract irrigated areas in Mediterranean region, the use of time series images is essential: irrigated areas are characterized by red colours in infrared combinations bands in summer time, meanwhile, at the same time, non-irrigated parcels have not vegetation.

SPOT-5 2011-06- | SPOT-5 2011-07-15

Harran (Turkey) SPOT-5 (2.5 m.) (NIR/R/G Band Combination). Date: 2011-06-04 and 2011-07-15 .Source: CNES 2011© Distribution Airbus DS/Spot Image.

- There are discrepancies between coverages on the overlapped area. It is not possible to produce a proper LCLU interpretation for irrigated land using only mono-temporal CORE03 images. In this case is only possible to detect irrigated parcels (in red colours) using the most suitable image (in this case the image dated 2011-07-15)


Akoren (Turkey) SPOT-5 (2.5 m.) (NIR/R/G Band Combination). Date: 2011-06-04 (left) and 2011-08-15 (right). Source: CNES 2011© Distribution Airbus DS/Spot Image. Irrigated parcels are only visible in the image dated 2011-08-15.

- When using only one acquisition date image, irrigated areas can be often dismissed. Further assessment and revision will be required.
- CORE03 and Landsat series will be used.
- The reference year for the time series selection must be the most frequent year on the CORE03 product.
- Both irrigated and non-irrigated area delimitation should be performed through CORE03 product, while time series Landsat images must be considered to assign the appropriate category (2111 or 2131).

2.1.4.1 Complex patterns of irrigated and non-irrigated arable land

Definition:

Small irrigated parcels mixed with non-irrigated arable land parcels. Includes irrigated fruits trees.
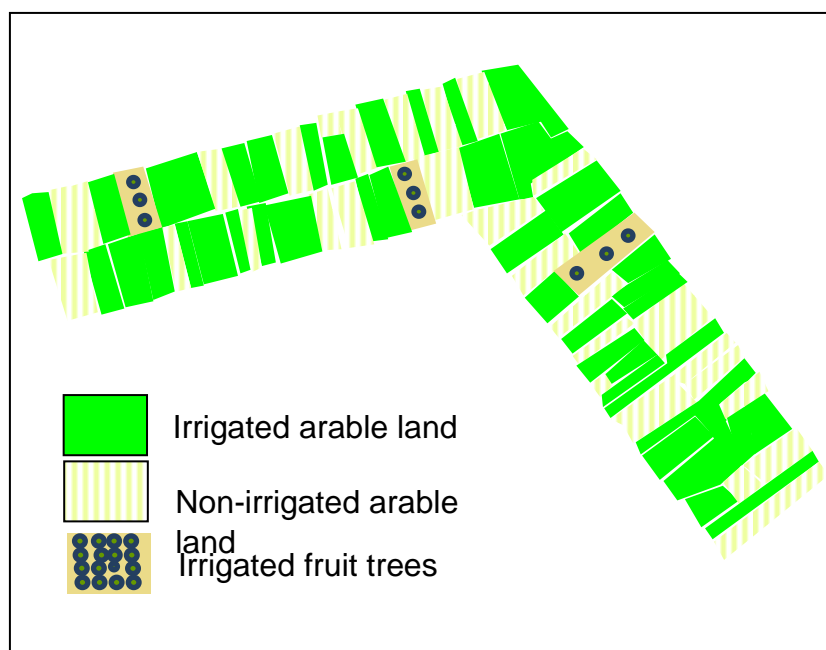
Schematic representation of complex patters of irrigated and non-irrigated arable land

This category includes:

- Mosaic of small irrigated and non-irrigated parcels.
- Mosaic of small irrigated and non-irrigated parcels due abandonment process of irrigated parcels in traditional irrigated arable land.
- This class includes irrigated fruits trees.

This category excludes:

- Irrigated land parcels larger than 0.5 ha. 2.1.3.1 *Irrigated arable land and rice fields.*
- Non-irrigated arable land parcels larger than 0.5 ha →2.1.1.1 *Non-irrigated arable land.*
- Mosaic of small parcels of diverse annual crops, pastures and/or permanent crops.→ 2.3.2.1 *Complex cultivation patterns.*
- Complex patterns of irrigated and non-irrigated arable with significant presence of natural vegetation → 2.3.3.1 *Land principally occupied by agriculture with significant areas of natural vegetation*.

Attributes:

- o N/A

Appearance:

Example of class 2.1.4.1. Kallithiro (Turkey).SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-09-02. Source: CNES 2011©, Distribution Airbus DS/Spot Image
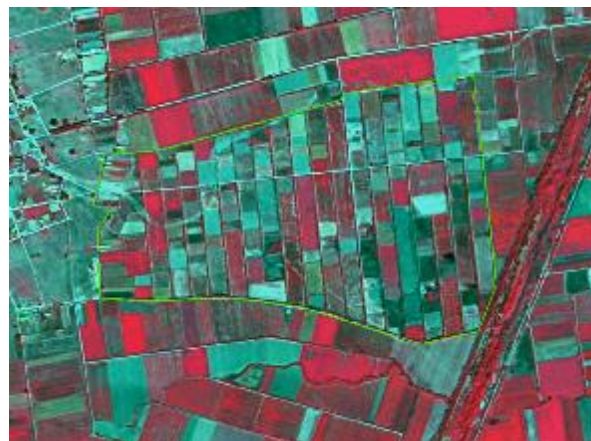
Example of class 2.1.4.1. Megala Kalivia (Greece). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-09-02. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- Mosaic of irrigated parcels (red colours in infrared bands combinations) and non-irrigated parcels (not presence of vegetation in summer-time).
- Small parcels with presence of red colours (infrared bands combinations) in summer-time.
- In many cases, presence of irrigated trees.
- In the case of irrigated land in abandonment process, located in traditional irrigated valleys.

Methodological approach:

- Visual interpretation.

2.2.1.1 Vineyards

Definition:

Plantations of traditional and intensive managed grapevine grown mainly for winemaking, but also raisins, table grapes and non-alcoholic grape juice.

Vineyards in Dordogne (France). Credits: C. Alonso

Vineyards in Duero Valley (Central Spain). Credits: M. Palacios

Vineyard in Loutsa (Island of Evia), Greece. Credits: N. Kolpatzik

This category includes:

- Plantations of traditional and intensive managed grapevine including vine-growing nurseries, interspaces of vegetation and small access roads.
- Complex cultivation patterns where vineyards cover more than 50% of the area.
- Abandoned vineyards in case they still have the characteristic structure.

This category excludes:

- Intensively irrigated vineyards in Mediterranean region → 2.1.3.1 *Irrigated arable land and rice fields.*
- Annual crops associated with vineyards (2.3.1.1 *Annual crops associated with permanent crops*) if the single features are < 0.5 ha.
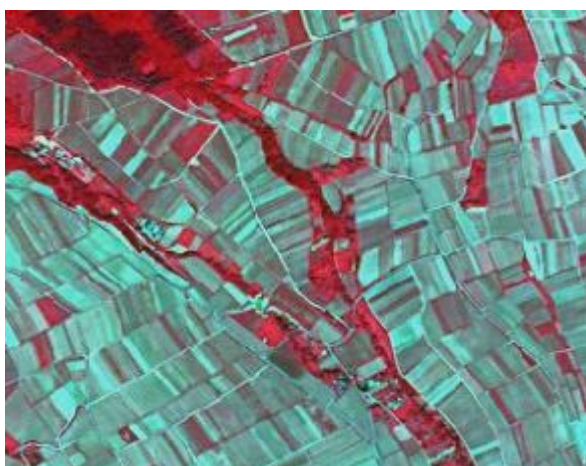
Attributes:
  o N/A

Appearance:

Vineyards at Úbeda (Spain). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-12. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- Characteristic structure: small parcel sizes, terraced cultivation and high reflectance of open soil when cultivated in rows.

Vineyard at Oestrich-Winkel (Germany). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2010-06-03. Source: CNES 2010©, Distribution Airbus DS/Spot Image.

- Characteristic structure: small parcel sizes, terraced cultivation and high reflectance of open soil when cultivated in rows.

Vineyard at Lösnich (Germany). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2010-06-03. Source: CNES 2010©, Distribution Airbus DS/Spot Image.

- Location in Central Europe and other Atlantic areas: very often located at steep river shores and at sun-oriented hillsides.

Methodological approach:

- Use of CLC class 2.2.1 as orientation.
- Final detailed delineation and identification using computer assisted visual interpretation.
- Use information of topographic maps to support the interpretation.
- Care has to be taken not to confuse orchards trained on espaliers with vineyards.
- If vineyards are associated with fruit trees within a single parcel, map
  - 2.2.1.1 *Vineyards* if vineyards cover $\geq 50\%$
  - 2.2.2.x *Fruit trees* if vineyards cover $< 50\%$
- If vineyards is associated to olive trees within a single parcel, map 2.2.1.1 *Vineyards*.

2.2.2.1 High stem fruit trees (extensively managed)

Definition:

Parcels planted with fruit trees, single or mixed fruit species, fruit trees associated with permanently grassed surfaces. Includes chestnut and walnut groves.

Apple trees in Slovakia. Credit: Eurostat Lucas 2009.

Almond trees in Valencia region (Spain). Credit: Eurostat Lucas 2009.

Cherry fruit trees, western Germany. Source: © LUCAS 2012.

This category includes:

- Scattered high-stem deciduous and evergreen fruit trees (e.g. apple, pear, plum, apricot, peach, cherry, citrus trees) planted in the field. The underground is mostly grassland, but can also be arable land.
- Central Europe: "meadow orchards" which is a traditional landscape in the temperate, maritime climate.
  Mediterranean zone: non-irrigated fruit trees (almonds and others as *ceratonia siliqua* or cherries and chestnut trees in mountainous areas), in many cases mixed with vineyards and olive groves and cereals. Pistachio trees in Turkey.
- Willow plantations for wicker production.
- Abandoned orchards which still preserve characteristic alignments.

This category excludes:

- Intensively irrigated fruit trees → 2.1.3.1 *Irrigated arable land and rice fields*.
- Fruit trees under greenhouses → 2.1.2.1 *Greenhouses*.
- Hop plantations → 2.1.1.1 *Non-irrigated arable land*.
- Berry plantations → 2.2.2.2 *Low stem fruits trees (extensively managed)*.
- Olive groves → 2.2.3.1 *Olive groves*.
- Vineyards → 2.2.1.1 *Vineyards*.
- Fruit tree nurseries → 2.1.1.1 *Non-irrigated arable land*.
- Carob trees → 3.1.x.x *Woodland and forest*.
- Chestnut/walnut for wood production → 3.1.x.x *Woodland and forest*.
- Abandoned orchards where plantation structures have disappeared → 3.4.1.1 *Transitional woodland and scrub*.
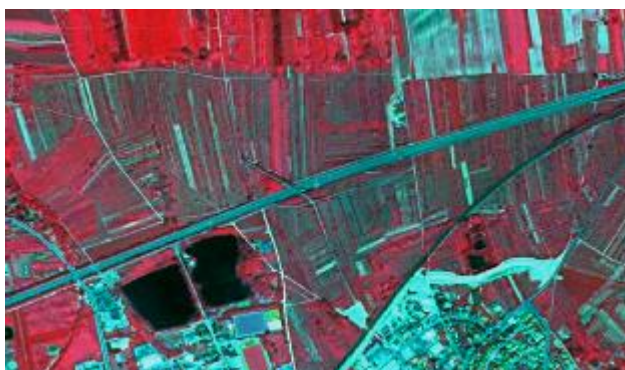
Attributes:

- N/A

Appearance:

Helmarshausen (Germany), SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2010-06-28. Source: CNES 2010©, Distribution Airbus DS/Spot Image.

- In vicinity to urban areas or agricultural farms; mostly private use.
- In most cases irregular planting scheme
- In Central Europe: understorey is normally grassland, sometimes also arable land (e.g. Luxemburg)

Ingelheim am Rhein (Germany), SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2010-06-03. Source: CNES 2010©, Distribution Airbus DS/Spot Image.

- Sometimes planted in small stripes
- In Central Europe: understorey is normally grassland, sometimes also arable land (e.g. Luxemburg)

Example of pistachio cultivation. Nizip (Turkey) 1/2/3 Band Combination). Date: 2011-05-07. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- Regular planting scheme.
- Big tree crown and red color in infrared band combinations.
- Understory without vegetation.
- Usually in fertile soils.

Methodological approach:

- Use of CLC2006/2012 delineation to locate the areas and refine the interpretation
- Use additional information from topographic maps in order to support correct interpretation.
- In case, fruit trees are associated to olive trees on the same parcel, map
    - 2.2.3.1 Olive groves, if olive trees cover ≥ 50%
    - 2.2.2.1 High stem fruit trees (extensively managed), if olive trees cover < 50%

2.2.2.2 Low stem fruit trees and berry plantations

Definition:

Parcels planted with small fruit trees or shrubs, single or mixed fruit species and berry plantations.

Low stem fruit trees near Rome, Italy. Source: © LUCAS 2012

This category includes:

- Low stem deciduous or evergreen fruit trees and berry plantations.
- Dwarf trees, shrubs espaliers or perennial ligneous climbers.
- Permanent florist plantation of roses.
- Permanent industrial plants like coffee, cacao, mulberry and tea.
- Plantation of vineyards associated to fruit trees within the same parcel where vines cover at least 40% of the cover

This category excludes:

- Hop plantations → 2.1.1.1 *Non-irrigated arable land*.
- Strawberries → 2.1.1.1 *Non-irrigated arable land*.
- Olive groves → 2.2.3.1 *Olive groves*.
- Vineyards → 2.2.1.1 *Vineyards*.
- Fruit tree nurseries → 2.1.1.1 *Non-irrigated arable land*.
- Permanently irrigated low stem fruit tree and berry plantations → 2.1.3.1 *Irrigated arable land and rice fields*.
- Multi-year plants as asparagus → 2.1.1.1 *Non-irrigated arable land*.

Attributes:

- N/A

Appearance:

- Appearance similar to orchards and shrub, but regular planting scheme
- Coarse texture
- Appearance similar to arable crops
- In many cases (e.g. tea plantations) ancillary data is needed for identification.
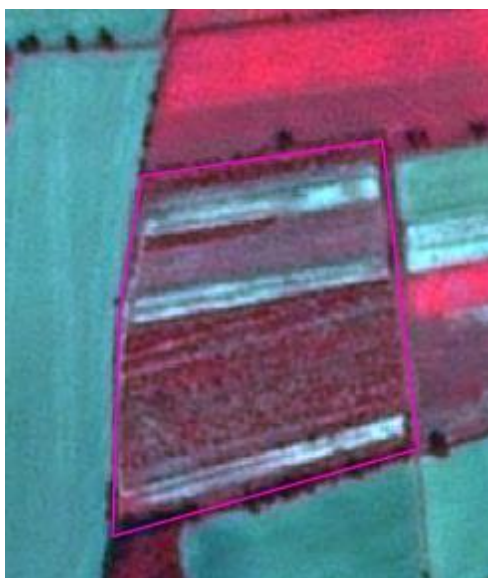
Schwarmstedt (Germany). SPOT-5 (2.5 m) (1/2/3 Band Combination). Central Europe (Germany). Date: 2013-09-05. Source: CNES 2013©, Distribution Airbus DS/Spot Image.
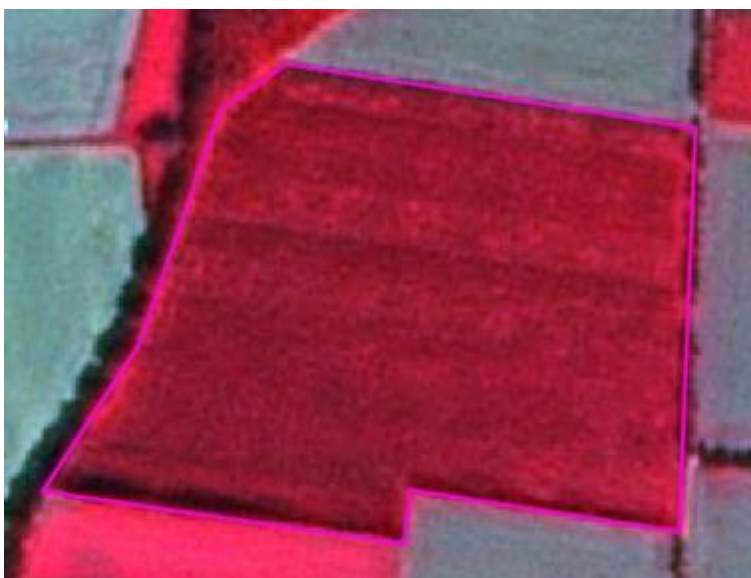
Apple plantation at Schwarmstedt (Germany). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2013-09-05. Source: CNES 2013©, Distribution Airbus DS/Spot Image.

Methodological approach:

- Ancillary data will be necessary in most cases to discriminate this class.
- Use CLC class 2.2.2 as basis and do a refinement.
- Where low stem fruit trees are associated to vines on the same parcel, the following rules are applied:
  Fruit tree cover 50%, vine cover 50% → *2.2.1.1 Vineyard*.
  Fruit tree cover > 50%: → *2.2.2.2 Low stem fruit trees*.
  Fruit tree cover < 50%: → *2.2.1.1 Vineyards*.
- Where low stem fruit trees are associated to olive trees on the same parcel, the following rules are applied:
  - Fruit tree cover 50%, vine cover 50% → *2.2.3.1 Olive trees*.
  - Fruit tree cover > 50%: → *2.2.2.2 Low stem fruit trees*.
  - Fruit tree cover < 50%: → *2.2.3.1 Olive trees*.

Generalization for low stem fruit trees mixed with fallow land or annual agricultural crops:

- Inside class 2.2.2.2, a differentiation between potential annual agricultural parcels and fallow land that is under preparation for new plantations is not feasible. Those areas of fallow or annual arable land will therefore be included in class 2.2.2.2 although they may partially be slightly > 0.5 ha in order to represent the dominating character of class 2.2.2.2.

Śniadków Dolny (Poland). Spot 6 (1.5 m) (4/1/3 Band Combination). Date: 2013-08-06. Source: CNES 2013©, Distribution Airbus DS/Spot Image.

Approach for small, unvegetated stripes of fallow land/annual crops inside areas which are mainly covered by low stem fruit trees:

- Cut out big, related blocks of unvegetated areas (see yellow arrow)
- Integrate smaller unvegetated stripes into 2.2.2.2
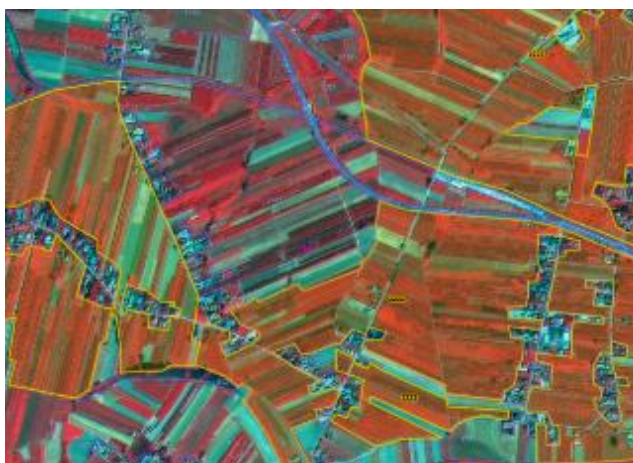
Bogoria (Poland). Spot 6 (1.5 m) (4/1/3 Band Combination). Date: 2013-08-06. Source: CNES 2013©, Distribution Airbus DS/Spot Image.

- If > 75% of area is covered by fruit trees, map whole area as 2.2.2.2
- Areas with < 75 % fruit trees will be mapped as 2.3.2.1 *Complex cultivation patterns*

2.2.3.1 Olive groves

Definition:

Areas planted with olive trees.

Olive groves in a mountainous area in South-western Spain. Credits: M. Palacios

Young plantation of olive trees in Southern Spain. Credits: J. Pecci

Olive groves in Kathenes (Island of Evia), Greece. Credits: N. Kolpatzik

Olive groves in Kallithea (Island of Evia), Greece. Credits: N. Kolpatzik

This category includes:

- Olive trees dedicated to production of olives and oil.
- There are some instances when olive and vineyard parcels are combined, in this case the parcels have to be delimitated individually if they are > 0.5 ha, but should be included in the same polygon when they are < 0.5 ha. Whether they are assigned to olive grove or to vineyards will depend on density.

This category excludes:

- Olive trees are considered as non-irrigated crops, except in specific sites where they are in association or mosaic with irrigated annual crops → 2.1.3.1 *Irrigated arable land and rice fields.*
- Wild olive trees → 3.4.1.1 *Transitional woodland and scrub.*
- Abandoned olive trees → 5.2.1.1 *Transitional woodland and scrub.*

Attributes:

- o   N/A

Appearance:

- Scattered trees on grassland or arable land.
- Regular and irregular planting scheme.
- In most cases clearly visible in the images due to characteristic spotted structure.

Olive grove with vineyards around. Úbeda (Spain). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-12. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Olive grove, Badajoz (Spain). SPOT-5 (2.5 m.) (1/2/3 Band Combination). Date: 2011-03-18. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- Use of CLC class 2.2.3 as information source, excluding the areas irrigated over the images.
- In situ data (as Spanish SIOSE land cover map)
- Spectral signature.
- Final detailed delineation and identification using computer assisted visual interpretation.
- In case, fruit trees are associated to olive trees on the same parcel, map
  - 2.2.3.1 *Olive groves*, if olive trees cover ≥ 50%.
  - 2.2.2.2 *Low stem fruit trees*, if olive trees cover < 50%.

2.3.1.1 Annual crops associated with permanent crops

Definition:

Non-permanent crops (arable land or pasture) associated with permanent crops on the same parcel.
Mosaic of annual crops and permanent crops (parcels less than 0.5 ha).
This class is used in Mediterranean areas, where associations olive groves/vineyards and annual crops are not rare.

Typical landscape of annual crops in association and mosaic with olive groves and vineyards in Spain. Credit: Eurostat Lucas 2009.

This category includes:

- Association of annual and permanent crops while the proportion of each crop is below the MMU of 0.5 ha.

This category excludes:

- Permanents crops (vineyards and olive groves) non-cultivated in mosaic or association with annual crops → 2.2.1.1 *Vineyards*/2.2.3.1 *Olive groves.*

Attributes:

o   N/A

Appearance:

- The same appearance that annual crops, olive groves and vineyards.

-

Methodological approach:

- Computer assisted visual interpretation of Core_03_EO data and other available data sources
- Classification based on CLC guideline for class 2.4.1
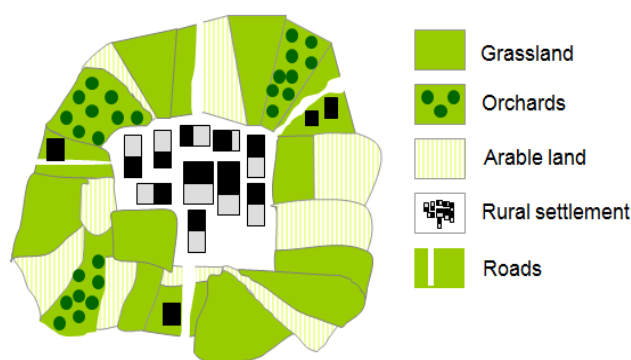
2.3.2.1 Complex cultivation patterns

Definition:

Mosaic of small parcels of diverse annual crops, pastures and/or permanent crops.
This class includes mixed parcels (< 0.5 ha) of permanent crops (fruits trees as almonds and others, berry plantations, vineyards and olive groves.

The distinction from 2.3.3.1 *Land principally occupied by agriculture with significant areas of natural vegetation* is that in class 2.3.3.1 natural vegetation (patches of trees, small forests, scrub) or natural objects like little lakes or ponds need to be present. This is not the case for class 2.3.2.1. Here we only have a mixture or annual crops, grassland and/or permanent crops, but no natural vegetation.

In the case of distinction from 2.1.4.1 *Complex cultivation patterns* regarding irrigation, is that in class 2.1.4.1 are irrigated parcels (annual and permanents crops) but due the size of the parcels (<0.5 ha) is not possible to distinguish between 2.1.3.1 *Irrigated arable land and rice fields* and non-irrigated land.

	Grassland
	Orchards
	Arable land
	Rural settlement
	Roads

Schematic representation of 2.3.2.1 complex cultivation patterns
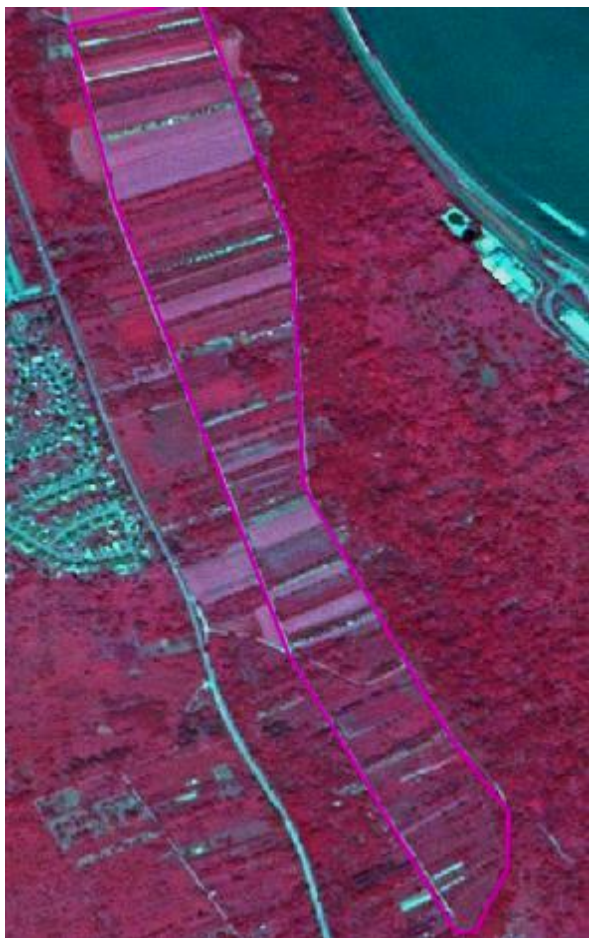
This category includes:

- Diverse annual crops, pastures and/or all kinds of permanent crops (vineyard, fruit trees, berry plantation, olives groves, etc.).
- Mixed parcels of permanent crops (fruits trees as almonds and others, berry plantations, vineyards and olive groves. Each category covers less than < 0.5 ha.

This category excludes:

- This class does not include irrigated complex cultivation patterns. These are included in class 2.1.3.1 *Irrigated arable land and rice fields*.
- Hobby gardens / city gardens / allotment gardens → 1.4.2.x *Sport and leisure facilities*.
- Market gardening → 2.1.1.1 *Non-irrigated arable land*.
- Nursery cultivation → 2.1.1.1 *Non-irrigated arable land*.

Attributes:

- N/A

Appearance:

Mix of annual and permanent crops, Bad Salzig (Germany). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2010-06-03. Source: CNES 2010©, Distribution Airbus DS/Spot Image.

- Coarse texture
- Mix of diverse colours
- Small parcels separated or mixed with rows of trees or vine
- Very fine texture and characteristic pattern caused by small parcels of diverse annual crops, pasture and/or annual crops.

Methodological approach:

- Apply CLC guidelines for class 2.4.3 and do a refinement.
- Investigate image texture and structure to find objects of this class.
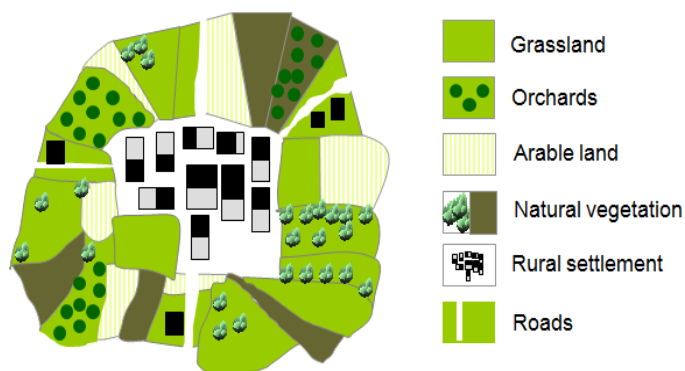- Computer assisted visual interpretation.

2.3.3.1 Land principally occupied by agriculture with significant areas of natural vegetation

Definition:

Areas principally occupied by agriculture (mix of crops/grassland), interspersed with significant natural areas.

Agricultural parcel included in an area with vegetation natural (spontaneous grasses, trees, scrub, etc.). Credits: M. Rodriguez

Schematic representation of 2.3.3.1 land principally occupied by agriculture with significant areas of natural vegetation

This category includes:

- Parcels of annual cropland in mosaic/association with natural vegetation < 0.5 ha.
- Parcels of permanent crops in mosaic/association with natural vegetation < 0.5 ha.
- Parcels of natural/semi-natural vegetation (forest, groups of trees, shrub, small water bodies) < 0.5 ha mixed with arable land.
- *Hortillonage* (vegetable crops and canals) in France.
- Agriculture and scattered heaps of stones.

This category excludes:

- Mixture of arable land and permanent crops without parcels of natural vegetation → 2.3.2.1 *Complex cultivation patterns.*
- Areas, where agricultural area (2.1.x.x, 2.2.x.x, 2.3.x.x) is > 75% → 2.x.x.x *Croplands.*
- Areas, where natural/semi-natural area is > 75% → 3.x.x.x *Woodland and forest.*
- Hedged areas.
- Areas with grassland and natural vegetation → 4.1.1.1. *Managed grassland with trees and scrubs* or 4.2.1.1 *Dry grassland with trees*, 4.2.1.1 *Mesic grassland with trees.*
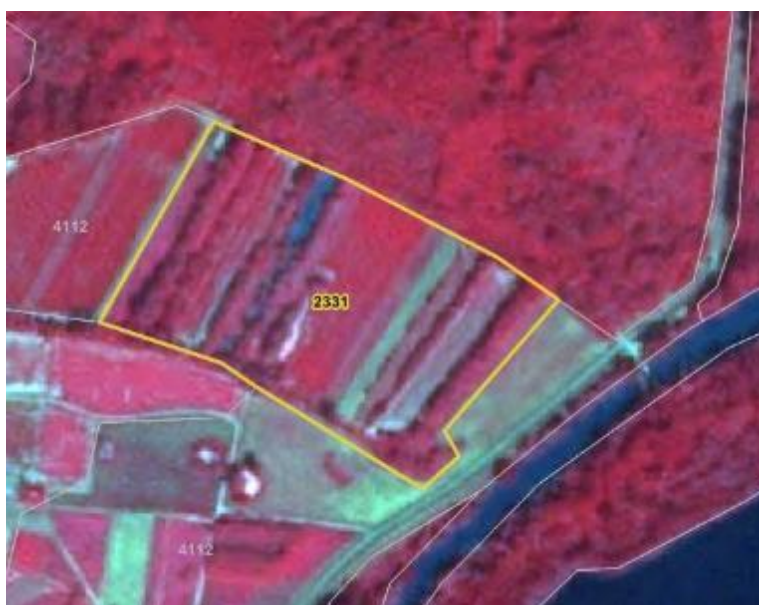
Attributes:

- N/A

Appearance:

Heterogeneous areas with predominant land parcels structure but presence of natural vegetation.
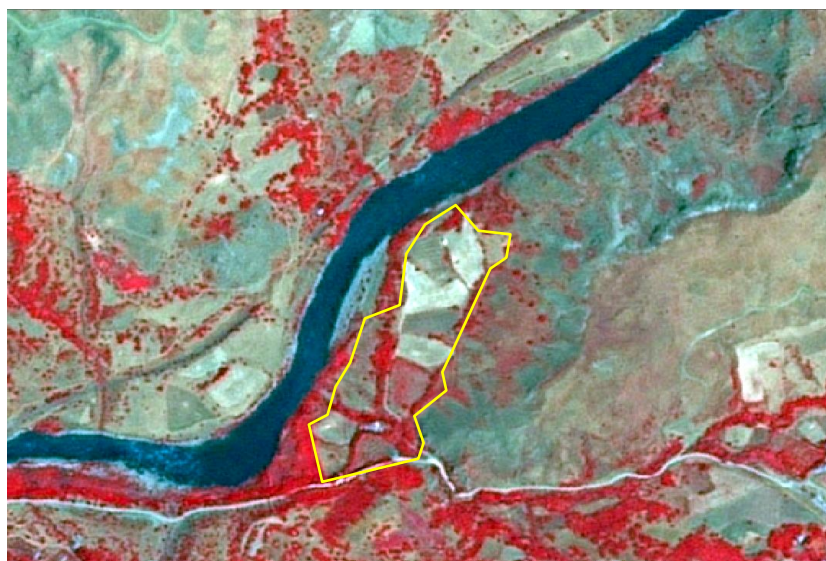
Agricultural area with vegetation natural in Inandik (Anatolia, Turkey) SPOT-5 (2.5 m.) (NIR/R/G Band Combination). Date: 2011-07-16.Source: CNES 2011© Distribution Airbus DS/Spot Image.

Land principally occupied by by agriculture with significant areas of natural vegetation (2331) in Germersheim (Germany). SPOT-5 (2.5 m.) (NIR/R/G Band Combination). Date: 2010-07-14. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- Computer assisted visual interpretation.

2.3.4.1 Agro-forestry T.C.D. ≥ 30%

Definition:

Agro-forestry is a land use management system in which trees or shrubs are grown around or among crops or pastures. It combines agricultural and forestry techniques to achieve a more sustainable land use system. An example of this landscape is the *dehesa* (located in southern and central Spain and southern Portugal where it is called *montado*).

This category is limited to Mediterranean area.

In this landscape the understory is regularly cleared of scrubs to improve grasslands or trees.

Agroforestry areas with more than 50% of scrub understory is considered as forest.

Dehesa of cork oaks with very high T.C:D. in South-western Spain. Credits: M. Palacios

Dehesa invaded by scrubs. Credits: M. Palacios

This category includes: (areas with T.C.D. ≥ 30%)

- Trees (several species of *quercus*) with an understory of grasses (predominant) or arable land.

This category excludes:
- Scandinavian forest meadows → 4.2.x.x *Natural grasslands with trees*/ 3. Woodland with low density.
- High stem fruit trees including meadow orchards of Central Europe → 2.2.2.1 *High stem fruit*.
- Complex cultivation patterns → 2.3.2.1 *Complex cultivation patterns*.
- Annual crops associated with permanent crops → 2.3.1.1 *Annual crops associated with permanent crops*.
- Olive groves → 2.2.3.1 *Olive groves.*

Attributes:

o N/A

Appearance:

Badajoz (Spain).SPOT-5 (2.5 m.) (1/2/3 Band Combination). Date: 2011-03-18. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

- Land with scattered trees.
- Big parcels with different management and appearance: grasses (dry in summer-time), arable land and scrubs.

Methodological approach:

- Use of CLC class 2.4.4 as information source.
- Use of in situ-data.
- Final detailed delineation and identification using computer assisted visual interpretation.
- Distinction from forest (3.x *Woodland and Forest*) is based in the use of in situ data (e.g. specific national databases as SIOSE in Spain).
- T.C.D. assignation.

2.3.5.1 Agro-forestry T.C.D. < 30%

Definition:

Agro-forestry is a land use management system in which trees or shrubs are grown around or among crops or pastures. It combines agricultural and forestry techniques to achieve a more sustainable land use system. An example of this landscape is the *dehesa* (located in southern and central Spain and southern Portugal where it is called *montado*).

This category is limited to Mediterranean area.

With this T.C.D. is frequent the presence of arable land.

Agroforestry areas (grassland understory) included in this category whit less 10% T.C.D. are considered as grassland.

Dehesa in Spain in spring-time. Credit: C. Alonso

Schematic representation of 2.3.5.1 Agro-forestry T.C.D. < 30%

This category includes:

- Areas of forest trees imbricated with fruit trees/ olive trees but neither of them dominates.
- Trees (predominantly *quercus* species.) planted in agricultural lands.
- Pastures mixed with agricultural lands, or parcels that vary their use (between agricultural or pasture) depending on the year, mixed with trees.

This category excludes:

- Scandinavian forest meadows → 4.2.x.x *Natural grasslands with trees*/ 3. Woodland with low density.
- Grasslands with trees in other locations.
- Atlantic parkland (EUNIS Code E7.1) and sub-continental parkland (EUNIS Code E7.2) → 4.x. *Grassland.*

Attributes:

- o N/A

Appearance:

- Land with very disperse trees.
- Big parcels with different management and appearance: grasses (dry in summer-time), arable land and scrubs.
- Distinction from forest with low density (3.x *Woodland and Forest*) and 4.x Grassland is based in the use of in situ data (e.g. specific national databases as SIOSE in Spain).

Example of Agroforestry T.C.D. < 30% with grassland and arable land understory. Extremadura (Spain). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-03-18. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- Use of CLC class 2.4.4 as source of information.
- Use of in situ-data.
- Final detailed delineation and identification using computer assisted visual interpretation.
- T.C.D. assignation.

3. Woodland and forest

The woodland and forest classes are mainly dominated by woody vegetation of various age or by succession of climax vegetation types (MAES et al. 2013). The interpretation is done according to FAO (2000) with tree cover >10%, MMU of 0.5 ha and trees able to reach 5m height in-situ at maturity. Young natural stands and all plantations established for forestry purposes, which have yet to reach a crown density of 10% or tree height of 5 m, are also included as forest. These areas normally are part of the forest area although temporarily unstocked because of human intervention or natural reasons but which are expected to revert to forest.

Forest further comprises:
- nurseries and seed orchards that constitute an integral part of the forest;
- forest roads;
- cleared tracts < 0.5 ha;
- firebreaks and other small open areas < 0.5 ha;
- forest in national parks, nature reserves and other protected areas with an area of more than 0.5 ha and width of more than 10 m (which goes beyond the FAO Forest definition of 20m);
- plantations primarily used for forestry purposes, including rubber wood plantations and cork oak stands.

Land predominantly used for agricultural practices is excluded. Excluded is also land with

- either a crown cover (or equivalent stocking level) of 5-10% of trees able to reach a height of 5m at maturity in situ;
- a crown cover (or equivalent stocking level) of more than 10% of trees not able to reach a height of 5m at maturity in situ (e.g. dwarf or stunted trees);
- shrub or bush cover of more than 10 percent are not accounted as Forest.

The differentiation between broadleaved, coniferous and mixed forest is in accordance with CLC interpretation guideline and HR Forest definition.

Broadleaved forest: Vegetation formation composed principally of trees, including shrub and bush understoreys, where broadleaved species predominate and represent more than 75% of the pattern.

Coniferous forest: Vegetation formation composed principally of trees, including shrub and bush understoreys, where coniferous species predominate and represent more than 75% of the pattern.

Mixed forest: Vegetation formation composed principally of trees, including shrub and bush understoreys, where neither broadleaved nor coniferous species predominate. The share of coniferous or broad-leaved species does not exceed 25% in the canopy closure.

The differentiation of Woodland and Forest is mainly oriented along aggregated EUNIS habitat classes. Main classes are riparian and fluvial forest, swamp forest, other natural and semi-natural forest and highly artificial forest (e.g. plantations), following the EUNIS classification scheme.
Tree Cover Density is mainly derived from the High Resolution Tree Cover Density (T.C.D.) layer based on CORE_01 EO data.

The values are derived by applying a semi-automatic approach which is based on a segmentation of Landsat data (provision of large, homogeneous forest stands, good correlation to 20m TCD forest values). The resulting segments are used to import the MEAN Tree Cover density values derived from GIO TCD layers. These are stratified into 5 strata (0, 10, 30, 50, 80) compliant to the applicable Nomenclature attributes. The strata are then aggregated according to the MMU of 0.5 ha and checked visually. Areas covered by clouds/cloud shadows in the GIO TCD layer are classified manually using VHR data.

In addition to this specified procedure, a completely manual approach has to be applied in areas with very low tree cover densities where an automatic approach will not provide reliable results (dry Mediterranean areas).

Forest type interpretation might be problematic in locations with sunny slopes or in hilly regions with shady slopes. In those cases additional data sets (e.g. Bing Maps) will be used to support the interpretation.

Fire breaks will be classification according their current land covers.

This category includes:

3.1 Broadleaved forest
        3.1.1.1 Riparian and fluvial broadleaved forest
        3.1.2.1 Broadleaved swamp forest
        3.1.3.1 Other natural & semi-natural broadleaved forest
        3.1.4.1 Broadleaved evergreen forest
        3.1.5.1 Highly artificial broadleaved plantations
3.2 Coniferous forest
        3.2.1.1 Riparian and fluvial coniferous forest
        3.2.2.1 Coniferous swamp forest
        3.2.3.1 Other natural & semi-natural coniferous forest
        3.2.4.1 Highly artificial coniferous plantations
3.3 Mixed forest
        3.3.1.1 Riparian and fluvial mixed forest
        3.3.2.1 Mixed swamp forest
        3.3.3.1 Other natural & semi-natural mixed forest
        3.3.4.1 Highly artificial mixed plantations
3.4 Transitional woodland and scrub
        3.4.1 Transitional woodland and scrub
            3.4.1.1 Transitional woodland and scrub
            3.4.1.2 Lines of trees and scrub
3.5 Damaged forest
        3.5.1 Damaged forest
            3.5.1.1 Forest damaged by fire
            3.5.1.2 Other damaged forest

3.1.1.1 Riparian and fluvial broadleaved forest

Definition:

„Riparian" forest comprises all forest inside riparian zones except those areas, where the riparian zone is extremely extended by the EU JRC 100-year flood map.[2] No distinction is made in this class between riparian broadleaved species (e.g. *Alnus*, *Betula*, *Populus* or *Salix)* and riparian floodplain species (e.g. *Acer*, *Fraxinus*, *Prunus* or *Ulmus*) as this discrimination is not feasible with the available EO data sources like CORE_01, CORE_03, CORE_08 or Landsat due to spectral and spatial sensor limitations. Therefore, both species have been put together in the MAES class 3.1.1.1.

Moreover, a separation between the class "Riparian and fluvial broadleaved forest" and other natural & semi-natural broadleaved forest types is as well limited by the spectral and spatial sensor characteristics of the available EO data sources. Therefore, the separation between the MAES classes "Riparian and fluvial forest" and "Swamp forest" is performed by using the product "Potential Riparian Zone", derived by Task 3: Delineation of Riparian Zone. Broadleaved forest belonging to the "Potential Riparian Zone" will be classified as 3.1.1.1.

Riparian and fluvial broadleaved forest in La Rioja region (Spain). Credits: C. Alonso

Poplar (Populus sp.) plantation located in the Potential Riparian Zone.. Credits: M. Palacios

This category includes:

- Vegetation formation composed of trees, including shrub and bush understoreys, where broadleaved species (EUNIS classes G1.1, G1.2 and G1.3) predominate and represent more than 75% of the pattern
- Forest influenced by the river system
- Highly artificial broadleaved plantations that are located inside the Potential Riparian Zone
- Linear broadleaved forest stripes at river sides at rivers with Strahler level ≥3-5
- Broadleaved evergreen forest located in the Potential Riparian Zone

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[2] *http://floods.jrc.ec.europa.eu/climate-change-impact-assessment.html*

This category excludes:

- Broadleaved forest located in swamp areas → 3.1.2.1 *Broadleaved swamp forest.*
- Heathlands and Moorlands where vegetation cover is composed of heather, scrub and transitional woodland (e.g. birch, alder, pine) → 5.1.1. *Heathlands and Moorlands.*
- Scrub and reeds (only Mediterranean area) in rivers or at river shores → 3.4.1.1 *Transitional woodland and scrub.*
- Clear-cut or regrowth of riparian/fluvial broadleaved forest → 3.4.1.1 *Transitional woodland and scrub.*
- Broadleaved evergreen forest → 3.1.4.1 *Broadleaved evergreen forest.*

Attributes:

- T.C.D Forest >80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:
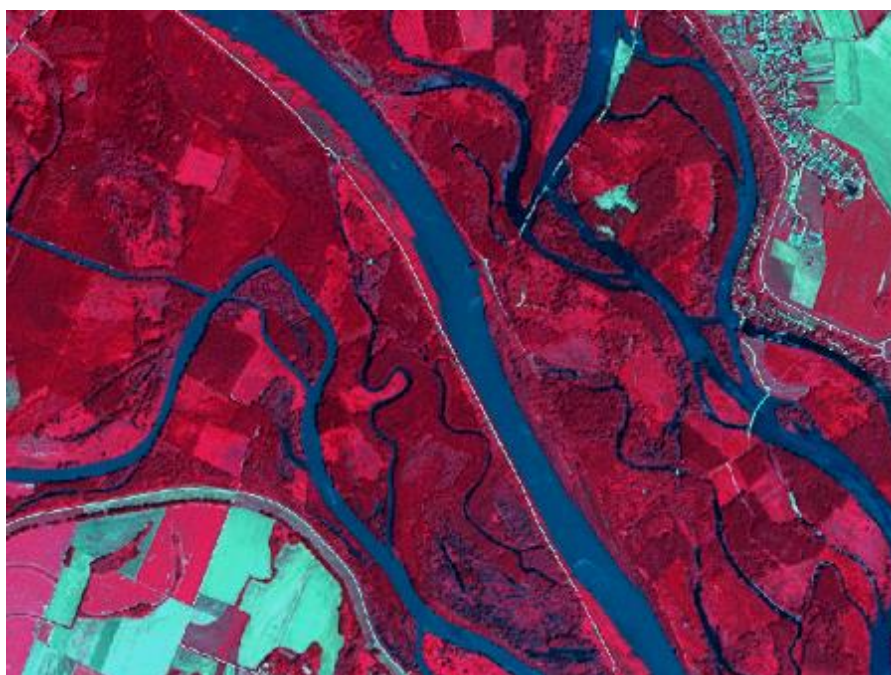
Riparian & fluvial broadleaved forest at the Danube river near Kisbodak (Hungary). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-07-10. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- Located at or near the river on mostly wet grounds.
- Often flown through by rivers.
- Lakes, oxbows, swamps and moorlands are interspersed.
- No spectral difference to other broadleaved forest located outside the riparian zone.

- A semi-automatic approach using the segments of the Tree Cover Density calculation is applied to derive this class. Segments covered by more than 60% by the Potential Riparian Zone product are classified as „Riparian Forest". This methodology provides a quite natural appearance of Riparian Forest. Visual checks and manual recoding is carried out for long narrow stripes and areas covered by clouds/cloud shadows/data gaps in the GIO TCD layer.
- In areas with very low tree cover (e.g. parts of Mediterranean area), Riparian forest may also be classified manually.

3.1.2.1 Broadleaved swamp forest

Definition:

Forest on wet ground (e.g. moors, swamps, marshes, fens or peat bogs) but not located in the Potential Riparian Zone. On non-acid peat the class is comprised of the tree species *Alnus*, *Populus*, *Quercus* swamp woods not (EUNIS G1.4). On wet acid peat *Betula pubescens* or rarely *Alnus glutinosa* (EUNIS G1.5) are predominate.
A pure spectral differentiation between the broadleaved tree species is not feasible with the available EO data, therefore additional information such as wetland layers, the Potential Riparian Zone layer and topographic maps will be used.

Broadleaved swamp forest (T.C.C.D. >50-80%), Island Rügen, Germany Credits: U. Weingart

This category includes:

- Vegetation formation composed principally of trees, including shrub and bush understorey, where broadleaved species (EUNIS classes G1.4, G1.5) predominate on acid peat/not on acid peat but wet soil and represent more than 75% of the pattern.

This category excludes:

- Broadleaved forest belonging to the "Potential Riparian Zone" → 3.1.1.1 *Riparian and fluvial Broadleaved forest.*
- Clear-cut or regrowth of broadleaved swamp forest → 3.4.1.1 *Transitional woodland and scrub.*
- Heathlands and Moorlands where vegetation cover is composed of heather, scrub and transitional woodland (e.g. birch, alder, pine) → 5.1.1.1 *Heathlands and Moorlands.*

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:
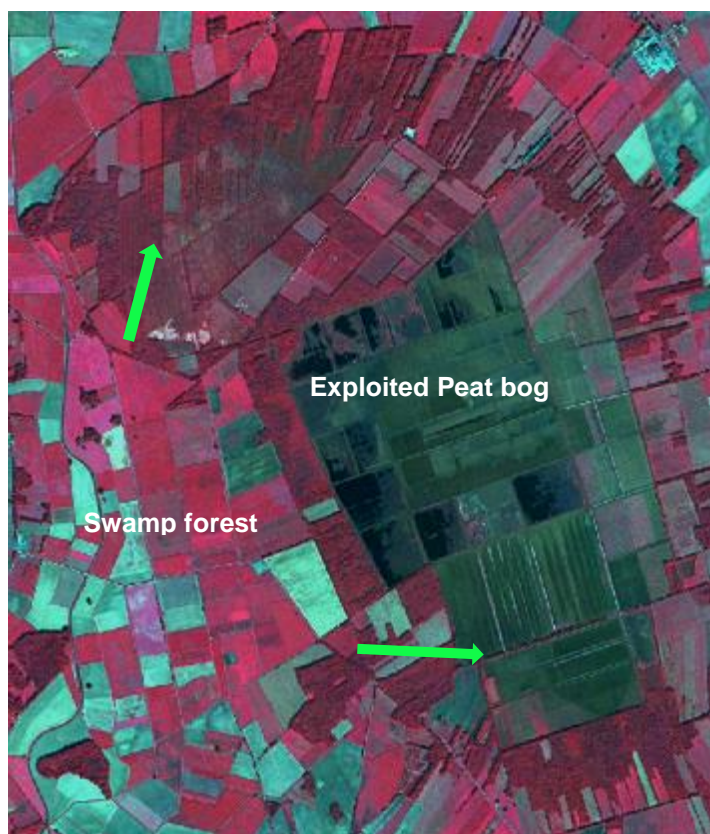
"Borsteler Moor" near Borstel, Germany. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2013-09-05. Source: CNES 2013©, Distribution Airbus DS/Spot Image

- Located on wet grounds.
- Near or in vicinity to exploited/unexploited peat bogs, moors, swamps or marshes. Therefore, swamp forest often shows regular, streaky shape.
- Not flown through by rivers.

Methodological approach:

- Additional information from topographic maps or other auxiliary data sets is necessary to indicate the location nearby moors, swamps, marshes, fens or peat bogs.
- Use CLC information and look for forest located inside class 4.1.1 or 4.1.2.
- T.C.D. attribute is either derived automatically by intersection with the High Resolution Forest Layer (Tree Cover Density product) or manually, if an automatic approach is not feasible.

3.1.3.1 Other natural & semi natural broadleaved forest

Definition:

This class is comprised of the tree species *Fagus* (EUNIS G1.6), deciduous or semi-deciduous thermophilous types like *Quercus* species and *Carpinus orientalis*, *Castanea sativa* or *Ostrya carpinifolia* (EUNIS G1.7). Moreover, *Quercus robur* or *Quercus petraea* on acid soils (G1.8), non-riverine/swamp forest composed of *Betula*, *Populus tremula* or *Sorbus aucuparia* (G1.9) species; *Quercus robur*, *Ulmus spp.*, *Fraxinus excelsior*, *Tilia cordata* or *Acer platanoides* (G1.A) and non-riparian, non-marshy woods dominated by *Alnus* (G1.B).

Broadleaved forest (beech), Bavaria, Germany.
Credits: M. Probeck

Broadleaved forest (beech and maple), Stockholm, Sweden.
*Credits: E. Alkrona*

This category includes:

- Vegetation formation composed of trees, including shrub and bush understoreys, where broadleaved species (EUNIS classes G1.6, G1.7, G1.8, G1.9, G1.A and G1.B) predominate and represent more than 75% of the pattern.
- Includes all extensively managed, but sometimes regularly planted semi-natural broadleaved forests in Southern, Central and Northern Europe composed of regional forest types.
- All broadleaved forest that is not located in the "Potential Riparian Zone" or on wet soils.

This category excludes:

- Riparian and fluvial broadleaved forest → 3.1.1.1 *Riparian and fluvial Broadleaved forest*
- Broadleaved swamp forest → 3.1.2.1 *Broadleaved swamp forest.*
- Clear-cut or regrowth of other natural & semi-natural broadleaved forest → 3.4.1.1 *Transitional woodland and scrub.*
- All intensively managed highly artificial broadleaved forest plantations, composed of exotic types → 3.1.5.1 *Highly artificial broadleaved plantations.*

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:
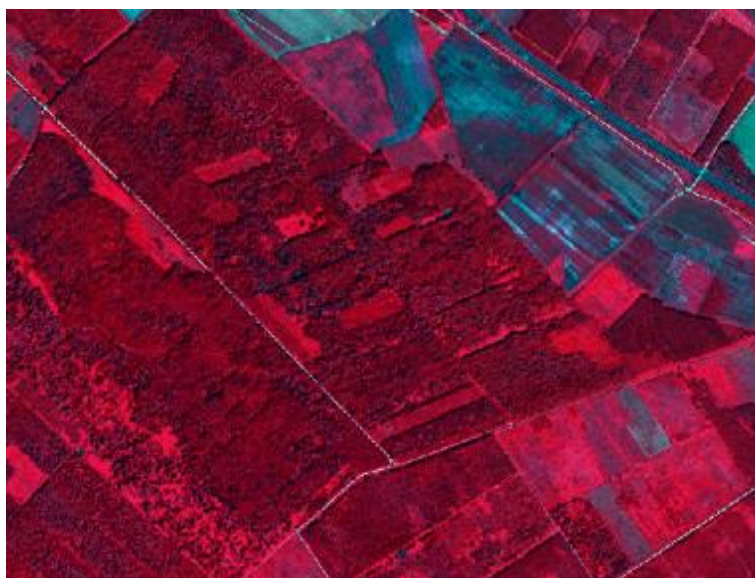
Other natural & semi-natural broadleaved forest near the Danube river near Károlyháza (Hungary). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-07-10. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- No spectral difference to fluvial/riparian or swamp broadleaved forest.
- Distinction by location: Not located at or near the river, not located on mostly wet grounds.

Methodological approach:

- Manual/visual or semi-automatic classification of broadleaved forest border according to CORE_03 data.
- Automatic separation of class 3.1.3.1 from "Riparian and fluvial broadleaved forest" by applying the „Potential Riparian Zone".
- T.C.D. attribute is either derived automatically by intersection with the High Resolution Forest Layer (Tree Cover Density product) or manually, if an automatic approach is not feasible.

3.1.4.1 Broadleaved evergreen forest

Definition:

This class comprises broadleaved sclerophyllous or lauriphyllous evergreen trees and palms, which are characteristic for the Mediterranean and warm-temperate humid zones (EUNIS class G2). In these regions broadleaved evergreen forest is predominate and represents more than 75% of the pattern.

The spectral differentiation between broadleaved and evergreen broadleaved forest will be done using multi-temporal data available from CORE_08 and CORE_01 (coverage 1 and coverage 2 data) images.

Broadleaved evergreen forest (Quercus ilex, Quercus coccifera, etc..) in Ano Vathia (Island of Evia), Greece. Credits: N. Kolpatzik

This category includes:

- Broadleaved evergreen forest of the Mediterranean and warm-temperate humid zones.

This category excludes:

- Broadleaved evergreen forest belonging to the "Potential Riparian Zone" → 3.1.1.1 *Riparian and fluvial Broadleaved forest.*
- Broadleaved evergreen forest on wet grounds → 3.1.2.1 *Broadleaved swamp forest.*
- Broadleaved evergreen Eucalyptus plantations → 3.1.5.1 *Highly artificial broadleaved plantations.*

Attributes:

- o T.C.D Forest > 80%
- o T.C.D Forest > 50 – 80%
- o T.C.D Forest > 30 – 50%
- o T.C.D Forest ≥ 10 – 30%

Appearance:
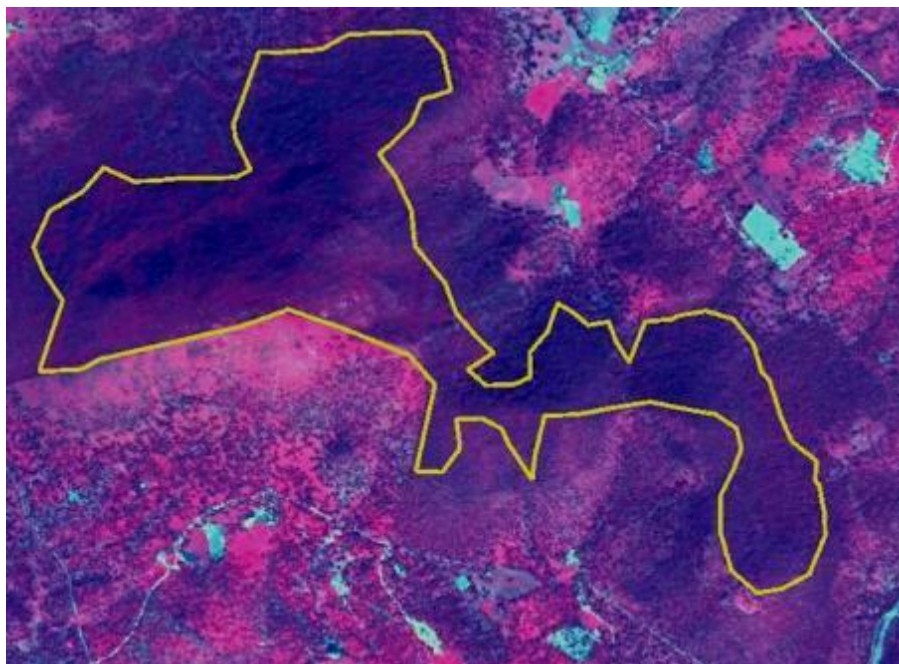
Mediterranean sclerophyllous forest (Quercus rotundifolia) in South Western Spain. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-03-18. Source: CNES 2011© Distribution Airbus DS/Spot Image

Methodological approach:

- Visual interpretation or automatic pre-classification based on CORE_08, CORE_03 and CORE_01 data using HR forest layer as training data.
- Spectral separation between broadleaved, coniferous and broadleaved evergreen.
- Manual enhancement of broadleaved evergreen forest border according to CORE_03 data.
- T.C.D. attribute is either derived automatically by intersection with the High Resolution Forest Layer (Tree Cover Density product) or manually, if an automatic approach is not feasible.

3.1.5.1 Highly artificial broadleaved plantations

Definition:

Cultivated deciduous broadleaved tree formations planted for the production of wood, composed of <u>exotic species</u> or native species <u>out of their natural range</u>, planted in clearly unnatural stand or as monocultures (e.g. row plantation).

This category includes:

- Exotic species (e.g. *Eucalyptus sp.)* planted in clearly unnatural (basically row plantation).
- Monoculture stands out of their natural range with clearly artificial planting pattern.
- Visible clear cuts more than 0.5 ha in *Eucalyptus* sp. plantations. Many of these plantations have a management based on harvesting (felling, chipping and hauling) and short-term regeneration. In this case the clear cuts between harvesting and regeneration are considered as fallow land and will be included in class 3.1.5.1.

This category excludes:

- Small, linear forest stands > 25m width, planted for wind shield purposes → 3.1.3.1 *Other natural & semi natural broadleaved forest.*
- Natural stands planted in monocultures and structured by regular road network.
- Semi-natural broadleaved forest pla*nted in the natural stands for timber production* → 3.1.3.1 *Other natural & semi natural broadleaved forest.*
- Naturalized plantations (basically not visible rows or plantations integrated in the landscape) of exotic trees (mainly *Eucalyptus* sp.) → 3.1.3.1 *Other natural & semi natural broadleaved forest.*

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:

Eucalyptus sp. monocultures:

- Red colors in infrared bands combinations.
- Plantation in stands.
- Visible rows.
- Presence of forest tracks and forest and firebreaks.
- Presence of clear cuts.

Eucalyptus sp. plantation in Southern Spain. Credit: 2009 Ministerio de Fomento IGN

Eucalyptus sp. plantation in Southern Spain. Lepe (Huelva, Spain) SPOT-5 (2.5 m) (NIR Band Combination). Date: 2011-08-06. Source: CNES 2011© Distribution Airbus DS/Spot Image.

Methodological approach:

- Manual interpretation of semi-automatic classification of broadleaved forest border
- T.C.D. attribute is either derived automatically by intersection with the High Resolution Forest Layer (Tree Cover Density product) or manually, if an automatic approach is not feasible.
- If other local in-situ data available, use if suitable.

Harvesting clear cuts in eucalyptus sp. Plantations delineation rules:

- Included in eucalyptus sp. Plantations (class 3.1.5.1 *Highly artificial broadleaved plantation*).
- Bare soil visible
- Plantations rows visible.

Clear cuts between harvesting and restoration in an Eucalyptus plantation. Cortegana (Huelva, Spain) SPOT-5 (2.5 m) (NIR Band Combination). Date: 2011-08-06. Source: CNES 2011© Distribution Airbus DS/Spot Image

3.2.1.1 Riparian and fluvial coniferous forest

Definition:

Vegetation formation composed principally of coniferous trees, including shrub and bush understoreys and where coniferous species are predominate and represent more than 75% of the pattern. „Riparian" coniferous forest comprises all coniferous forest and scrub inside riparian zones except those areas, where the riparian zone is extremely extended by the EU JRC 100-year flood map.[3]

The pure spectral separability between different coniferous tree species is limited using the available EO data and would not achieve the required thematic accuracy. Therefore, wetland layers, the Potential Riparian Zone layer and topographic maps are used.

Riparian and fluvial coniferous forest (Pinus) in Sweden. Source: © LUCAS 2012.

This category includes:

- Coniferous forest and scrub located in the "Potential Riparian Zone".
- Highly artificial coniferous plantations located in the "Potential Riparian Zone".
- Linear coniferous forest stripes at river sides at rivers with Strahler level ≥3-5

This category excludes:

- Coniferous forest located in swamps → 3.2.2.1 *Coniferous swamp forest*.
- Coniferous forest located outside the "Potential Riparian Zone" and not on wet grounds → 3.2.3.1 *Other natural & semi natural coniferous forest*.

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

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[3] *http://floods.jrc.ec.europa.eu/climate-change-impact-assessment.html*

Appearance:

Riparian & fluvial coniferous forest located at the Monsini Danube river near Magyarkimle (Hungary). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-07-10. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- Located at or near the river on mostly wet grounds.
- Often flown through by rivers.
- Lakes, oxbows, swamps and moorlands are interspersed.
- No spectral difference to other coniferous forest that is not located in the riparian zone.

Methodological approach:

- A semi-automatic approach using the segments of the Tree Cover Density calculation is applied to derive this class. Segments covered by more than 60% by the Potential Riparian Zone product are classified as „Riparian Forest". This methodology provides a quite natural appearance of Riparian Forest. Visual checks and manual recoding is carried out for long narrow stripes and areas covered by clouds/cloud shadows/data gaps in the GIO TCD layer.
- In areas with very low tree cover (e.g. parts of Mediterranean area), Riparian forest may also be classified manually.

3.2.2.1 Coniferous swamp forest

Definition:

This class is comprised of coniferous tree and scrub species (EUNIS G3.D) like e.g. *Pinus sylvestris*, *Pinus rotundata* and *Picea abies*, growing on a humid to wet peaty substrate, with an permanently high water level and even higher than the surrounding water table.

This forest type is not located in the "Potential Riparian Zone".

Dwarf pine on swampland, Bavaria, Germany. Credits: M. Probeck

This category includes:

- Vegetation formation composed principally of trees, including shrub and bush understoreys, where coniferous species are predominate and represent more than 75% of the pattern.
- Coniferous forest and scrub on moors and swamps.

This category excludes:

- Riparian and fluvial coniferous forest → 3.2.1.1 *Riparian and fluvial coniferous forest.*

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:

N/A

Methodological approach:

- Additional information from topographic maps or other auxiliary data sets is necessary to indicate the location nearby moors, swamps, marshes, fens or peat bogs.
- Use CLC information and look for forest located inside 411 or 412.
- Manual/visual interpretation of coniferous forest border according to CORE_03 data.
- T.C.D. attribute is either derived automatically by intersection with the High Resolution Forest Layer (Tree Cover Density product) or manually, if an automatic approach is not feasible.

3.2.3.1 Other natural & semi natural coniferous forest

Definition:

Class is comprised of coniferous tree species mainly evergreen (*Abies*, *Cedrus*, *Picea*, *Pinus*, *Taxus*, *Cupressaceae*) but also deciduous *Larix* (EUNIS G3) or *Juniperus Sabina* (but with low TCD).

Other natural coniferous (spruce) forest in Attali (Island of Evia), Greece. Credits: N. Kolpatzik

Coniferous forest (Pinus canariensis). Credits: M. Palacios

This category includes:

- Vegetation formation composed principally of coniferous trees, including shrub and bush understoreys, where coniferous species are predominating and represent more than 75% of the pattern.
- Includes evergreen coniferous forest.
- Includes all extensively managed, but sometime regularly planted semi-natural coniferous forests in Southern, Central and Northern Europe composed of regional forest types.
- All coniferous forest that is not located in the "Potential riparian zone" or on wet soils.

This category excludes:

- Riparian & fluvial coniferous forest → 3.2.1.1 *Riparian and fluvial coniferous forest.*
- Coniferous forest in swamp areas → 3.1.2.1 *Coniferousswamp forest.*
- Heathlands and Moorlands where vegetation cover is composed of heather, scrub and transitional coniferous woodland (e.g. pine) → 5.1.1.1 *Heathlands and Moorlands.*
- Clear-cut or regrowth of coniferous forest → 3.4.1.1 *Transitional woodland and scrub.*
- Artificial coniferous plantation of exotic species → 3.2.4.1 *Highly artificial coniferous plantations.*

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:

Other natural or semi-natural coniferous forest located near Bezenye (Hungary). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-07-10. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Other natural or semi-natural coniferous forest, Harz, Germany. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-09-03. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- No spectral difference to fluvial/riparian or swamp coniferous forest.
- Distinction by location: Not located at or near the river on mostly wet grounds.

Methodological approach:

- Manual/visual or semi-automatic classification of coniferous forest.
- T.C.D. attribute is either derived automatically by intersection with the High Resolution Forest Layer (Tree Cover Density product) or manually, if an automatic approach is not feasible.

3.2.4.1 Highly artificial coniferous plantations

Definition:

Cultivated coniferous tree formations planted for the production of wood, composed of exotic species or native species out of their natural range, planted in clearly unnatural stands or as monocultures (e.g. clearly visible row plantation).

Highly artificial coniferous plantations (Pine) in the north west of Spain. Source: © LUCAS 2012.

This category includes:

- Highly artificial coniferous tree formations planted in monocultures and out of their natural range.
- Christmas tree plantations.

This category excludes:

- Small, linear forest stands > 25m MMW, probably planted as wind shield – No plantation.
- Semi-natural coniferous forest planted in the natural environments for timber production, also when planted in monocultures → 3.2.3.1 *Other natural & semi natural coniferous forest.*
- Highly artificial coniferous plantations located in the Potential Riparian Zone → *3.2.1.1 Riparian Coniferous Forest*

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:

Highly artificial coniferous plantation (Christmas trees) near Gifhorn, Germany. Spot 6 (1.5 m) (4/1/3 Band Combination). Date: 2013-09-28. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Highly artificial coniferous plantation (Christmas trees) near Bischofsheim, Germany. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2012-05-25. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- Regular planting scheme
- Coniferous plantations in arable land (in many cases related to set-aside obligations). Only highly artificial coniferous plantation are included here.

Highly artificial coniferous plantation in Central Spain. Credit: 2009 Ministerio de Fomento IGN
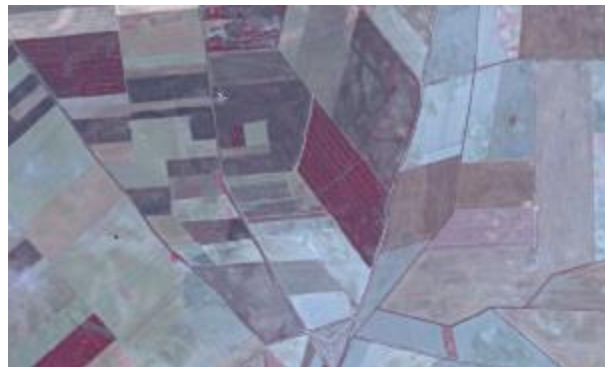
Coniferous plantation in Central Spain. Credit: SPOT-5 (2.5 m) (NIR Band Combination). Date: 2012-07-04. Source: CNES 2011© Distribution Airbus DS/Spot Image.

Methodological approach:

- Semi-automatic or manual/visual classification based on CORE_03 data.
- If situation is unclear, map „3.2.3.1 Other natural & semi natural coniferous forest".
- T.C.D. attribute is either derived automatically by intersection with the High Resolution Forest Layer (Tree Cover Density product) or manually, if an automatic approach is not feasible.

3.3.1.1 Riparian and fluvial mixed forest

Definition:

Vegetation formation composed of coniferous and deciduous trees, including shrub and bush understoreys. Neither broadleaved nor coniferous species predominate. The share of coniferous or broadleaved species does not exceed 25% in the canopy closure. „Riparian" mixed forest comprises all mixed forest and scrub inside riparian zones except those areas, where the riparian zone is extremely extended by the EU JRC 100-year flood map.[4]

The Potential Riparian Zone will be used to derive this class.

Riparian and fluvial mixed forest (Spruce and broadleaved tree species), Germany. Source: © LUCAS 2012

This category includes:

- Mix of broadleaved and coniferous forest types. This class can be composed of either a mix of single coniferous and deciduous trees or a mix of small coniferous or deciduous patches < 0.5 ha.
- Forest influenced by the river system.
- Highly artificial broadleaved mixed plantations that are located inside the potential riparian zone.
- Linear stripes of mixed forest on the river sides at rivers with Strahler level ≥ 3-5.

This category excludes:

- Mixed forest in swamp areas → 3.1.2.1 *Broadleaved swamp forest.*
- Clear-cut or regrowth of riparian & fluvial mixed forest → 3.4.1.1 *Transitional woodland and scrub.*

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[4] *http://floods.jrc.ec.europa.eu/climate-change-impact-assessment.html*

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:

- Located at or near the river on mostly wet grounds.
- Often flown through by rivers.
- Lakes, oxbows, swamps and moorlands are interspersed.
- No spectral difference to other mixed forest located outside the riparian zone.

Methodological approach:

- A semi-automatic approach using the segments of the Tree Cover Density calculation is applied to derive this class. Segments covered by more than 60% by the Potential Riparian Zone product are classified as „Riparian Forest". This methodology provides a quite natural appearance of Riparian Forest. Visual checks and manual recoding is carried out for long narrow stripes and areas covered by clouds/cloud shadows/data gaps in the GIO TCD layer.
- In areas with very low tree cover (e.g. parts of Mediterranean area), Riparian forest may also be classified manually.

3.3.2.1 Mixed swamp forest

Definition:

Mixed forest on wet ground (e.g. moors, swamps, marshes, fens or peat bogs) but not located in the Potential Riparian Zone.

This category includes:

- Vegetation formation composed principally of trees, including shrub and bush understoreys, where neither broad-leaved nor coniferous species predominate and the share of coniferous or broad-leaved species does not exceed 25% in the canopy closure.

This category excludes:

- Mixed forest belonging to the "Potential Riparian Zone" → 3.3.1.1 *Riparian and fluvial* mixed forest.
- Clear-cut or regrowth of mixed swamp forest → 3.4.1.1 *Transitional woodland and scrub.*
- Heathlands and Moorlands where the vegetation cover is composed of heather, scrub and transitional woodland (e.g. birch, alder, pine) → 5.1.1.1 *Heathland and Moorland.*

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:
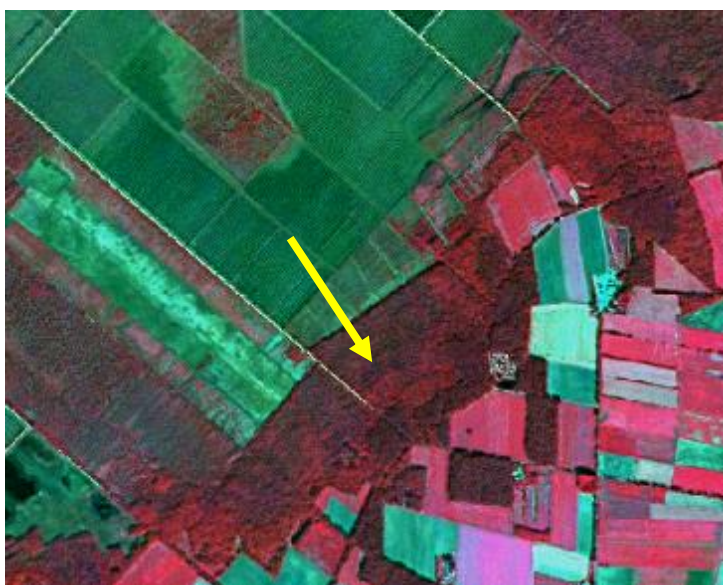
Mixed swamp forest, "Großes Moor" near Uchte, Northern Germany. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2013-09-05. Source: CNES 2013©, Distribution Airbus DS/Spot Image

- Located on wet grounds.
- Near or in vicinity to exploited/unexploited peat bogs, moors, swamps or marshes. Therefore, swamp forest often shows regular, streaky shape.
- Not flown through by rivers.

Methodological approach:

- Additional information from topographic maps or other auxiliary data sets is necessary to indicate the location nearby moors, swamps, marshes, fens or peat bogs.
- Use CLC information and look for forest inside classes located inside 411 or 412.
- T.C.D. attribute is either derived automatically by intersection with the High Resolution Forest Layer (Tree Cover Density product) or manually, if an automatic approach is not feasible.

3.3.3.1 Other natural & semi natural mixed forest

Definition

Mix of broadleaved deciduous or evergreen and coniferous trees.

Riparian and fluvial mixed forest (Pinus sylvestris, Quercus petraea), Germany. Source: © LUCAS 2012

This category includes:

- Vegetation formation composed principally of trees, including shrub and bush understoreys, where neither broadleaved nor coniferous species predominate and the share of coniferous or broad-leaved species does not exceed 25% in the canopy closure.
- Includes all extensively managed, semi-natural mixed forests in Southern, Central and Northern Europe composed of regional forest types.
- All mixed forest that is not located in the "Potential Riparian Zone" or located on wet soils.

This category excludes:

- Riparian and fluvial mixed forest → 3.3.1.1 *Riparian and fluvial mixed forest.*
- Mixed forest on wet ground→ 3.3.2.1 *Mixed swamp forest.*
- Clear-cut or regrowth of other natural & semi-natural mixed forest → 3.4.1.1 *Transitional woodland and scrub.*

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:

Other mixed forest near Runkel, Germany. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2010-06-03. Source: CNES 2010©, Distribution Airbus DS/Spot Image

Methodological approach:

- Manual/visual or semi-automatic classification of broadleaved forest border according to CORE_03 data.
- Automatic separation of class 3.3.3.1 from "Riparian and fluvial mixed forest" by applying the „Potential Riparian Zone".
- T.C.D. attribute is either derived automatically by intersection with the High Resolution Forest Layer (Tree Cover Density product) or manually, if an automatic approach is not feasible.

3.3.4.1 Highly artificial mixed plantations

Definition:

Mixed plantations (EUNIS G4.F) of coniferous and deciduous species where at least one constituent is exotic or outside its natural range, or if composed of native species planted in clearly unnatural stands.

This category includes:

- Cultivated mixed tree formations planted for the production of wood, composed of exotic species, of native species out of their natural range, or of native species planted in clearly unnatural stands, often as monocultures

This category excludes:

- Small, linear forest stands (MMW > 25m) of mixed forest, planted for wind shield purposes → 3.3.3.1 *Other natural & semi natural mixed forest.*
- Semi-natural mixed forest planted in the natural stands for timber production → 3.3.3.1 *Other natural & semi natural mixed forest.*
- Highly artificial mixed plantation belonging to the "Potential Riparian Zone" → 3.3.1.1 *Riparian and fluvial mixed forest.*

Attributes:

- T.C.D Forest > 80%
- T.C.D Forest > 50 – 80%
- T.C.D Forest > 30 – 50%
- T.C.D Forest ≥ 10 – 30%

Appearance:

N/A

Methodological approach:

- Manual interpretation of semi-automatic classification of mixed forest border.
- T.C.D. attribute is either derived automatically by intersection with the High Resolution Forest Layer (Tree Cover Density product) or manually, if an automatic approach is not feasible.

3.4.1.1 Transitional woodland and scrub

Definition:

Bushy or herbaceous vegetation with scattered trees that represent either woodland degradation or forest regeneration/recolonization. The class is comprised of EUNIS G5.6 which defines early stages of woodland regrowth or newly-colonizing woodland composed predominantly of young individuals of high-forest species that are still less than 5 m in height as transitional woodland.

Transitional woodland. Credits: M. Palacios

Transitional woodland, Scotland Credits: M. Rosengren

This category includes:

- Pre- or post-formation of broadleaved evergreen forest with usually thick evergreen shrub stratum composed of evergreen oaks, olive trees, pines etc. Crown cover < 30%.
- Abandoned agricultural land under recolonization of trees and shrub. Scattered trees or shrub cover more than 30%.
- Abandoned peat bogs covered by scrubs and trees in recovering process
- Abandoned fruit tree plantations and orchards.
- Abandoned vineyards, where original structure is not visible any more.
- Shrub along river sides and on river banks (in Mediterranean areas reeds/scrub vegetation along rivers is included)

Reeds alongside a Mediterranean River: Credits: M. Palacios

- Abandoned military training areas in regeneration process
- Clear-cuts in forest areas.
- Forest regrowth areas, that haven't reached the climax vegetation
- Young forest plantations of young trees that are still less than 5 m in height.
- Forest nurseries inside forest areas
- Short-rotation Salix beds for biomass production.
- Vegetation on xeric grass on calcareous grounds.

This category excludes:

- Forest stands with canopy cover of at least 50% → 3.1.x.x/ 3.2.x.x/3.3.x.x *Broadleaved forest/ Coniferous forest/ Mixed forest.*
- Abandoned olive groves → 5.2.1.1 *Sclerophyllous vegetation.*
- Climax vegetation → 3.x.x.x
- Stable/climax tree-like forest formations on wet land with a tree height of less than 4 m → 5.1.1.1 or 5.1.1.2 *Heathland and Moorland* or *Other scrub land.*

Attributes:

N/A

Appearance:
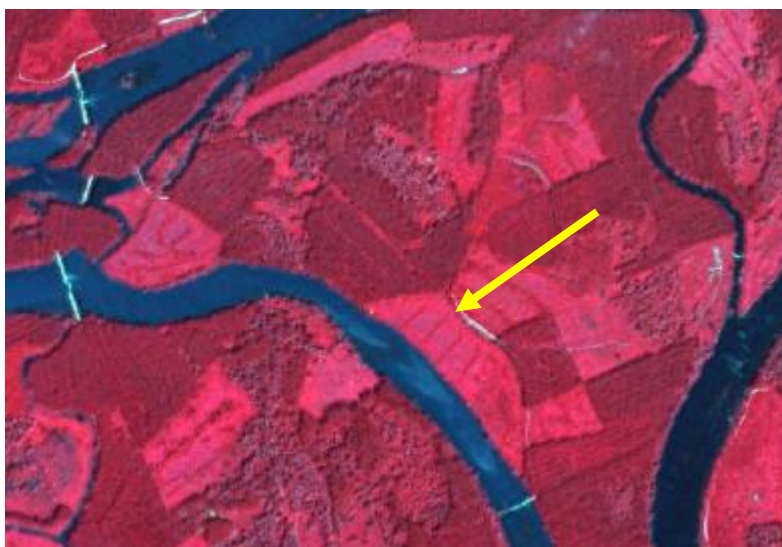
Forest clear-cuts at the Danube river side (Hungary). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-07-10. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- Colour and texture of young clear-cuts is very similar to natural or managed grassland.
- Forest clear-cuts often show rectangular shapes.
- Multi-temporal information is helpful to clarify whether the area was forest before.
- Often scattered single trees or tree patches.
- Sometimes coarse texture and mix with open areas.

Transitional forest near Zella-Mehlis, Germany. SPOT-5 (2.5 m) (1/2/3 Band Combination).
Date: 2012-08-01. Source: CNES 2012©, Distribution Airbus DS/Spot Image

Methodological approach:

- Check agricultural and woodland environments for this class.
- Use CLC class 324 to check for stable objects of this class.
- Perform manual/visual interpretation on CORE_03 data.
- Use auxiliary information e.g. geological maps to clarify specific geomorphological conditions like e.g. calcareous grounds.

3.4.1.2 Lines of trees and scrub

Definition:

More or less continuous lines of trees forming strips within a matrix of grassy or cultivated land or along roads, typically used for shelter or shading. The width of these trees lines is between 10m and 25 m.

Class is comprised of EUNIS G5.1 – early stages of woodland regrowth or newly-colonizing woodland composed predominantly of young individuals of high-forest species that are still less than 5 m in height. Includes young native woodland replanted with indigenous trees and naturally-colonizing stands of non-native trees.

Lines of tress and scrub, eastern Germany. Source: © LUCAS 2012.

This category includes:

- Lines of trees and shrub ≥ 10m and ≤ 25 m width and ≥ 0.5 ha MMU inside urban or agricultural areas.
- Lines of trees along rivers < Strahler Level 3 (except clear and relevant Mediterranean gallery forests-– narrow stretches or strips of forests along the banks of a water body-).
- Lines of trees and scrub inside agricultural or urban areas.

This category excludes:

- Lines of forest along rivers with Strahler Level ≥ 3-5: → Riparian forest.
- Lines of trees at the border of forest clear-cuts → 3.4.1.1 *Transitional woodland and scrub.*

Attributes:

N/A

Appearance:

Lines of trees and scrub near Novákpuszta (Hungary). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-07-10. Source: CNES 2011©, Distribution Airbus DS/Spot Image
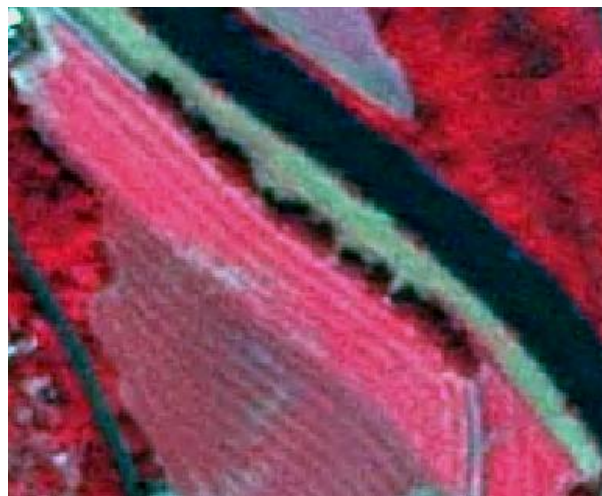
Lines of trees and scrub near Guntershausen, Germany. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2010-07-10. Source: CNES 2010©, Distribution Airbus DS/Spot Image

- Mostly deciduous or mixed forest.
- Includes bushes.
- In case of very small rivers, lines of trees and scrub will cover the creek.
- Lines of trees and scrub may adjoin to forest features.

Example: Lines of trees along river with Strahler level 3 → Riparian Forest SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-10-04. Source: CNES 2011©, Distribution Airbus DS/Spot Image
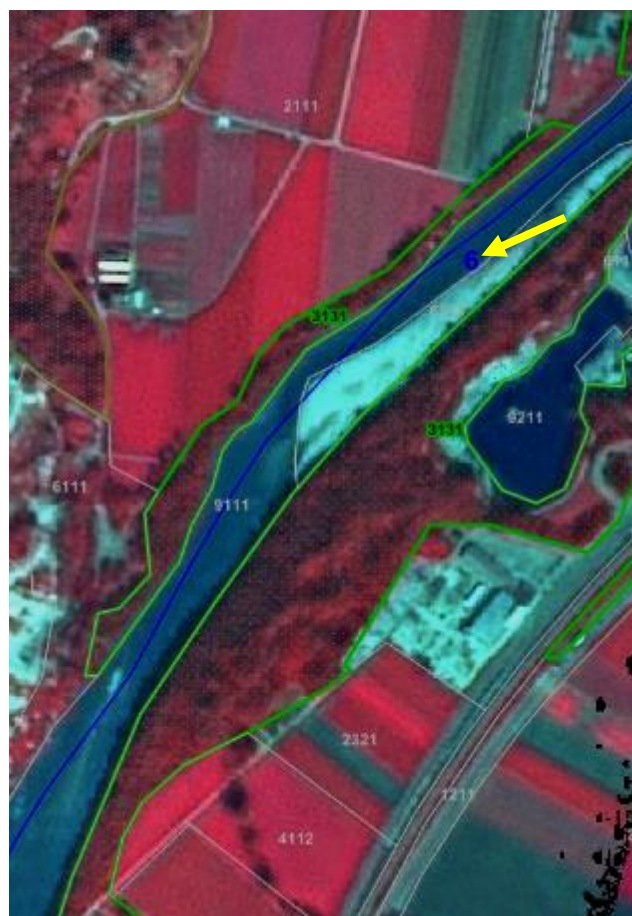
Example: Lines of forest along river with Strahler level 4 (or higher) → Riparian Forest (in this case 3.1.3.1) SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2012-09-17. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- Visual interpretation and manual delineation of respective features.
- Do not include forest shadow areas.
- Map lines of trees and scrub a bit smaller and map the "general" tree outline.
- Use GLE data set, when available, to avoid overlays.

3.5.1.1 Forest damaged by fire

Definition:

Parts of the forests affected by forest fires not older than 1-2 years and still visible in the image due to discoloration. This class comprises either wildfires or human induced forest fires caused either by accident or on purpose.

Forest damaged by fire will mainly occur in southern Europe where wildfires are a common phenomenon. In Central Europe forest fires are rare and occur only sometimes during very hot and dry summers on south-facing slopes.

Wildfire in Alcala la Real (Spain). http://commons.wikimedia.org/wiki/
File:Desolador_paisaje_tras_un_incendio,_en_Alcal%C3%A1_la_Real_(Ja%C3%A9n,_Espa%C3%B1a_2005)
.jpg#mediaviewer/
File:Desolador_paisaje_tras_un_incendio,_en_Alcal%C3%A1_la_Real_(Ja%C3%A9n,_Espa%C3%B1a_-
_2005).jpg

This category includes:

- Forest damaged by fire.

This category excludes:

- Other damaged forest → 3.5.1.2 *Other damaged forest.*
- *Other natural features damaged by fire → 6.2.2.2 Burnt areas.*

Attributes:

o N/A

Appearance:
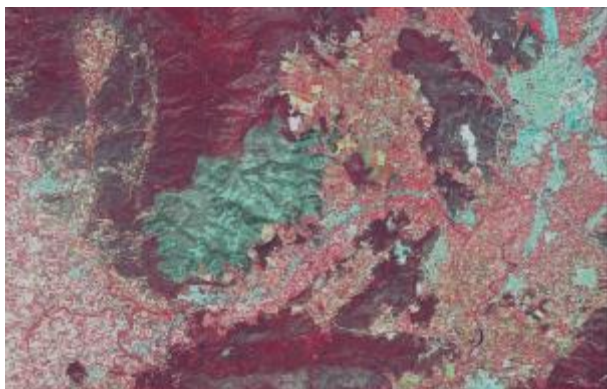
Forest damaged by fire in Benicolet (Spain). Credit: SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-06-22. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Almost 1.500 ha of forest affected by fire in San Joan de Labritja (Spain). Credit: SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-06-17. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

- Clearly visible in EO data due to different colour scheme: greenish to bluish colours instead of red/brown colours for forest areas.
- Located inside or at the border of forests.
- Located primarily in Southern Europe.
- Compact area.

Methodological approach:

- Recent fire events show blackish shades. When several months have passed, forest damaged by fire may resemble other causes such pests. Therefore, when a potentially fire affected area is detected, auxiliary information should be used to verify whether the cause was fire or pest.
- Final detailed delineation and identification using computer assisted visual interpretation.

3.5.1.2 Other damaged forest

Definition:

Damaged forest includes areas not older than 1 to 2 years and still visible in the satellite image e.g. spectrally due to discoloration of needles and leaves or trees lying on the ground. Either pests, storm or tornado events or snow and ice damage may have caused the forest damage.

In most cases, the damage affects monocultures, as these are more vulnerable than mixed forests. Severe bark-beetle attacks, however, are most evident in National Parks, as the park regulations do not allow counteractions that may confine the damage.

Other damaged forest: Bark-beetle damage, Bavarian Forest, Germany. Credits: M. Probeck.

Other damaged forest: Bark-beetle damage, Bavarian Forest, Germany. Credits: M. Probeck

This category includes:

- Forest damaged by storm, tornado or snow events as long as trees are lying on the ground.
- Forest damaged by pests like e.g. bark-beetle as long as the damage is visible due to discoloration.

This category excludes:

- Forest damaged by fire → 3.5.1.1 *Forest damaged by fire.*
- Areas already cleared after a storm event → 3.4.1.1 *Transitional woodland and scrub.*
- Areas already cleared and prepared or ready for afforestation → 3.4.1.1 *Transitional woodland and scrub.*
- Forest clear-cuts → 3.4.1.1 *Transitional woodland and scrub.*
- Afforestation → 3.4.1.1 *Transitional woodland and scrub.*

Attributes:

N/A
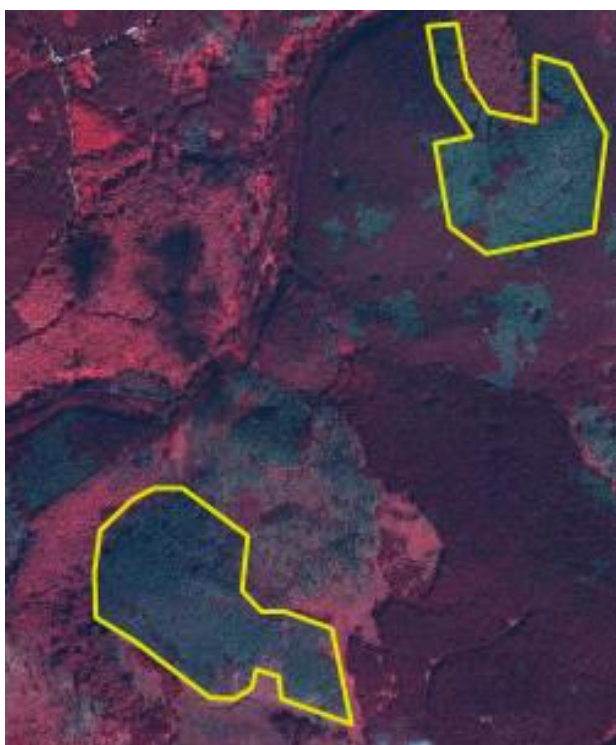
Appearance:

Bark-beetle damage, Harz National Park, Central Germany. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-09-03. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- In case of bark-beetle clearly visible due to greenish appearance of deadwood inside vital forest stands.
- Sometimes mix of deadwood and natural regrowth - mix of green and light red spectral signatures.

Methodological approach:

- In case of tornado/wind/storm or snow damage: verification of the observation of forest damage in the media (e.g. internet, newspaper) or based on additional data sources. Visual interpretation and manual delineation of the areas affected.
- Usage of boundary of National Parks to identify locations that are prone to bark beetle attacks. Visual interpretation and manual delineation.
- Analysis of multi-temporal time series, if appropriate.

4. Grassland

The grassland classes are areas dominated by grassy vegetation of two kinds –managed pastures and (semi-) natural (extensively managed) grasslands[5]. Generally grasses (basically *graminacea* plants but can include tall forbs, rushes and sedges, mosses and lichens) covers more than 30% of the soils (EUNIS description).

According to Annex I of the EU Habitats Directive, European natural grasslands are limited to alpine meadows (as Alpine, Pyrenean and Oro-Iberian grasslands) and other located grasslands.

In this sense, MAES level 2 natural grasslands are considered as natural and semi-natural grasslands and managed grasslands are agricultural grasslands. The main characteristics of agricultural grassland is the high human influence, basically cultivation and visible parcel structure in EO data.

Semi-natural grasslands are frequently associated with trees and scrubs. These grasslands should be managed to maintain their grass coverage, basically by cutting out scrubs manually or mechanically. The combination of trees and grasslands is also present in many locations in Europe (in alluvial areas; in wooded hay meadows; due forest clearing, etc.). *Dehesas* and other wooded pastures, as *Fennoscandinavian wooded pastures,* are included in MAES Croplands class (agroforestry systems located in South Western Europe) or woodland and forest (in the case of forest pastures). The Tree Cover Density, main input for class separation on Level 3, is mainly derived from the High Resolution Tree Cover Density layer based on CORE_01 EO data. In case of obvious errors in the density values, alternative ancillary data will be used to correct/enhance these values. A distinction between dry and mesic grasslands is proposed in relation to semi-natural grasslands, according EUNIS habitat types.
This category includes:

4.1 Managed grassland
      4.1.1 Managed grassland
            4.1.1.1 Managed grasslands with trees and scrubs (T.C:D. ≥ 30%)
            4.1.1.2 Managed grasslands without trees and scrubs (T.C.D. < 30%)
4.2 Natural grassland
      4.2.1 Natural grassland prevailingly with trees and scrubs
            4.2.1.1 Dry grassland with trees (T.C.D. ≥0%)
            4.1.1.2 Mesic grasslands with trees (T.C.D. ≥30%)
      4.2.2 Natural grasslands without trees and scrubs
            4.2.2.1 Dry grasslands without trees and scrubs (T.C.D. < 30%)
            4.2.2.2 Mesic grasslands without trees and scrubs (T.C.D. < 30%)
            4.2.2.3 Alpine and subalpine grasslands without trees (T.C.D. < 30%)

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[5] European Commission (2013): Mapping and Assessment of Ecosystems and Their Services. An Analytical Framework for Ecosystem Assessment under Action 5 of the EU Biodiversity Strategy to 2020. Discussion Paper, Final, April 2013.

4.1.1. Managed grasslands with trees and scrubs (4.1.1.1)/ managed grasslands without trees and scrubs (4.1.1.2)

Definition:

Managed grasslands are considered intensively managed areas for the production of grass. From a land use point of view, in the case of these agricultural grasslands, grass is a crop in the same way as cereals or others. Managed grasslands could be divided into improved and semi-improved grasslands according to their management.

Agricultural grasslands occupy huge areas in the lowlands of the European plain and in United Kingdom and Ireland, where they have a longer growing season due to climatic conditions, leaving dryer areas for arable crops. In many areas, arable land and agricultural grasslands are mixed.

This category corresponds to 2.3.1 Corine class (Pastures). According to the statistical analysis of Corine Land Cover 2006 data, pastures (231 class) occupied 66% of more than 60.000.000 ha considered as grasslands (classes 231-pastures- and 321 –natural grasslands-).

The main characteristics of an ideal improved agricultural grassland farmland are [6]

- The grass farmland is dominated by selected grasses, especially perennial, and the crop is very dense. In early spring, the grassland is often fertilized by the farmer. These grass farmland areas are chlorophyll rich almost all year long and do not contain or contain very little dead biomass.
- Intensive cutting and grazing is done during the grass growing season (usually from April to September).
- The grass could be cut and preserved for winter feeding. The grass for silage must be harvested in an optimum moment.
- Some farmers spread the grass by mower to achieve a better wilt, with the objective to remove excessive moisture for silage. This process could generate rows in the land due to accumulation of grasses. In many cases, this makes grasses undistinguishable from arable land using remote sensing techniques.
- Fertilizers are applied.
- Agricultural grassland could be reseeded.
- Usually there are farm buildings (silages; covered yards; stables, etc.) around.
- Often/mainly used for grazing.
- Improved grassland could be included in rotation. In many countries and in European regulations (as EC Regulation 796/2004 related to EU agricultural policy) an area is considered as "permanent grassland" if the land is covered by grasses during at least five years.

Per definition, there is no tree or scrub presence in improved grasslands (4.1.1.2 Managed grasslands without trees and scrubs (T.C.D. < 30%)

In between the intensively used grass farmland or in specific regions (as the *bocage* landscape in France), there can be plots of less intensive or extensive grassland, e.g. mowed only one time per year. This type of grasslands (lowland and mountain hay meadows) could be considered as semi-improved grasslands (*prairie* in France; *prado* in Spain). Like in mountain alpine meadows, the percentage of wild floral species could be higher here. These grasslands could content trees and scrubs, especially trees walls around the parcels (4.1.1.1 *Managed grasslands with trees and scrubs* (T.C.D. ≥ 30%).

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[6] Intensive British Agricultural Grasslands. An Introduction to Production & Biodiversity.
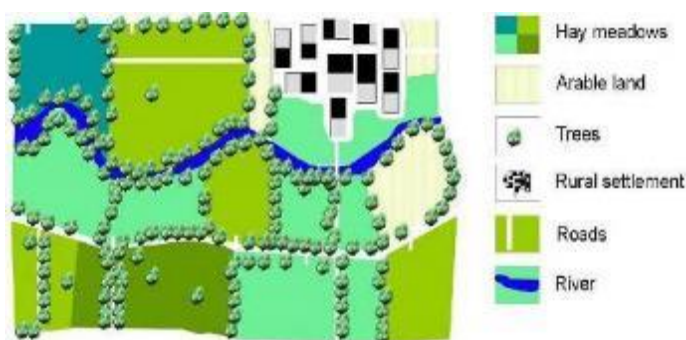http://www.countrysideinfo.co.uk/ag_grasslnd/index.htm

Managed (improved) grasslands in Friesland (The Netherlands). Credit: European Union, 2012. LUCAS
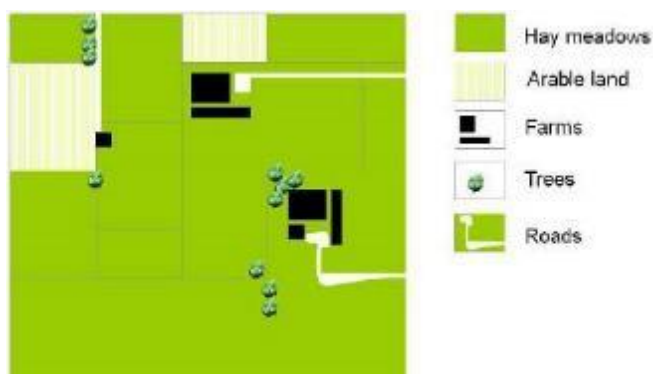
Schematic representation of managed (improved) grasslands

Managed (semi-improved) grasslands. Prairies in Auvergne, France. Credit: C. Alonso

Schematic representation of managed (semi-improved) grasslands

Managed grasslands are discriminated from arable land using Landsat and VHR images, specific color and structure patterns (arable land parcels are generally more angular in shape than pastures and the texture is smooth) and the identification of cultivation tracks, but a certain grade of confusion between two classes is expected. Arable land, in Continental; Mediterranean and Nordic environments, typically appears on flat, lowland soils with clay / fine sediment and few blocks. They are therefore generally more angular in shape than pastures and the texture is smooth.

Managed grassland in Scandinavia. Borders to arable land. SPOT-5 image. (1/2/3 Band Combination). Date: 2011-08-24. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

This category includes:

- Improved and semi-improved grasslands.
- Improved and semi-improved grasslands without trees → 4.1.1.2 *Managed grasslands without trees and scrubs* (T.C.D. < 30%)
- Grassland areas, where most of the grassland plots are fenced by lines of trees (including hedges and/or scrub) → 4.1.1.1 *Managed grasslands with trees and scrubs* (T.C.D. ≥ 30%).
- Abandoned arable land used as pastures or without use (*set aside*) within agricultural areas.
- Managed grasslands may content patches of arable land (less than 25% according CORINE rules; 30% according EUNIS general rules)
- Managed grasslands with scrub and trees (basically due process of land abandonment in mountain but also in lowland environment) where grasses are dominant.

Managed grasslands plot containing scrubs and trees (right), in this case due a process of land abandonment (Central Spain). Credit: M. Palacios

This category excludes:

- Agroforestry systems (*dehesas*). → 2.3.4/2.3.5 *Agroforestry.*
- Urban grasslands (Urban lawns and sport turfs like golf, cricket, tennis, football or polo courses, plots without use in non-urban dense environments colonized by herbaceous plants and grasses of aerodromes, grassland belonging to industrial areas). → 14.1 *Green urban areas/1.4.2 Sports and leisure facilities*.
- Land plot clearly dominated by scrubs and trees and where grasses are not dominant → 3.4.1.1 *Transitional woodland and scrub*.

Attributes:

- o N/A

Appearance:

Managed (improved) grasslands

- Located in fertile soils, preferably in Atlantic and Continental regions in flat or low slope sites.
- In many cases, presence of agricultural buildings.
- Land plot structure present.
- Homogenous texture based on high permanent grasses density.
- Red colors present in band combinations based on infrared during all the year. Decrease of greenness due to summer-time mowing.

Hade Edge (United Kingdom). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2012-01-31. Source: CNES 2012©, Distribution Airbus DS/Spot Image

Managed (semi-improved) grasslands

- Located in lowland areas in humid regions around Europe.
- Sometimes presence of trees in walls used as fence between grassland plots. These trees in walls/fences are not considered as 3.4.1.2 *Lines of trees and scrub*.
- Presence of buildings (villages and agricultural facilities).
- Frequently mixed with agricultural grasslands. Lowland hay meadows are placed in less productive locations. In many cases related to forests.
- Land plot structure present (in many cases bigger than surrounded agricultural grasslands).
- Homogenous texture based on high permanent grasses density, but in any cases covered by scrubs and trees.
- Red colors present in band combinations based on infrared during all the year.
- Managed (semi-improved) grasslands fenced by lines of trees (including hedges and/or scrub) are considered as 4.1.1.1 *Managed grasslands with trees and scrubs* (T.C.D. ≥ 30%).

Example of grassland with trees. Omex (France). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-10-04. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- Use of Corine class 2.3.1 as reference.
- Arable land/managed grasslands (= permanent) discrimination: use of Landsat imagery or other EO datasets acquired outside the vegetation period (August-October, March/April) and application of specific colour patterns.
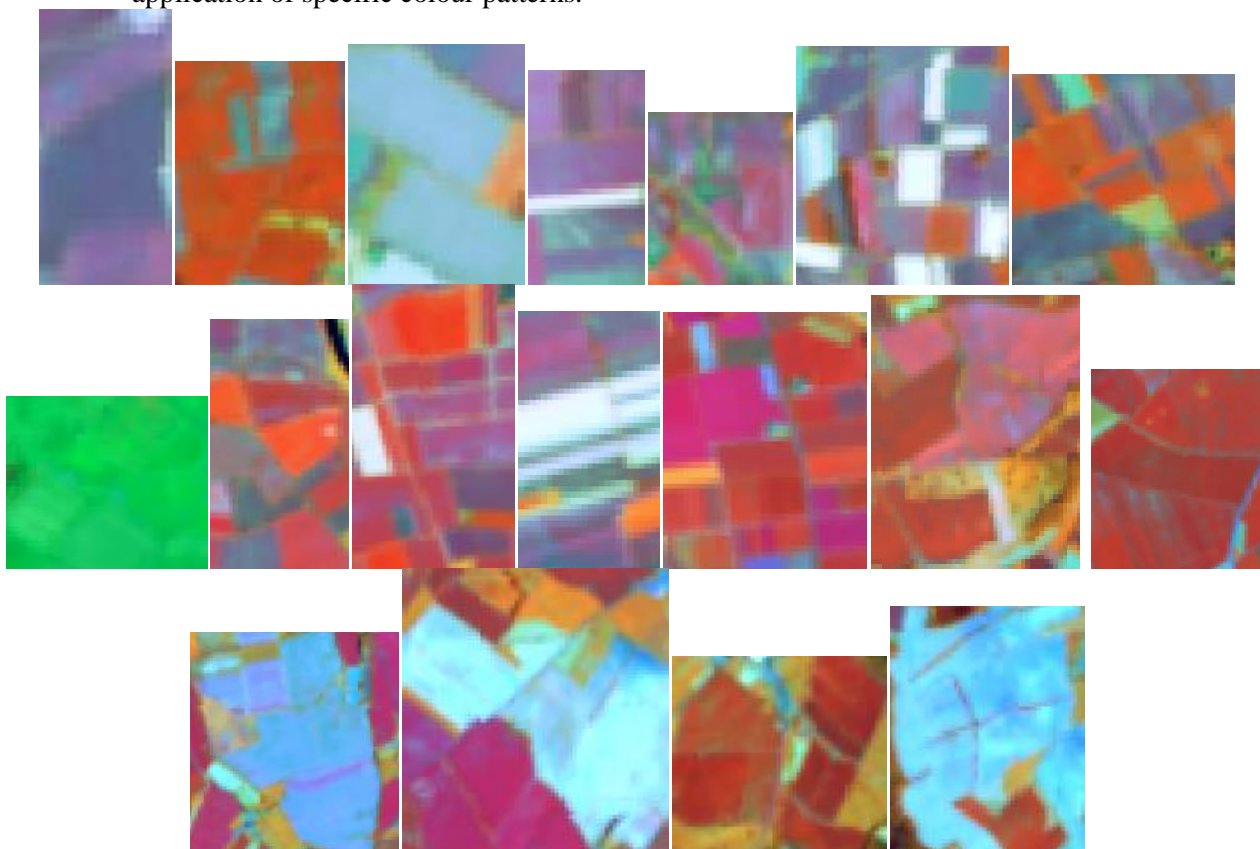
Typical arable land colour patterns in Landsat images
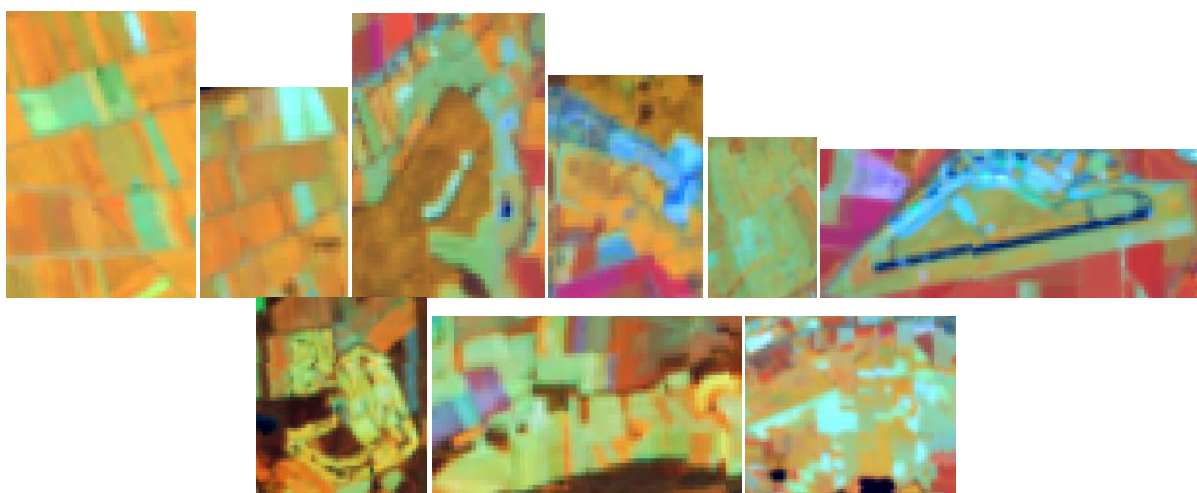
Typical grasslands colour patterns in Landsat images

- Use of VHR images to detect cultivation tracks. In many cases, mowing management of grassland produces tracks similar to those in arable land but with different pattern and row distance.
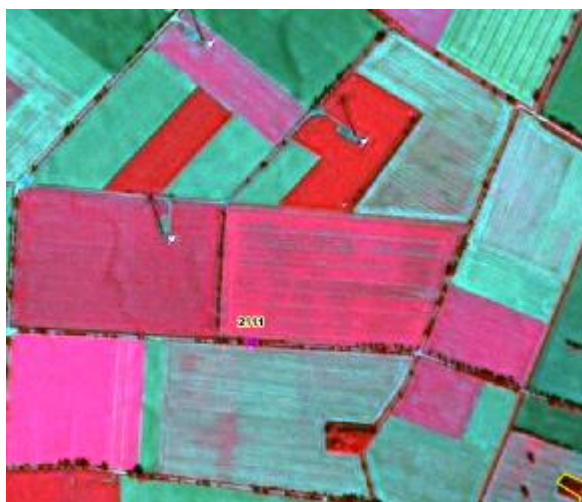
Visible cultivation tracks near Beppen (Germany). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2013-09-05. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Homogenous parcels of grassland without visible mowing tracks, Ahsen-Oetzen (Germany). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2013-09-05. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Tracks in cropland and grassland with no tracks. SPOT-5 (2.5m), Band combination (1/2/3). Date: 2011-05-06. Source: CNES 2012©, Distribution Airbus DS/Spot Image

Examples of rows in a grassland parcel due mowing management. Credits: Eurostat. LUCAS 2009

- Use of specific in-situ data (as Land Parcel identification System in the case of Sweden).
- Grassland is often situated in specific locations, e. g. along rivers and near lakes.
- Final detailed delineation and identification using computer assisted visual interpretation.
- Use of semi-automatic methods or visual interpretation to determine tree density.

Special case: grasslands containing trees and scrubs:

- Grassland with trees (including trees in fences < 10 meters) → 4.1.1.1 *Managed grasslands with trees and scrubs*/4.2.1 *Natural grasslands with trees*
- Small patches of forest inside these areas → 4. *Forests*
- Lines of trees with more 10 meters → 3.4.1.2 *Lines of trees and scrub*

4.2.x Dry grasslands with trees (4.2.1.1)/ dry grasslands without trees (4.2.2.1)

The EUNIS definition of dry grassland is: "*Well drained or dry lands dominated by grass or herbs, mostly not fertilized and with low productivity. Included are [Artemisia] steppes. Excluded are dry mediterranean lands with shrubs of other genera where the shrub cover exceeds 10%; these are listed as garrigue* (F6)[7]."

By (semi-) natural grasslands we mean areas where the herbaceous plants are natural but are created and maintained as permanent grasslands by less intensive agricultural activities[8]. Here are also included marginal grasslands: abandoned crop invaded by grasses; areas near roads and other infrastructures; abandoned dumping sites, etc.

The Annex I of Habitat Directive considers diverse grassland types as dry grasslands, from **calcareous grasslands of central and western Europe,** to steppes in Pannonic region or pseudo-steppes in Mediterranean areas. In all cases, these are grasslands located in less fertile soils, and are extensively managed (not ploughed and rarely fertilized) and used for livestock grazing. In Annex I this type of grasslands are considered as semi-natural. In the Mediterranean Region, dry grasslands are considered by the Annex I of Habitat Directive as **pseudo-steppes**. They are characterized by their loss of greenness in summer-time and are devoted to livestock grazing. In Hungary and other countries we find steppes grasslands (known here as *puszta*), as part of the dry grasslands. **Pannonian steppes** are flat alluvial plains dominated by herbaceous plants extensively managed and strongly transformed by agriculture. Turkey is also dominated by the **Eurasian steppe** (Central Anatolia steppe; Easter Anatolia Montane Steppe and Ponto-Sarmatic steppes in the Black Sea region). Semi-natural dry grasslands are also present in **salt steppes** and in **gypsum steppes** across Europe. Mediterranean salt steppes (Limonietalia); Iberian gypsum vegetation (Gypsophiletalia) and Pannonic salt steppes and salt marshes are also considered as semi-natural grasslands. Nordic *alvar* grasslands are also included here. These grasslands are located in dry calcareous and limestone bedrocks, covered by snow in winter and subjected to strong winds. Regularly clearing is necessary to avoid scrubs. Coastal grasslands as *machairs* (specific coastal old landscape present in dunes in western Ireland and Scotland) dominated by grasses are also included.

In the case of steppes (Anatolian steppe) and Mediterranean pseudo-steppes (dry Mediterranean grasslands), grasses and grass-like plants are mixed with patches of rocks and/or sparsely vegetated areas. These habitats (specially Anatolian steppes) are characterized by low biomass due dry conditions and poor soils. In many cases these steppes suffers for over-grazing and erosion[9]. As results, especially during summer time, it is not feasibly the distinction using EO data between areas covered by grasses (MAES class 4. *Grassland*) and rocks and areas with sparsely vegetation (MAES class 6. *Sparsely vegetated land*). In this case has been adopted the concept of steppes and pseudo-steppes as an edaphic climax habitat dominated by grasses and grass-like plants but with a high presence of sparsely vegetated areas. In this sense, generalization rules are applied (inclusion as grassland patches of low vegetation biomass) in order to avoid an excessive mapping fragmentation.

Dry grassland in Atlantic and Continental regions are restricted to very located sites affected by poor soils conditions such as calcareous dry grasslands in Western Germany, grasslands located in chalk cliffs in Denmark, grassland located in karstic regions in the Balkans or Nordic *alvars*[10].

Natural dry grasslands are divided into two categories, according the presence of trees:

- 4.2.1.1 Dry grasslands with trees (T.C.D. $\geq$ 30%)
- 4.2.2.1 Dry grasslands without trees (T.C.D. $<$ 30%)

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[7] http://eunis.eea.europa.eu/habitats/539
[8] FAO, http://www.fao.org/agriculture/crops/core-themes/theme/spi/gcwg/definitions/en/
[9] Richard, D. and Condé, S. (coordinators): Biogeographical regions in Europe, The Anatolian region –the biogeographical transition to Asia in Europe's biodiversity –biogeographical regions and seas, European Environment Agency.
[10] European Communities (2008): LIFE and Europe's grasslands-Restoring a forgotten habitat, Office for Official Publications of the European Communities, Luxembourg.
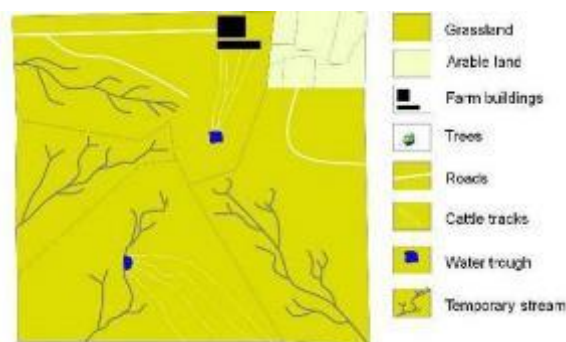
Dry grassland with trees on the Franconian Alb (juniper heathland), Germany. Credit: M. Probeck
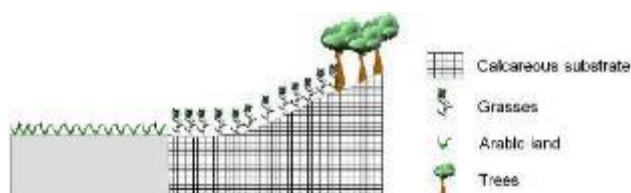
Schematic representation of calcareous dry grasslands

Dry Mediterranean grasslands in Extremadura region, South Western Spain. Credit: M. Palacios

Schematic representation of Mediterranean pseudo-steppes in summer time

Pannonian dry grasslands in Northwestern Hungary. Credits: European Union, 2012. LUCAS

Nordic alvar (Oländ, Sweden). Credits: European Union, 2012. LUCAS

Grasses covering an abandoned arable land. Credit: M. Palacios

Grasses in a military camp. Credit: M. Palacios

This category includes:

- Dry (semi-) natural grasslands, according Corine 3.2.1 classification.
- Grasses covering abandoned arable land.
- Mediterranean dry grasslands ploughed to remove scrubs are also included within this category.

Examples of Mediterranean grasslands ploughed 3-5 years to remove scrubs invading the parcel. Example in Extremadura, Spain. Credits: European Union, 2012. LUCAS

- Dry grasses in military training areas.
- Marginal grasses located near infrastructures (as intersections of railroads) if > 0.5 ha.

This category excludes:

- Managed grasslands → 4.1.1 *Managed grassland*.
- Agroforestry systems. → 2.3.4/2.3.5. *Agroforestry*.
- Grasslands growing in temporary wet areas.
- All grasslands with more than 30% scrub cover is considered as scrub (CORINE consider 25%).→ 5. *Heathland and scrub*.
- Clear-cut areas, new forests. → 3.4.1.1 *Transitional woodland and scrub*.

Attributes:

o   N/A

Appearance:

Calcareous/limestone dry grasslands:

- Located in less fertile soils (such as limestone) in Atlantic and Continental regions.
- Frequently mixed with rocks and scrubs/trees.
- Land plot structure present (big plots surrounded by smaller agricultural grassland plots)
- Medium texture
- Predominant green/orange colours present in band combinations based on infrared during all the year. Less greenness than agricultural grasslands in the same area

Calcareous dry grasslands example with trees (Himsklamm Natura 2000 site, Germany. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2012-08-27. Source: CNES 2012©, Distribution Airbus DS/Spot Image

Mediterranean dry grasslands:

- Located in the Mediterranean regions in areas affected by dry summers.
- Frequently mixed with scrubs. In some areas mixed with wooded grasslands.
- Generally land plot structure present (big plots).
- Non-homogenous texture.
- Green/Red colors in spring-time band combinations based on infrared. Brown colors in summer-time (annual grasses). In some cases white colors due over-grazing.
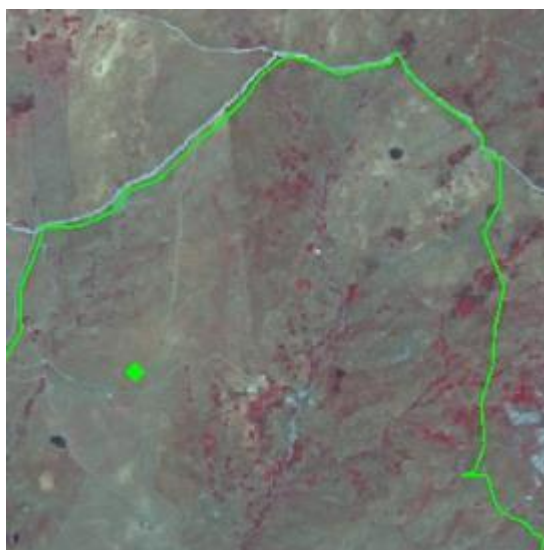
Mediterranean dry grasslands example (Contrada Giammaiano Natura 2000 site, Sicily, Italy). SPOT-5 (2.5 m.) (1/2/3 Band Combination). Date: 2011-07-16. Source: CNES 2012©, Distribution Airbus DS/Spot Image

Pannonian steppes:

- Located in flat areas in Pannonian region (Hungary; Romania; Slovak Republic; Czech Republic; Austria; Serbia and Croatia), but centered in the Hungarian plaine (*puszta*).
- Mixed with agricultural land areas located in areas less productive.
- Usually big plots with presence of drainage channels in specific locations (Duna-Tizsa plaine).
- Non-homogenous texture based on a medium grasses density and bare soil patches.
- Green-brown colours in spring and autumn respectively.

Pannonic steppe grasslands example. (Hortobágy Natura 2000 site, Hungary. SPOT-5 (2.5 m.) (1/2/3 Band Combination). Date: 2011-09-22. Source: CNES 2012©, Distribution Airbus DS/Spot Image

Anatolian steppes:

- Located in Centre and Eastern Anatolian (montane steppes) and Black Sea region.
- Frequently mixed with scrubs. No tree presence.
- No land plot structure present, but surrounded by arable land plots.
- Non-homogenous texture.
- Green-Brown colour during all the year in dry locations. Green colours in montane steppes during less dry periods.

Anatolian steppe example. Sultanhanı (South of Tuz Lake, Turkey). SPOT-5 (2.5 m.). Date: 2011-11-27. Source: CNES 2012©, Distribution Airbus DS/Spot Image

- Located to sand dunes in Scotland and Ireland.
- Could be mixed with scrubs and agricultural plots.
- No land plot structure present.
- Homogenous texture based on a medium grasses coverage and the presence of sand.
- Red colours present in band combinations based on infrared during all the year. Also brown due to the sand

Machair example. Termoncarragh Lake and Annagh Machair SPA (Ireland). In green, Nature 2000 site limits. IRS (20 m.) (3/4/2 Band Combination)Date: 2011-03-31.

Nordic *alvar*:

- Located in Boreal region (basically Sweden and Baltic countries).
- Grasses occupying areas with rocks and scrubs.
- Without land plot structure.
- Non-homogenous texture (grasses, rocks and scrubs)
- Grasses appears in red to green colours.
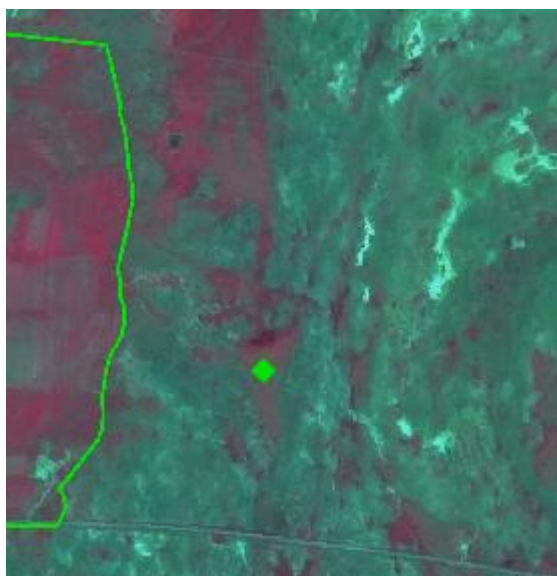
Nordic Alvar example. Stora Alvaret Natura 2000 site, Sweden. Grasslands appears in red colour. SPOT-5 (2.5 m.) (1/2/3 Band Combination) Date: 2011-06-29. Source: CNES 2012©, Distribution Airbus DS/Spot Image

Grasslands in military camps:

- Non-homogeneous texture (grasses, sandy areas, low bushes, heath)
- Xeric grassland appears in green colours
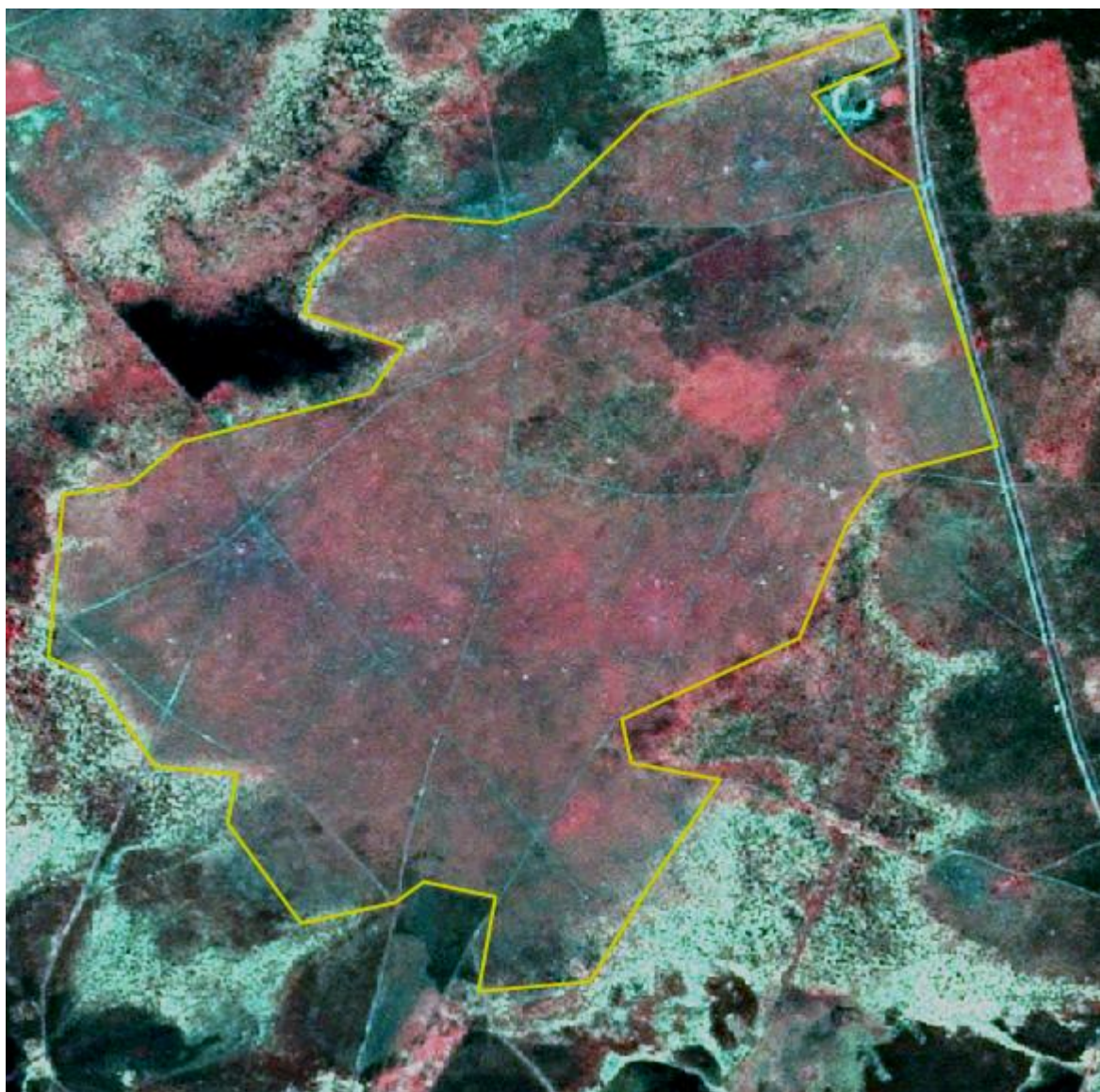
Dry natural grassland without trees (4.2.2.1) on a former military training site. SPOT-5 (2.5m), Band combination (1/2/3). Date: 2011-05-06. Source: CNES 2012©, Distribution Airbus DS/Spot Image

***Methodological approach**:*

- Use of Corine class 3.2.1 as reference.
- Subtract alpine-subalpine grasslands using digital elevation model as reference.
- Soil identification as a proxy: calcareous, sand, chalk, gypsum....
- Identification of potential area of dry grasslands using biogeographical regions information.
- Final detailed delineation and identification using computer assisted visual interpretation.

4.2.x.x. Natural mesic grasslands with trees (4.2.1.2)/ without trees (4.2.2.2)

Definition:

The EUNIS definition of mesic grasslands (E2) is: "*Lowland and montane mesotrophic and eutrophic pastures and hay meadows of the boreal, nemoral, warm-temperate humid and mediterranean zones. They are generally more fertile than dry grasslands (E1), and include sports fields and agriculturally improved and reseeded pastures*". In EUNIS habitat classification[11], the habitats are separated according the presence of water: waterlogged (the water table at or above ground level for at least half of the year), permafrost (habitats where the soil is at a temperature of less than 0ºC throughout the year) and other (always dry; mesic, moist or humid; only seasonally wet; regularly but infrequently flooded or occasionally flooded by extreme weather conditions but which are free-draining; wet but not waterlogged; permanent snow and ice.). Here we consider mesic grasslands as mesic and moist or humid grasslands. The separation between mesic grasslands and wetlands is that the latter are waterlogged or frequently flooded.

Taken into account Annex I Habitat Directive and EUNIS classification following grasslands types are included here:

- Semi-natural humid meadows: wet pastures (including riverine meadows), Mediterranean alluvial meadows and Northern boreal alluvial meadows.
- Mesophile grassland not included in 4.1.1.x. *Managed grasslands,* including abandoned hay meadows.

Natural mesic grasslands are divided into two categories, according the presence of trees:

- 4.2.1.2 Mesic grasslands with trees (T.C.D. $\geq 30\%$)
- 4.2.2.2 Mesic grasslands without trees (T.C.D. $< 30\%$)

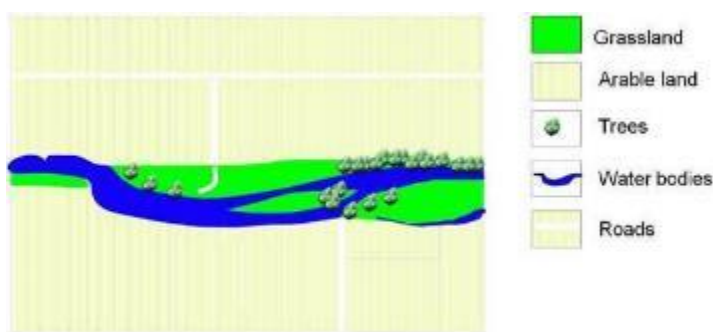*Spontaneous grassland in Bieszczday district (Poland). Credits: Eurostat, LUCAS, 2009*

Wet grassland in Donegal (Ireland): Credits: Eurostat, LUCAS, 2009

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[11] http://searchmesh.org/pdf/GMHM1%20EUNIS_Habitat_Classification_Revised_2004.pdf

Wet grassland alongside river humid soils in Spain. Credit: M. Palacios

Schematic representation of Mediterranean alluvial meadows

This category includes:

- Mesic (semi-) natural grasslands, according Corine 3.2.1 classification.
- Hydrophilous tall herbs areas.
- Wet grasslands alongside river in dry environments (including former gravels covered by grasses and grass-like plants).
- Mesic grasses of military training areas.

This category excludes:

- Wet grasslands, which are wet in most times of the year, should be considered to be included in the wetland layer (in the case of sedge communities and tall rush swamps). → 7. Wetland.
- Habitats of bogs and boreal mires (including herbaceous plants such as sphagnum and others) → 7. Wetland.
- Clear-cut areas, new forests → 3.4.1.1 Transitional woodland and scrub.
- (In Nordic conditions) Grazed/moved humid pastures → 4.1.1 Managed grassland.

Attributes:

- o N/A

Appearance:

Semi-natural mesophile grassland:
- Located in Atlantic and Continental biogeographic regions or in mountains in other areas.
- Could be mixed with scrubs, trees and agricultural plots.
- No land plot structure present.
- Homogenous texture based on medium grasses coverage.
- Red colors present in band combinations based on infrared during all the year. Also brown due to the sand.
- The texture is often more rough than arable land and flamed with alternating dryer and more humid parts.
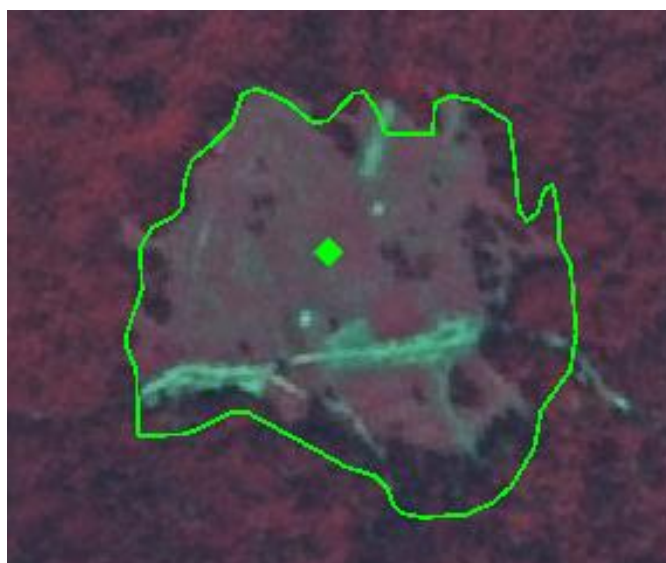
Hydrophilous tall herb example. Rečice Natura 2000 site, Croatia. SPOT-5 (2.5 m). Date: 2011-08-25. Source: CNES 2012©, Distribution Airbus DS/Spot Image

Example from Scandinavia. Low lying grassland in proximity to running water. (1/2/3 Band Combination). SPOT-5 image. Date: 2011-07-08. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Alluvial meadows:

- Associated to humid soils/valleys alongside rivers and humid soils.
- Frequently flooded. In big alluvial grassland mixed with agricultural plots.
- Shape related to rivers valleys. In big rivers presence of abandoned meander.
- No land plot structure present.
- Homogenous-medium texture based on high permanent grasses density (water sometimes)
- Red colors present in band combinations based on infrared during all the year. In many locations affected by a loss of greenness in summer-time (green colors).

Alluvial meadow example in Umurca (Turkey) SPOT-5 (2.5 m.) (NIR/R/G Band Combination). Date: 2011-07-05.Source: CNES 2011© Distribution Airbus DS/Spot Image.

Methodological approach:

- Use of Corine class 3.2.1 as reference.
- Soil identification as a proxy: calcareous, sand, chalk, gypsum, etc.
- Identification of potential area of dry grasslands based on biogeographical regions delimitation.
- Final detailed delineation and identification using computer assisted visual interpretation.

Differentiation between natural mesic grasslands (4.2.1.2/4.2.2.2) and wetlands (7.1.1.x):

Differentiation between grasslands and wetlands near Drozdowo (Poland). SPOT-5 (2.5 m.) (1/2/3 Band Combination). Date: 2011-08-27. Source: CNES 2011© Distribution Airbus DS/Spot Image

<div style="display:flex;">
<div>

Grasslands

-Colour:
- Deep red, light red
- blue-green, red-green

-Sometimes mowing structures.

-No parcels, heterogeneous appearance.
-Texturized.

</div>
<div>

Wetlands

-Colour:
- Brown, deep red, orange-green-brown
- Red-blue/grey

-Sometimes mowing tracks (cutting of reeds).
-No parcels.
-Heterogeneous appearance.
-use auxiliary data (GIO wetlands layer) to identify permanent water plains.

</div>
</div>

4.2.2.3 Alpine and subalpine grasslands without trees (T.C.D. < 30%)

Definition:

According EUNIS definition "*primary and secondary grass- or sedge- dominated formations of the alpine and subalpine levels of boreal, nemoral, mediterranean, warm-temperate humid and Anatolian mountains*"12.

This category include following natural grasslands identified in Annex I Habitat Directive:
- 6140 *Siliceous Pyrenean Festuca eskia grasslands*13 (in the Pyrenees and Cantabrian mountains in Spain);
- 6150 *Siliceous alpine and boreal grasslands*14 (acidic grasslands of mountains in the Alps, Carpathians and Scandinavia together with higher mountains elsewhere in northern Europe such as in the north of the British Isles);
- 6160 *Oro-Iberian Festuca indigesta grasslands*15 (located in the high Mediterranean mountains of the Iberian Peninsula) and
- 6170 *Alpine and subalpine calcareous grasslands* (present in the Alps, Pyrenees, Carpathian and Scandinavian mountains, highest mountains of Corsica, Apennines, Cantabrian, Betic and Iberic mountains in Spain, Dinaric Alps, the mountains of Greece and Turkey and the Scottish Higlands16)

These natural grasslands are known commonly as *alpine meadows.* In all the cases, these alpine meadows involve grasses growing above the limits of the mountain hay meadows and forests (in many cases in areas with mountain scrublands and barren rocks).
The majority of these alpine grasslands are grazed traditionally in summer-time under traditional transhumance regimes.

Per definition, there are no trees in alpine grasslands or their presence is rare.
Related EUNIS Habitat Classification: E4.

Oro-Iberian festuca indigesta grasslands at altitude above 2,000 m. in Madrid region (Spanish Central Mountains range) Credit: M. Palacios
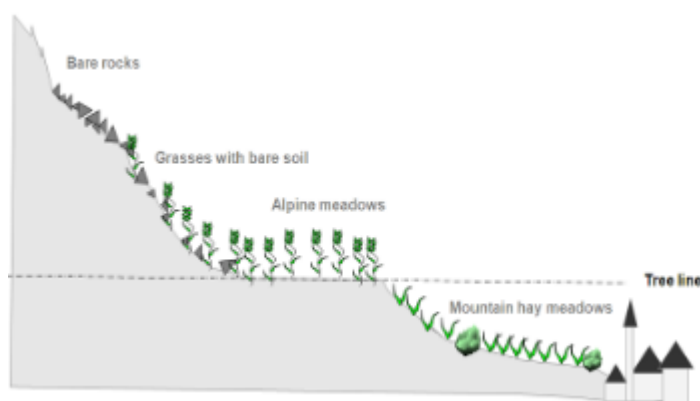
Schematic representation of alpine grasslands

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12 http://eunis.eea.europa.eu/habitats/146
13 http://eunis.eea.europa.eu/habitats/10114
14 http://forum.eionet.europa.eu/x_habitat-art17report/library/datasheets/habitats/grasslands/grasslands/6150-siliceous_grassland
15 http://eunis.eea.europa.eu/habitats/10116
16 http://ec.europa.eu/environment/nature/natura2000/management/habitats/pdf/6170_Alpine_calcareous_grasslands.pdf

Alpine and subalpine grassland could be located in alpine valley bottom, slopes or mountain tops.

*Location of alpine and subalpine grasslands. Credit: M. Rodriguez*

This category includes:

- Natural grasslands (occasionally grazed) above the tree line[17] with low fraction of bare rock or gravel, shrubs and sporadic trees. Grasslands cover at least 30% of the surface. Low managed grassland close to the tree line with high grasses density and no land plot structure present are also included here.
- In the case of Nordic countries this class includes natural grasslands and extensive/former grazed grasslands above the tree line.

This category excludes:

- Mountain hay meadows (managed grasslands) below tree line → 4.1.1 *Managed grassland*.

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[17] Berdanier, A. B. (2010) Global Treeline Position. Nature Education Knowledge 3(10):11.
http://www.nature.com/scitable/knowledge/library/global-treeline-position-15897370
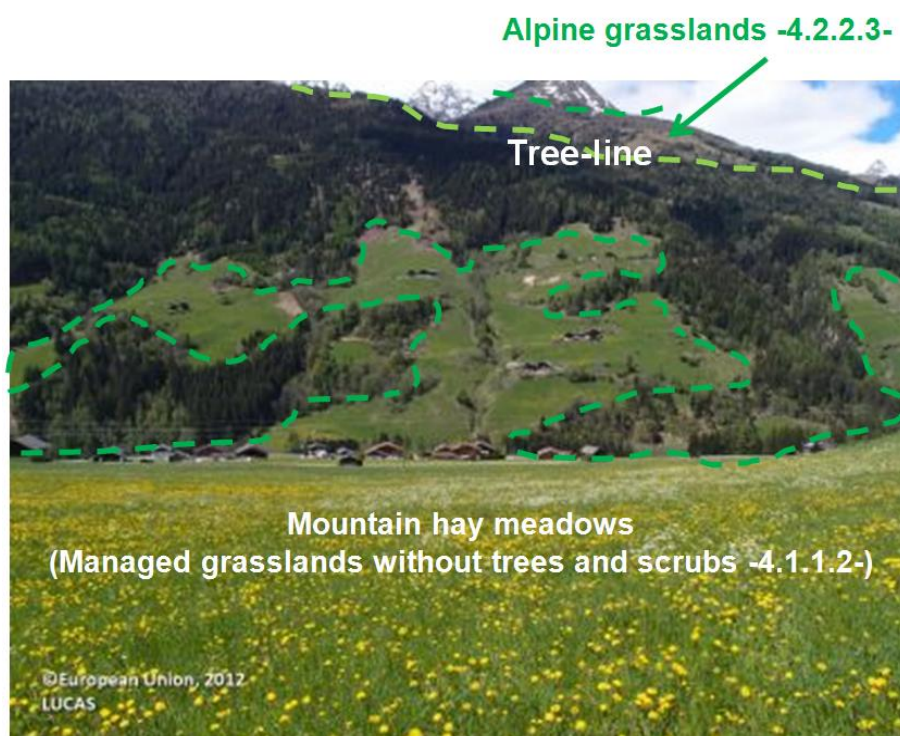
Alpine meadows/mountain hay meadows discrimination using a theoretical tree line (dotted line in red). Alps in Austria. Credit of photography: European Union, 2012. LUCAS

- Alpine heaths, usually located between the tree line and the grasslands formations → 5. *Heathland and scrub.*
- Surfaces covered by mosses and lichen → 6. *Sparsely vegetated areas.*
- Grasslands less than 50 % field cover (in climax stage), such as snowbed grassland → 6. *Sparsely vegetated areas.*

Attributes:

- o   N/A

Appearance:

- Located over the tree limit in high mountains in Alpine region (valleys and slopes).
- Frequently mixed with rocks; non-permanent water and peat bog.
- Discrimination affected by mountain shadows.
- No land plot structure present.
- Homogenous-medium texture based on high permanent grasses density (rocks)
- Red colors present in band combinations based on infrared during all the year (frequently covered by snow during winter-time). Grasslands in valleys present more greenness than slope grasses.
- In Nordic countries this category is normally a heterogeneous vegetation type where grass dominates in a mosaic of heath vegetation, mire vegetation, alpine willow bushes and rocky ground.
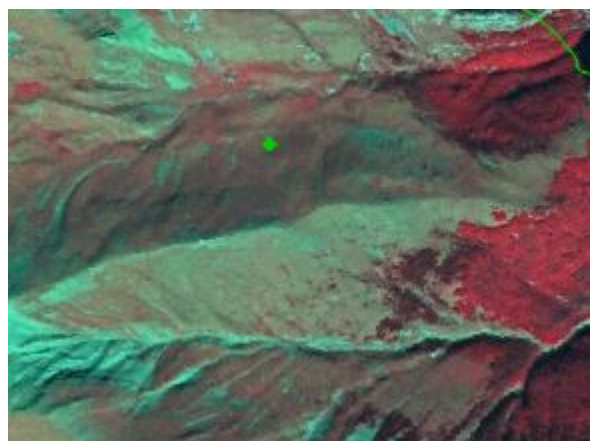
Siliceous Pyrenean Festuca eskia grassland example. SPOT-5 (2.5 m) (1/2/3 Band Combination). Tendeñera Natura 2000 site, Spain. Date: 2011-09-08.
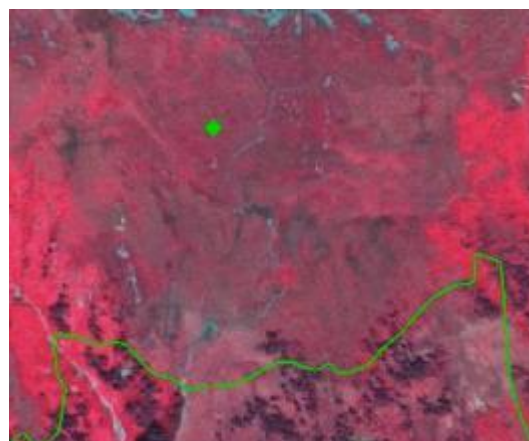

Alpine calcareous grassland example. Verwall Natura 2000 site, Austria. SPOT-5 (2.5 m) (1/2/3 Band Combination) Date: 2012-09-28. Source: CNES 2012©, Distribution Airbus DS/Spot Image
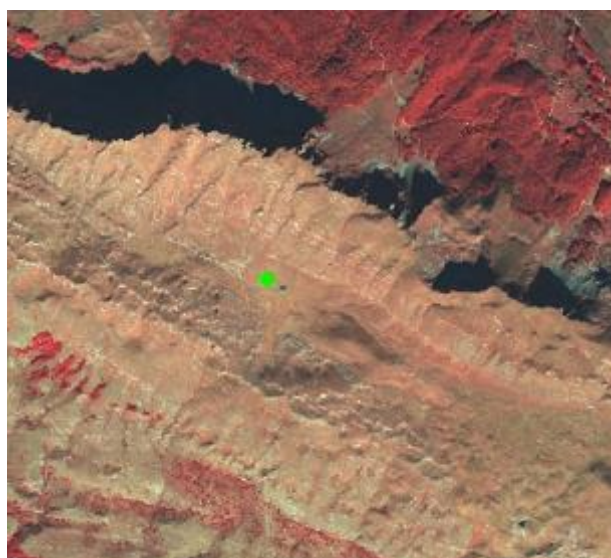
Alpine grassland example. Border between Bosnia and Herzegovina and Montenegro. SPOT-5 (2.5 m) (1/2/3 Band Combination) Date: 2011-10-18. Source: CNES 2012©, Distribution Airbus DS/Spot Image

Alpine grassland example. IRS (20 m.) example. (Durness Natura 2000 site, Scotland, UK). Date: 2013-06-05. Source: CNES 2012©, Distribution Airbus DS/Spot Image
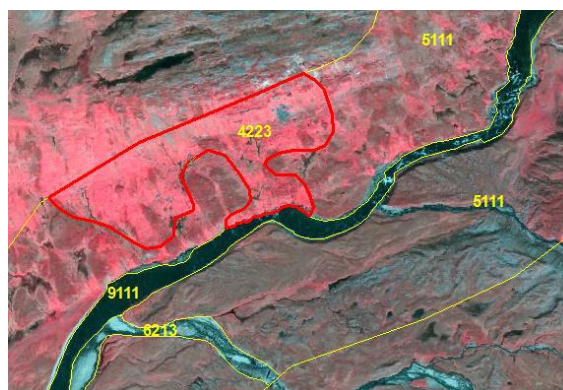
Example from mountaneus parts of Scandinavia. (1/2/3 Band Combination). Spot 6 image. Date: 2013-07-24. Source: CNES 2013©, Distribution Airbus DS/Spot Image.

Methodological approach:

- Extraction of potential subalpine (this zone also include forests) and alpine zones (above the tree line) included in LC/LU buffer area using EU-DEM according regional altitudinal zonification:

Mountainous area (associated AOI)	Subalpine altitudinal zone (above m.)
Alps	1,600 m.[18]
Black Forest, Harz, Vosgues	1,200 m. [19]
Pyrenees	1,600 m.[20]
Cantabrian Mountains and Mountains of Central Spain	1,700 m. [21]
Carpathians mountains	1,390 m.[22]
Tatra Mountains	1,550 m. [23]
Uplands of Scotland	900 m.[24]
Turkey mountains	1,500 m.[25]
Corsica mountains	1,600 m.[26]

- Analysis of the extraction of tree line from HRL Forest
- Final delineation and identification using computer assisted visual interpretation.
- In the case of Nordic countries, and considering the heterogeneous nature of this class, a polygon may include up to 30% of the classes 3131 (*Other natural and semi natural broadleaved forest*), 5111 (*Heathland and moorlands*), 5112 (*Other scrub land*), 7212 (*Unexploited peat bog*), 7112 (*Inland freshwater marshes with reeds*), 6111 (*Sparsely vegetated areas*) and 6221 (*Bare rocks and rock debris*) if these surfaces are too small to map separately. The specified class should therefore cover at least 70% of the surface. The minimum mapping unit for these heterogeneous classes will be around 1 ha.

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[18] Huetz de Lemps, A. (1970): La Végétation de la Terre, Masson et Cie, Paris.

[19] Huetz de Lemps, A. (1970): La Végétation de la Terre, Masson et Cie, Paris.

[20] Rivas-Martínez, S. (1990): Los pisos subalpino y alpino de los pirineos y de la Cordillera Cantábrica; relaciones y diferencias, Botánica pirenaico-cantábrica, 577-595, Jaca y Huesca.

[21] Rivas-Martínez, S. (1990): Los pisos subalpino y alpino de los Pirineos y de la Cordillera Cantábrica; relaciones y diferencias, Botánica pirenaico-cantábrica, 577-595, Jaca y Huesca.

[22] http://retro.seals.ch/cntmng?pid=gbi-002:1992:107::136

[23] http://geoinfo.amu.edu.pl/sgp/LA/LA11/LA11_06.pdf

[24] http://www.snh.org.uk/publications/on-line/advisorynotes/26/26.htm

[25] http://www.ukeconet.org/wp-content/uploads/2009/10/Colak_Rotherham_International_Foresty_Review.pdf

[26] http://www.oec.fr/modules.php?name=Sections&sop=viewarticle&artid=114

5. Heathland and scrub

Heathland and scrub is divided into two classes depending on whether the shrubby vegetation is evergreen and adapted to water loss (*Sclerophyllous vegetation*) or not (*Moors and heathland*).

Moors and heathland appears in both temperate and frigid zones. Areas with heath and dwarf scrub vegetation adheres to the MAES class *Heathland and moorlands*. Areas dominated by brush woods and bush-like forest adheres to the MAES class *Other scrub land*.

Sclerophyllous vegetation appears in Mediterranean region.

This category includes:

5.1 Moors and heathland
  5.1.1 Moors and heathland
    5.1.1.1 Heathland and moorlands
    5.1.1.2 Other scrub land

5.2 Sclerophyllous vegetation
  5.2.1 Sclerophyllous vegetation
    5.1.1.1 Sclerophyllous vegetation

5.1.1.1 Heathlands and Moorlands

Definition

Areas with low and closed cover, dominated by brush, bushes and herbaceous vegetation or dwarf shrubs. They are mostly secondary ecosystems with unfavourable natural conditions. The field layer has a cover > 50 % and tree cover < 10 %.

Ungrassed lichen area of Rödfjället, Dalarana, Sweden. Credit: Charlotta Cristvall

Stornärfjället, Dalarna (Sweden). Credit: Sebastian Kirppu

Juniperus communis subsp. nana in Mediterranean Alpine-subalpine mountains. Credits: M. Palacios-

Heathland invading grasslands in Ireland. Credit: A. Utanda

This category includes:

- Areas where the field layer has a cover of more than 50 % at the phenological mature stage. (The date of the satellite data is crucial, especially in the northern countries where the vegetation period is short. An area may change from 0 % to 100 % green field cover within weeks).
- Heath and scrub formation in Atlantic, sub-Atlantic and sub-Continental areas with *Ulex spp.*, *Calluna vulgaris*, V*accinium spp.*, *Erica spp*, *Genista spp.*, *Vaccinium myrtillus* and *Rubus spp.*
- Moors in supra-Mediterranean area (400 m-1100 m of elevation) with box trees and gorse, *Buxus spp.*, *Astragalus spp.*, *Bupleurum spp.*, etc.
- Sub Alpine tall herbs with dominating bushy facies, *Calluna spp., Vaccinium spp., Rubus spp., Juniperus nana, etc*.
- Arctic moors areas with moss, lichen, gramineous coverage and small dwarf or prostrate shrub formations (*Betula nana*, *Salix lapponum*, *Salix glauca*, *Juniperus alpina*, *Dryas spp*.);
- Heathland of Mediterranean mountains (apart from alpine and subalpine areas), including *Juniperus sp*. and *Erica* rich heaths.
- Grey dunes with heathland vegetation.
- Mosaics of complex distribution between the MAES classes 5111, 3131, 4223, 5112, 7212, 7112, 6111 and 6211where the MAES class 5111 cover at least 70% of the surface.

This category excludes:

- Low *maquis*/*matorral* vegetation (CLC class 323) and heathland under recolonizing process where tree-like species cover more than 30% of the surface (CLC class 324) are excluded
- Non-sclerophyllous scrub, such as dwarf pine (*Pinus mugo*) and green alder (*Alnus viridis*) in mountainous regions → class 5.1.1.2 *Other scrub land*.
- Juniper bush, leafy bush, bushy fens and Salix spp. thickets→ Class 5.1.1.2 *Other scrub land*.
- Areas with > 50% field coverage with predominance of grass vegetation → Class 4 *Grassland*.
- Areas with field coverage between 10-50 % field cover → Class 6 *Sparsely vegetated land*.
- Areas with peat producing vegetation → Class 7 *Wetland*.
- Areas with > 10 % tree coverage →Class 3 *Woodland and forest*.

Attributes:

N/A

Appearance:

- In Scandinavian condition this vegetation type occurs in a mosaic with mire vegetation, alpine grasslands, alpine willow bushes and rocky ground. This requires generalization where 5.1.1.1 should cover at least 70 % of the delineated area.
- Delineation between grass heath (4.2.2.3.) and herbaceous heath (5.1.1.1.) is associated with low accuracy when validated in field. A recommendation in the interpretation is to consequently also use additional supporting data.
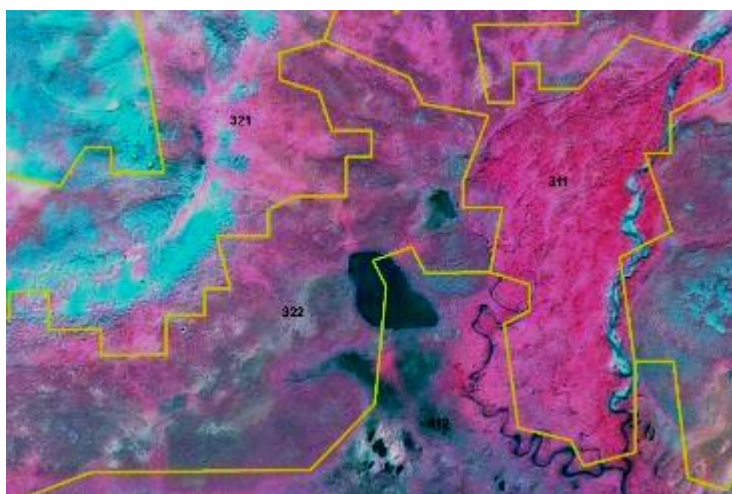
LC CLC classes. Alpine area south east of Kebnekaise, Sweden. (1/2/3 Band Combination). Spot 6 image. Date: 2013-07-24. Source: CNES 2013©, Distribution Airbus DS/Spot Image.

Example from alpine and subalpine areas with *Juniperus nana*, *Loiseleuria procumbens*, *Empetrum hermaphroditum*, *Arctostaphylos uva-ursi*, *Arctostaphylos alpina* and elements of Alpine flora.
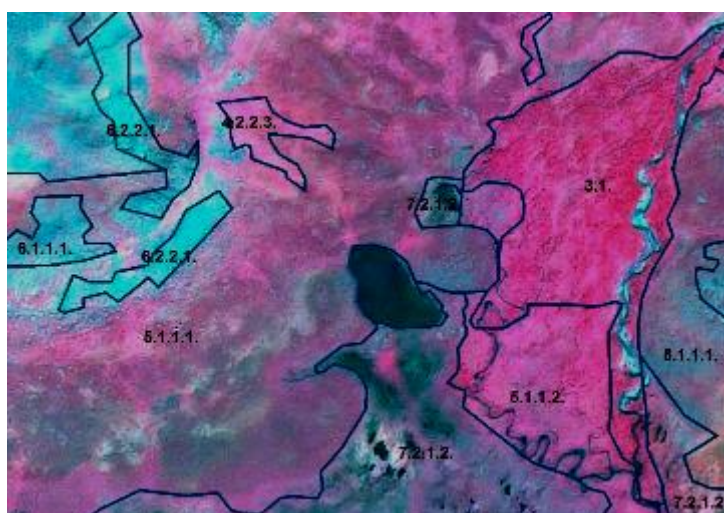
Heathlands and Moorlands, MAES class 5.1.1.1. SPOT 6 image. (1/2/3 Band Combination). (1/2/3 Band Combination). Spot 6 image. Date: 2013-07-24. Source: CNES 2013©, Distribution Airbus DS/Spot Image.

Examples from Scandinavian alpine area. Heathlands and Moorlands vary with areas of predominantly dwarf shrubs (brown to gray in IR) and more herbaceous (appears more red).

Areas with predominance of grass in alpine areas belong to MAES class 4.2.2.3 *Alpine and subalpine grassland*.
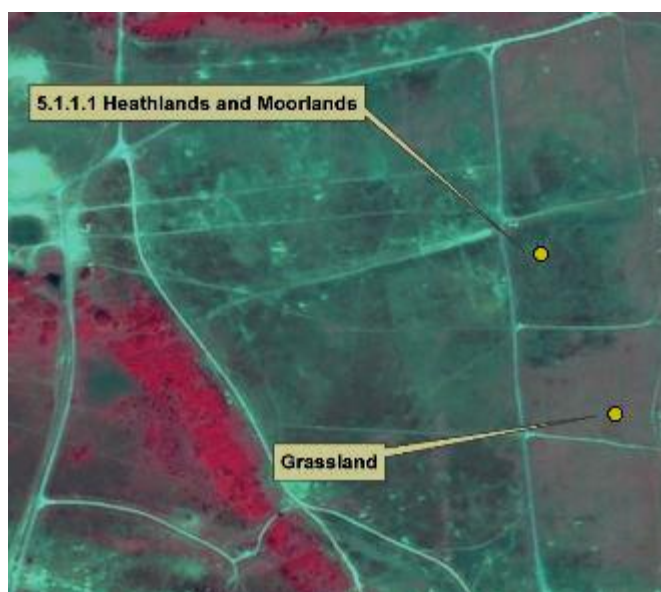
Example of delineation between grassland (>30% grass coverage) and Heathlands and Moorlands. The area is used as gunnery range.

Heathland and Moorlands in the southern parts of Scandinavia. SPOT-5 image. 1/2/3 Band Combination). Date: 2011-06-28. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Heathland on a military training site located near Munster, Germany (Niedersachsen), SPOT-5 (2.5m), Date: 2011-05-06. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- CLC class 322 (CLC 311, 333) as indication (see image below) And Landsat-5/8 images for orientation.

CLC Class 322 "Moors and heathland" used to localize heathland. Munster in Germany (Niedersachsen), SPOT-5 (2.5m), Date: 2011-05-06. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- National supporting data (vegetation map, topographical map, land cover map, Nature 2000 habitat map).
- Supporting remote sensing data.
- Computer assisted visual interpretation of SPOT-5 data.
- Other supporting data as GIO HRL layers.

5.1.1.2 Other scrub land

Definition:

Thickets, brush woods and bush-like forest of with a total crown cover of > 30%.

5.1.1.2 Other scrub land: Mountain dwarf pine in the Bavarian Alps, Germany. Credits: M. Probeck

5.1.1.2. Other scrub land, Salix in boreal climate zone of Kiruna, Sweden. Credits: S. Kirppu.

This category includes:

- Thickets and brush woods in temperate and boreal climate areas (box, bramble thickets, broom fields, gorse thickets, braken fields, common juniper-scrubs, willow brush).
- Brush woods and bush-like forest in Alpine area with dwarf mountain pine scrub or green alder scrub (*Pinus mugo ssp*. mughus and *Alnus spp*.) Alpine willow brush, etc., accompanied by *Rhododendron spp*.

This category excludes:

- Typical heath and dwarf scrub vegetation → 5.1.1.1. *Heathland and Moorlands.*
- Areas with vegetation > 5 meter, and a tree coverage > 10 % → 3 *Woodland and Forest.*
- Sclerophyllous bushes of arid zones, *Maquis* and *garrigue* in France and Spain, *Phrygana* in Greece, *Matorral* and *tomillares* in Spain. → Class 5.2.1.1. *Sclerophyllous vegetation.*
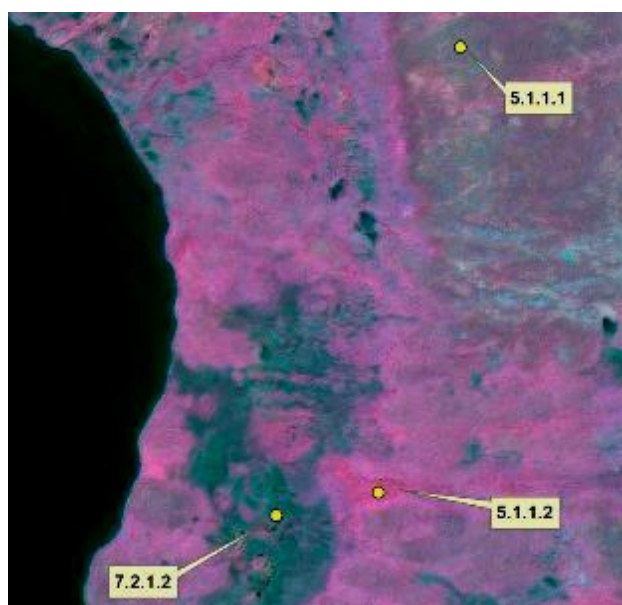
Attributes:

N/A

Appearance:
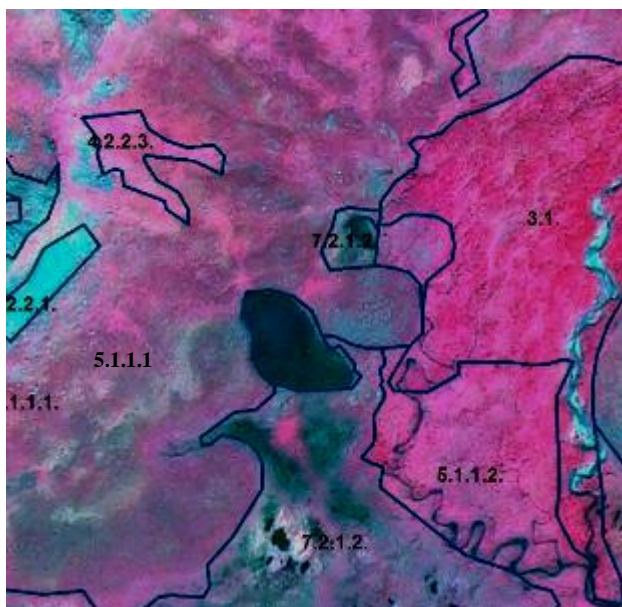
5.1.1.2. Other scrub land. Location: Kiruna, Sweden. SPOT-6 image (1.5 m), Band Combination. (3/4/2). Date: 2013-07-24. Source: CNES 2013©, Distribution Airbus DS/Spot Image.

Salix scrub (5.1.1.2. Other scrub land) appears in slightly more grey relative to the Nordic subalpine/subarctic forests with Betula pubescens ssp.Czerepanovii

Example from mountainous area near Kebnekaise, Sweden.

- Salix scrub, MAES class 5.1.1.2. Other scrub land.
- Dwarf scrubs, MAES class 5.1.1.1. Heathland and moorland.
- Peat producing areas, MAES class 7.2.1.2. Unexploited peat bog.
- Nordic subalpine / subarctic forests, MAES class 3.1. Broadleaved forest.

5.1.1.2. in low laying parts of mountainous areas relative to dwarf scrubs (5.1.1.1.). Location: Kiruna, Sweden. SPOT-6 image (1.5 m), Band Combination. (3/4/2). Date: 2013-07-24. Source: CNES 2013©, Distribution Airbus DS/Spot Image

Salix scrub (5.1.1.2.) appears in intense red color in low laying parts of mountainous areas relative to dwarf scrubs (5.1.1.1.).

Example from mountainous area south of Kebnekaise, Sweden.

- Salix scrub, MAES class 5.1.1.2.
- Dwarf scrubs, MAES class 5.1.1.1.
- Peat producing areas, MAES class 7.2.1.2.
- According to CLC the whole area is 322 - Moors and Heathland.

Salix scrubs in the Nordic alpine areas appears close to streams. May be included in CLC classes 311, 322 and 412 (yellow lines). A low, dense and rough texture is often seen in the orthographic photo.
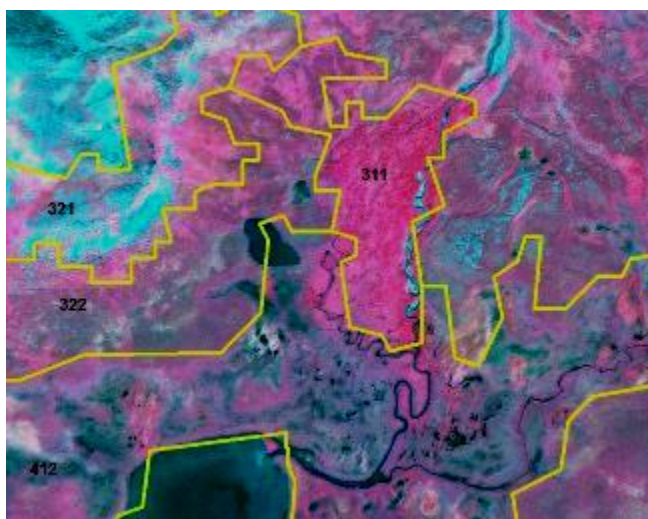
SPOT-6 image (1.5m), Band Combination (1/2/3). Location: Kiruna, Sweden. Date: 2013-07-24. Source: CNES 2013©, Distribution Airbus DS/Spot Image.
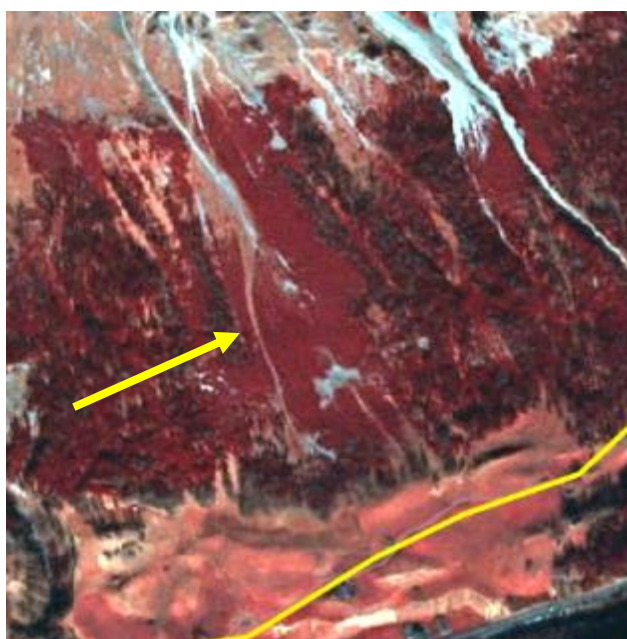
Dwarf pine region in the Alps (Austria).Difference in height and texture to neighbouring coniferous forest is clearly visible. SPOT-5 (2.5m), Band combination (1/2/3). CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- Computer-assisted visual interpretation in alpine and subalpine areas, CLC 322 (and 311).
- Additional in-situ data, information from the regional authorities and vegetation maps.
- The distinction from (Coniferous) Forest in mountainous areas will be done by using the HRL Forest Layer, DEMs and national in-situ data.

5.2.1.1 Sclerophyllous vegetation

Definition:

This class includes evergreen sclerophyllous bushes and scrubs, also includes *maquis*, *garrigue* and *phrygana*.

It corresponds to CLC class 3.2.3. and characterized by hard, leathery, evergreen foliage that is adapted to prevent moisture loss.

"Garriga" in Catalonia (Spain). Credits: European Union, 2012 LUCAS

Sclerophillous vegetation (Stipa tenaccissima) in Central Spain. Credits: European Union, 2012 LUCAS

Sclerophyllous vegetation (Asparagus spec., Euphorbia spec., Cistus spec., Olea europaea var. sylvestris) in Loutsa (Island of Evia), Greece. Credits: N. Kolpatzik

Scrubs (Retama sphaerocarpa) invading a grassland area in south-western Spain. Credits: M. Palacios

This category includes:

- Bushes of arid zones.
- *Maquis* and *garrigue* in France, Italy and Spain.
- *Phrygana* in Greece
- *Matorral*, *tomillares* and *espartales* in Spain.
- Either type must occupy more than 50% of the area.

This category excludes:

- Arborescent shrubs which are in the limits of forest formations with more or less dense arborescent cover. These arborescent shrubs have usually a thick high evergreen shrub stratum organized around several types of trees. The crown cover of these trees is more than 30%. They will be in the forest class. If the crown cover is less than 30%, it is assigned to class 3.4.1.1 *Transitional woodland and scrub*.
- If bushes of scrub occupy less than 50% of coverage → 6. *Sparsely vegetated areas*.

Attributes:

- o N/A

Appearance:

Tren, Albania. SPOT5, 2.5m. (1/2/3 Band Combination). Date: 2011-08-22. Source: CNES 2011©, Distribution Airbus DS/Spot Image.
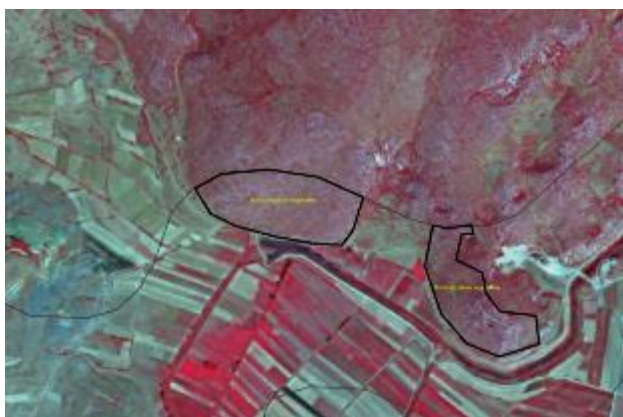
Mediterranean scrubs in Albania in summer-time.

Badajoz (Spain) SPOT-5 (2.5 m.) (1/2/3 Band Combination). Date: 2011-03-18.Source: CNES 2011© Distribution Airbus DS/Spot Image
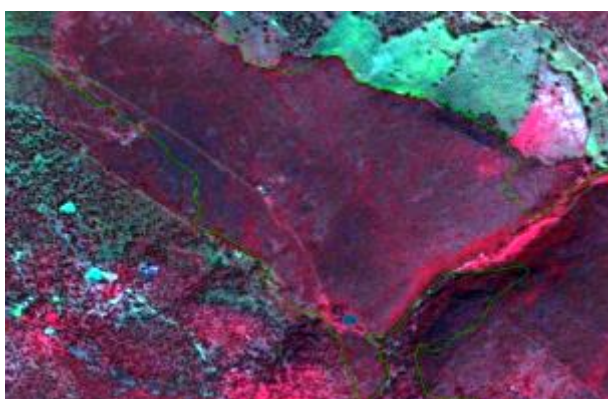
Matorral in South-Western Spain. In Mediterranean areas, rain is concentrated in spring and autumn and red colors in scrubs are not rare as is the case.

Methodological approach:

- Sometimes is complicate to distinguish this class from the forested areas, as the colours in the SPOT image are quite similar (sometimes the only difference is density). Therefore, auxiliary information is necessary to support a correct interpretation and delineation.
- Use of CLC class 3.2.3 as information source.
- Use HRL Forests to detect the trees, which can be potentially class 5.2.1.1.
- Final detailed delineation and identification using computer assisted visual interpretation.

6. Sparsely vegetated land

Natural areas covered with little or no vegetation, including open thermophile formations of sandy or rocky grounds distributed on calcareous or siliceous soils frequently disturbed by erosion, sparsely vegetated areas of stones on steep slopes, screes, cliffs, rock fares, limestone pavements with plant communities colonising their tracks, beaches, sand dunes and plains, riverbanks, perpetual snow and ice, and burnt areas (other than forest areas).

Sparsely vegetated areas have less than 50 % field cover (herb, grass and/or scrub) at the phenological mature stage and less than 10 % tree cover.

This category includes:

6.1 Sparsely vegetated areas
    6.1.1 Sparsely vegetated areas
        6.1.1.1 Sparsely vegetated areas

6.2 Bare soil, rock, perennial snow & ice
    6.2.1 Beaches, dunes, sands
        6.2.1.1 Beaches
        6.2.1.2 Dunes
        6.2.1.3 River banks
    6.2.2 Bare rocks, burnt areas, glaciers and perpetual snow
        6.2.2.1 Bare rocks and rocks debris
        6.2.2.2 Burnt areas (except burnt forest)
        6.2.2.3 Glaciers and perpetual snow

6.1.1.1 Sparsely vegetated areas

Definition:

Sparsely vegetated areas. The field layer has a cover between 10 % and 50 % at the phenological mature stage.

Sparsely vegetated areas in the foreground Nipfjället, Sweden. Credits S. Kirppu.

Sparsely vegetated areas in the background. South of Spain. Credits: M. Palacios.

This category includes:

- Sparsely vegetated with a field cover between 10 % and 50 % at the phonological mature stage.
- Snow-bed vegetation and transitions.
- Sparsely vegetated heath,
- Sparsely vegetated and unstable areas of stones, boulders, or rubble on steep slopes.
- Sparsely vegetation of 'lapie' areas, limestone paving and karstic areas.
- Mosaics of complex distribution between the MAES classes 6111 (*Sparsely vegetated areas*), 3131 (*Other natural & semi-natural broadleaved forest*), 4223 (*Alpine grasslands without trees*), 5111 (*Heathlands and moorlands*), 7212 (*Unexploited peat bog*), 7112 (*Inland freshwater marshes with reeds*) and 6211 (*Beache*s) where the MAES class 6111 (*Sparsely vegetated areas*) cover at least 70% of the surface.

This category excludes:

- Non-natural sparsely vegetated areas in Urban and Croplands → 1. *Urban*/2. *Croplands*.
- Areas with >10 % tree cover → 3. *Woodland and forest*.
- Areas with >50 % field cover → 4. *Grassland*/5. *Heathland and scrub*.
- Areas with < 10 % field cover → 6.2 *Bare soil, rock, perennial snow & glaciers*.
- Areas with dunes or sand plains with or without a grass cove → 6.2.1.2 *Dunes*.
- Burnt areas→ 6.2.2.2 *Burnt areas*.
- Wetland→ 7. *Wetland*.
- Bare rock, debris without vegetation →6.2 *Bare soil, rock, perennial snow & glaciers*.

Attributes:

N/A

Appearance:

Challenges with the 6.1.1.1 class:

- It is natural scattered and occurs in a mosaic with heath vegetation, mire vegetation, alpine grassland and willow bushes. This requires generalization where 6.1.1.1 should cover at least 70 % of the delineated area.
- The date of the satellite data is thus crucial, especially in the northern countries where the vegetation period is narrow. An area may change from 0 % field cover to 100 % field cover within weeks. A recommendation in the interpretation is to consequently also use additional supporting data.

In dry environments sparsely vegetated areas may be covered by grasses in spring.

Example from Ölands alvar (a limestone barren plain).

- 6.1.1.1 *Sparsely vegetated areas*
- 6.2.2.1 *Bare rock*
- 4.2.2.2 *Mesic grassland*
- 3.4.1.1 *Transitional woodland and scrub*

Sparsely vegetated areas, Ölands alvar, Sweden. SPOT-5 data.

Example from Turkey. The semi-arid condition of this areas (cold-steppe) give as a result this type of vegetation composed of very low density xeric scrubland.

Sparsely vegetated area (6.1.1.1) in Agalar (Anatolia, Turkey) SPOT-5 (2.5 m) (NIR/R/G Band Combination). Date: 2011-06-29.Source: CNES 2011© Distribution Airbus DS/Spot Image.
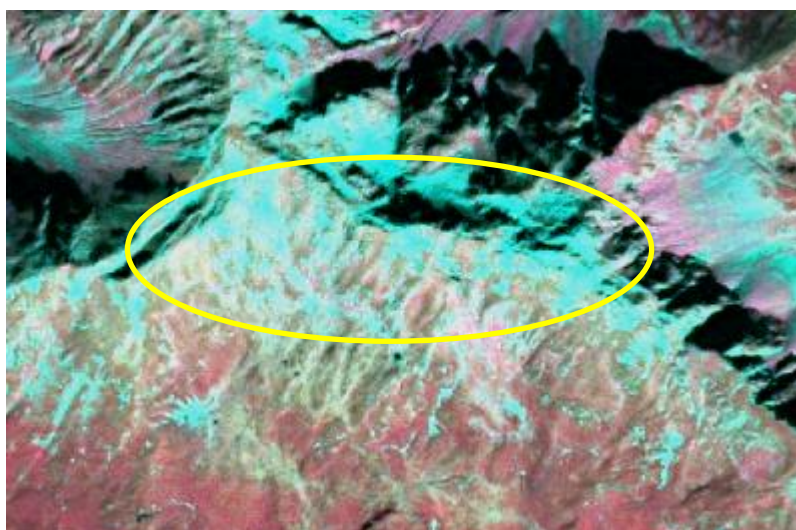
Example in the Alps

Sparsely vegetated area (6.1.1.1) in the Alps. Sparsely vegetated rea 6.1.1.1) in the Alps. SPOT-5 (2.5 m) (NIR/R/G Band Combination). Date: 2012-09-07.Source: CNES 2011© Distribution Airbus DS/Spot Image

Methodological approach:

- CORINE Land Cover class 3.3.3 (*Sparsely vegetated areas*) as indication
- National supporting map data: vegetation map, topographical map, land cover map, Nature 2000 habitat maps. To be used for building a skeleton to facilitate the interpretation.
- Supporting remote sensing data: other satellite data, national aerial orthophotos (often available as WMS-service), Google Earth.
- Other supporting data: GIO HLR layers, OpenStreetMap.
- Computer assisted visual interpretation of SPOT-5 data

6.2.1.1 Beaches

Definition:

Beaches with sand, gravel, shingle, pebbles or cobblestones along lakes, rivers or sea. Beaches up to the drift line (the high point of material deposited by water). Little or no vegetation (< 10 %).

Beach at Lanzarote (Canary Islands, Spain). Credit: K. Larsson

Beach at Doñana Natura 2000 site (Southern Spain). Credits: M. Palacios

This category includes:

- See definition.
- Artificial "beaches" in urban areas (if > 0.5 ha.), if not included in 1.4.2 Sport and leisure facilities.

This category excludes:

- Areas with > 10 % tree cover → 3. *Woodland and forest*.
- Areas with > 50 % field cover → 4. *Grassland*/5. *Heathland and scrub*.
- Dunes and sand plains above the drift line → 6.2.1.2 *Dunes*
- River banks with sand and gravel, accumulation of material at bars and floodplain → 6.2.1.3 *River banks*.
- Bare rocks → 6.2.2.1 *Bare rock and rock debris*.
- Wet areas → 7. *Wetlands*.

Attributes:

N/A

Appearance:
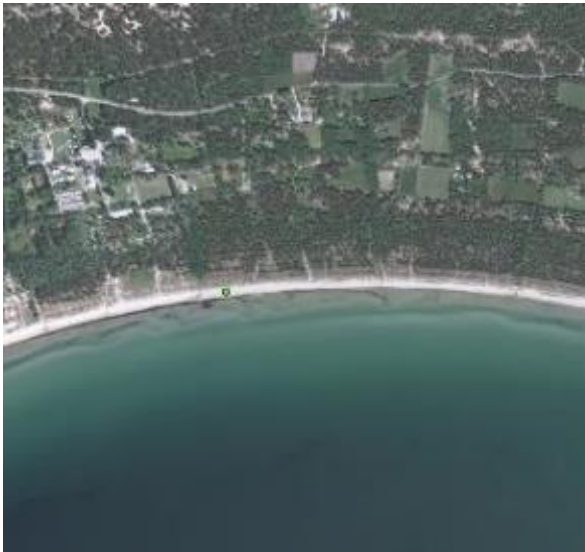
Example of Beach (sand), 20 -30 m wide. Sudersand, Sweden. Aerial orthophoto. Credit imagery: Lantmäteriet, Sweden

Example of Beach (sand). (Sudersand, Sweden). SPOT-5.Credit (1/2/3 Band Combination). Date: 2012-08-22. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Example of Beach (cobblestones), 10 -20 m wide. (Skäret, Sweden). Aerial orthophoto. Credit: Lantmäteriet, Lantmäteriet
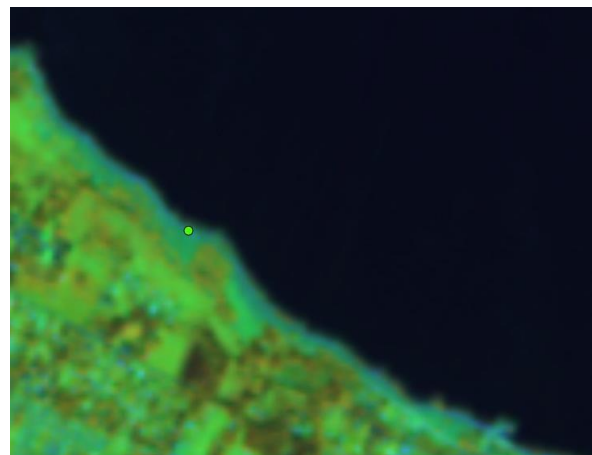
Example of Beach (cobblestones), 10 -20 m wide. Skäret, Sweden. SPOT-5.Credit: (1/2/3 Band Combination). Date: 2011-07-04. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- CORINE Land Cover class 3.3.1 (Beaches, dunes and sand plains) as indication
- National supporting map data: vegetation map, topographical map, land cover map, Nature 2000 habitat maps.
- Supporting remote sensing data: other satellite data, national aerial orthophotos (often available as WMS-service), Google Earth.
- Other supporting data: GIO HRL layers, OpenStreetMap.
- Computer assisted visual interpretation of SPOT-5 data.
- A discrimination of the drift line is seldom available in supporting map data (vegetation map with the class beach can be an exception). Proposed approach is to define the limit between the often lighter beach and the darker (debris)/or vegetated areas inland through interpretation of the remote sensing data.

6.2.1.2 Dunes

Definition:

Dunes and sand plains above the drift line (the high point of material deposited by water). Trees or shrub < 10%. The dunes and sand plains can be vegetated with grass.

Also artificial "beaches" in urban areas (if > 0.5 ha).

Maspalomas dune, (Canary Islands, Spain). Credits: M. Palacios

Dune in Doñana Natura 2000 site (Southern Spain) Credits: M. Palacios

This category includes:

- Dunes and sand plains close to the drift line along rivers, lakes and sea.
- Inland dunes and sand plains, i.e. not only just above the drift line.
- Shifting dunes with mobile, unvegetated or open grasslands (white dune).
- Grey dunes fixed, stabilised or colonised by more or less closed perennial grasslands.
- Machair (natural coastal sand-plain) formations if < 50 % of field vegetation not covered by grasses.

This category excludes:

- Inland dune heaths (crowberry and heather brown dunes) → 5.1. *Moors and Heathland.*
- Inland dunes thickets occupied by dense formations of shrubs including seabuckthorn privet, elder, willow, gorse or broom often festooned with creepers → 5.1.1 *Moors and Heathland.*
- Dune sclerophyllous scrubs → 5.2.1.1 *Sclerophyllus vegetation.*
- Areas with > 10 % tree cover → 3. *Woodland and forest.*
- Machair (natural coastal sand-plain) formations if > 50 % of field vegetation (grass) → 4. *Grassland.*
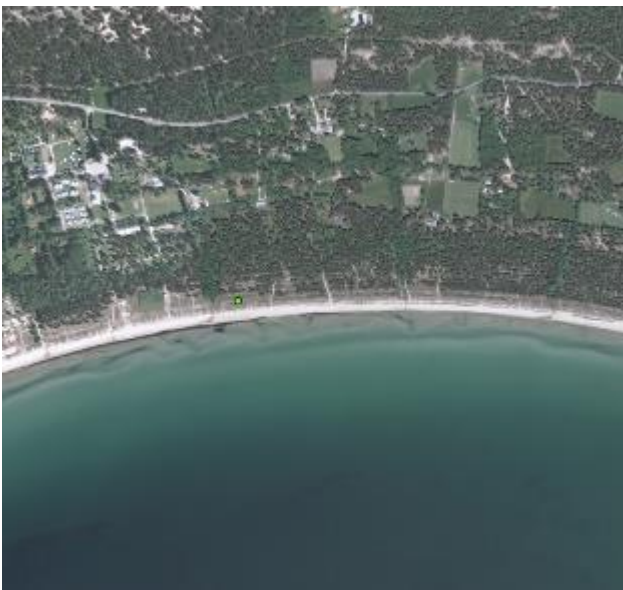- Wet areas → 7. *Wetland.*

Appearance:

Example White and Grey dunes marked (based on Nature 2000 habitats) (Ulla Hau, Sweden). Infrared orthophoto. Credit: Lantmäteriet, Sweden
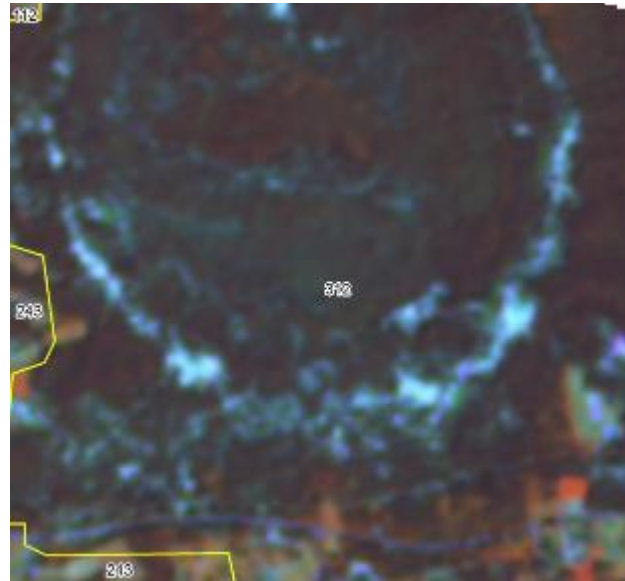
Coniferous forest (CLC)).The dunes are too small to be mapped. (Ulla Hau, Sweden). SPOT-5. (1/2/3 Band Combination). Date: 2012-08-22. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Example of Grey dunes. (Sudersand, Sweden). Aerial orthophoto. Credit: Lantmäteriet, Sweden

Example of Grey dunes. (Sudersand, Sweden). SPOT-5. (1/2/3 Band Combination). Date: 2012-08-22. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Attributes:

N/A

Methodological approach:

- CORINE Land Cover class 3.3.1 (Beaches, dunes and sand plains) as indication.
- National supporting map data: vegetation map, topographical map, land cover map, Nature 2000 habitat maps.
- Supporting remote sensing data: other satellite data, national aerial orthophotos (often available as WMS-service), Google Earth.
- Other supporting data: GIO HRL layers, OpenStreetMap.
- Computer assisted visual interpretation of SPOT-5 data.
- Approach to distinguish the drift line and thereby beaches from dunes/sand plains (see 6.2.1.1).

6.2.1.3 River banks

Definition:

Sand and gravel of river banks including accumulation of material at bars and floodplain. Little or no vegetation (< 10 %).

River bank in Var River (Alps Maritimes, France). Credit: European Union, LUCAS.

This category includes:

- Sand and gravel of natural river banks (at the time of the image).
- Deposit material at bars and floodplain may also consist of silt and clay.
- Alluvial fans with little or no vegetation or crops.

This category excludes:

- Beaches along lakes 6.2.2.1 → *Bare rocks and rock debris*.
- Beaches along sea → 6.2.1.1. Beaches

Attributes:
N/A

Appearance:

River banks. (Torneträsk, Sweden). Aerial orthophoto. Credit imagery: Lantmäteriet, Sweden.

River banks. (Torneträsk, Sweden). SPOT-5. (1/2/3 Band Combination). Date: 2011-07-22. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

River bank (6.2.1.3) in Anatolia (Turkey) SPOT-5 (2,5 m.) (NIR/R/G Band Combination). Date:2011-06-30. Source: CNES 2011© Distribution Airbus DS/Spot Image.

Methodological approach:

- National supporting map data: vegetation map, topographical map, land cover map, Nature 2000 habitat maps.
- Supporting remote sensing data: other satellite data, national aerial orthophotos (often available as WMS-service), Google Earth.
- Other supporting data: GIO HRL layers, OpenStreetMap.
- Computer assisted visual interpretation of SPOT-5 data.

6.2.2.1 Bare rocks and rock debris

Definition:

Bedrock outcrops and blocky areas with little or no high vegetation (< 10 %) but can be moss or lichen covered.
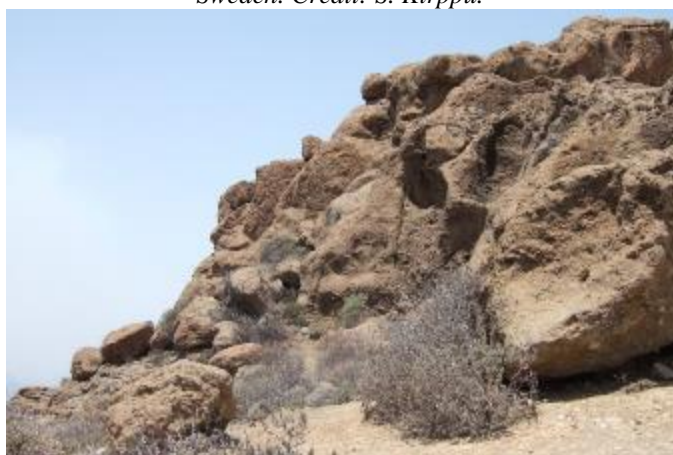

Bare rocks and rock debris (Sweden). Credits: K. Larsson

Bare rocks and rock debris in the background. Nipfjället, Sweden. Credit: S. Kirppu.

Etna's volcanic landscape. (Italy) Credits: A. Utanda

Volcanic bare rocks in (Canary Islands, Spain). Credits: M. Palacios

This category includes:

- Scree, cliffs, rock outcrops, rocks and reef flats.
- Block litter and mountain-top-debris.
- Unvegetated lapiaz.
- Sites and products of recent volcanic activities, volcanic ash and lapilli fields, barren lava fields.
- Unvegetated supra-littoral rocky zones.
- Eroded areas with little or no high vegetation (< 10 %).
- Bare areas in reservoirs.

This category excludes:

- Beaches with sand, gravel, shingle, pebbles or cobblestones along lakes or sea→ 6.2.1.1 *Beaches*.
- Areas with more than 10 % field, bush or tree cover.
- Rivers banks (sand and gravel) → 6.2.1.3 *River banks*.

Attributes:

N/A

Appearance:

Bare rocks formations (6.2.2.1) in Anatolia (Turkey). SPOT-5 (2,5 m.) (NIR/R/G Band Combination). Date: 2011-06-30.Source: CNES 2011© Distribution Airbus DS/Spot Image.

Examples of bare rock with <10% vegetation. It is a steep hillside dotted with birch. (Norway) Image to the left (1/2/3 Band Combination). Date: 2012-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image.
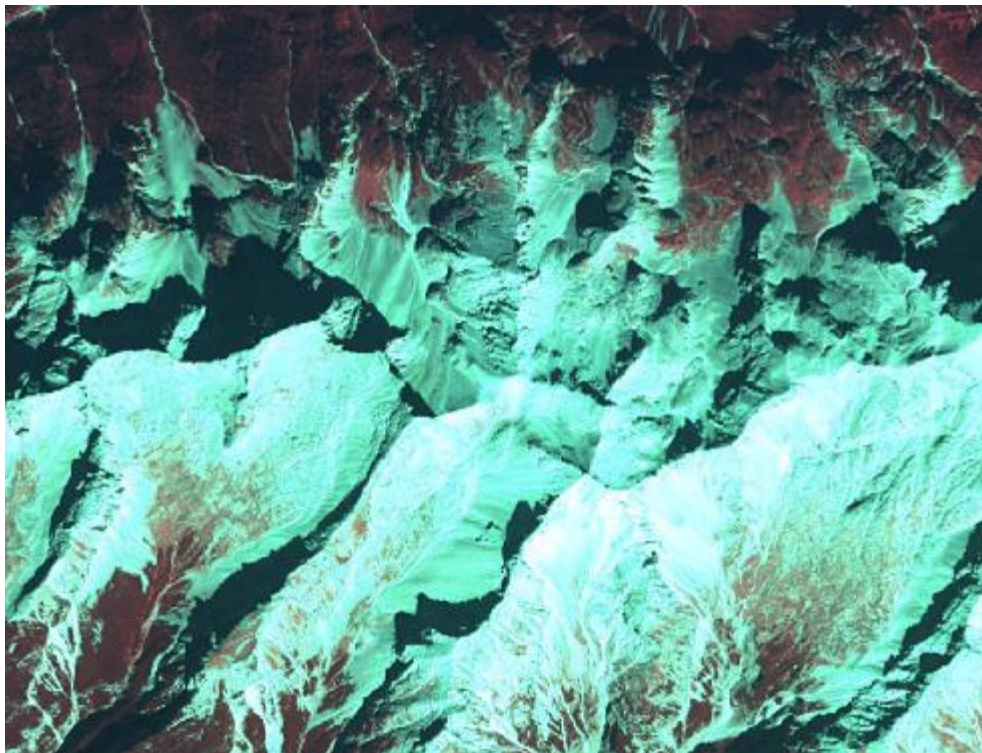
Examples of bare rock with <10% vegetation in the Alps (Austria). SPOT-5 (2.5m), Date: 2012-09-07. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- CORINE Land Cover class 3.3.2 (Bare rocks) as indication
- National supporting map data: vegetation map, topographical map, land cover map, Nature 2000 habitat maps.
- Supporting remote sensing data: other satellite data, national aerial orthophotos (often available as WMS-service), Google Earth
- Other supporting data: GIO HRL layers, OpenStreetMap.
- Computer assisted visual interpretation of SPOT-5 data.

6.2.2.2 Burnt areas (except burnt forest)

Definition:

Areas affected by recent fires, still mainly black, not in forest.

Scrubland affected by fire (North Western Spain). Credit: European Union, LUCAS

This category includes:

- All vegetation classes except forest (class 3) which recently have been affects by fires and do not show any new vegetation cover

This category excludes:

- Human farming management by burning arable lands → 2. *Cropland*.
- Burnt forest area→ 3.5.1.1 *Forest damage by fire*.
- Fires in urban areas → 1. *Urban*.

Attributes:
N/A

Appearance:

Black areas in the image.

Methodological approach:

- CORINE Land Cover class 3.3.4 (Burnt areas) as indication.
- National supporting map data: vegetation map, topographical map, land cover map, Nature 2000 habitat maps.
- Supporting remote sensing data: other satellite data, national aerial orthophotos (often available as WMS-service), Google Earth.
- Other supporting data: GIO HRL layers, OpenStreetMap.
- Computer assisted visual interpretation of SPOT-5 data.
- Use supporting data to distinguish that the natural/semi-natural area burned is non-forest.

6.2.2.3 Glaciers and perpetual snow

Definition:

Land covered by glaciers or permanent snowfields.

Glacier (6.2.2.3) de Bossons (French Alps). Credit: K. Larsson

Glacier (6.2.2.3) de Bossons (detail). Credit: M. Rodriguez
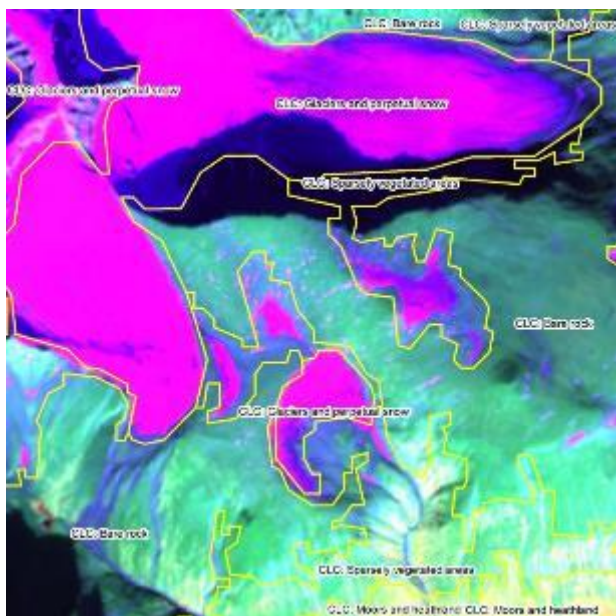
This category includes:

- Glaciers and perpetual snow.

This category excludes:

- Temporary snow or ice covered areas

Attributes:

N/A

Appearance:

Glacier and perpetual snow (Kebnekaise, Sweden). SPOT-5. The delineation of the class (yellow polygons) is from CORINE Land Cover and corresponds well to a MAES delineation (3/4/2 Band Combination). Date: 2010-09-07. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Glacier and perpetual snow according to topographical map. (Kebnekaise, Sweden). Credit: Lantmäteriet, Sweden

Infrared orthophoto over glacier and perpetual snow. (Kebnekaise, Sweden). Credit: Lantmäteriet, Sweden.

Methodological approach:

- CORINE Land Cover class 3.3.5 (Glaciers and perpetual snow) as indication
- National supporting map data: vegetation map, topographical map, land cover map, Nature 2000 habitat maps.
- Supporting remote sensing data: other satellite data, national aerial orthophotos (often available as WMS-service), Google Earth.
- Other supporting data: GIO HRL layers, OpenStreetMap.
- Computer assisted visual interpretation of SPOT-5 data.
- Use supporting map data to identify glaciers and permanent snow, especially when the date of the image is not appropriate.

7.Wetland

According to Article 1.1 of the Ramsar Convention[27] (1971), wetlands are: "*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters*". This MAES class refers only to inland freshwater/saline wetlands.

Inland wetlands are predominantly **water-logged** specific plant and animal communities supporting **water regulation** and **peat-related processes**. This class includes natural or modified mires, bogs and fens, as well as peat extraction sites[28] (MAES). Surfaces of temporary water are included in wetlands. According EUNIS guidelines (see table below), water-logged means the presence of the water table at or above ground level for at least half of the year.

Adaptation of water interpretation in EUNIS[29] and related MAES classes

| PRESENCE OF WATER	MAES CLASSIFICATION
Always dry (except extraordinary floods)	1 Urban (except ponds related to industrial units); 2 Croplands (except rice fields); 3 Woodland and forest (except riparian/fluvial and swamp forests; 4 Grassland (except mesic grasslands),; 5 Heathland and scrub; 6.1 Sparsely vegetated areas; 6.2.2.1 Bare rocks and rock debris; 6.2.2.2 Burnt areas
Permafrost	N/A
Ice	6.2.2.3 Glaciers and perpetual snow
Permanent snow	6.2.2.3 Glaciers and perpetual snow
Mesic, moist, or humid	3.x Riparian and fluvial forest 4.2.x Mesic grasslands
Water-logged (the water table at or above ground level for at least half of the year). Wet soil (including periods with presence of dry soils in dry regions).	3.x. Swamp forest 7. Wetland 8.1.1 Salt marshes & salines
Permanently covered by water table, but water level variations occurs. (including occasionally periods with presence of wet soils)	9.1.1.1 Permanent interconnected running water courses; 9.1.2 Separated water bodies bonging to the river system; 9.2.1 Lakes and reservoirs (except temporary water bodies);8.1.2 Intertidal flats; 8.2.1 Coastal lagoons ; 8.2.2 Estuaries
Permanently covered by water with tidal movements	10 Marine (other)

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[27] http://www.ramsar.org/
[28] European Commission (2013): Mapping and Assessment of Ecosystems and Their Services. An Analytical Framework for Ecosystem Assessment under Action 5 of the EU Biodiversity Strategy to 2020. Discussion Paper, Final, April 2013.
[29] DAVIES, C.E., MOSS, D. and O HILL, M. (2004): EUNIS Habitat Classification Revised, 2004, report to European Environment Agency/European Topic Centre on Nature Protection and Biodiversity.

Class 7. *Wetland* includes only inland wetlands. Maritime wetlands are included in class 8. *Lagoons, coastal wetlands and estuaries.*

A decision criteria tree is established to clarify guideline distinctions between MAES Level 4 classes as follows:
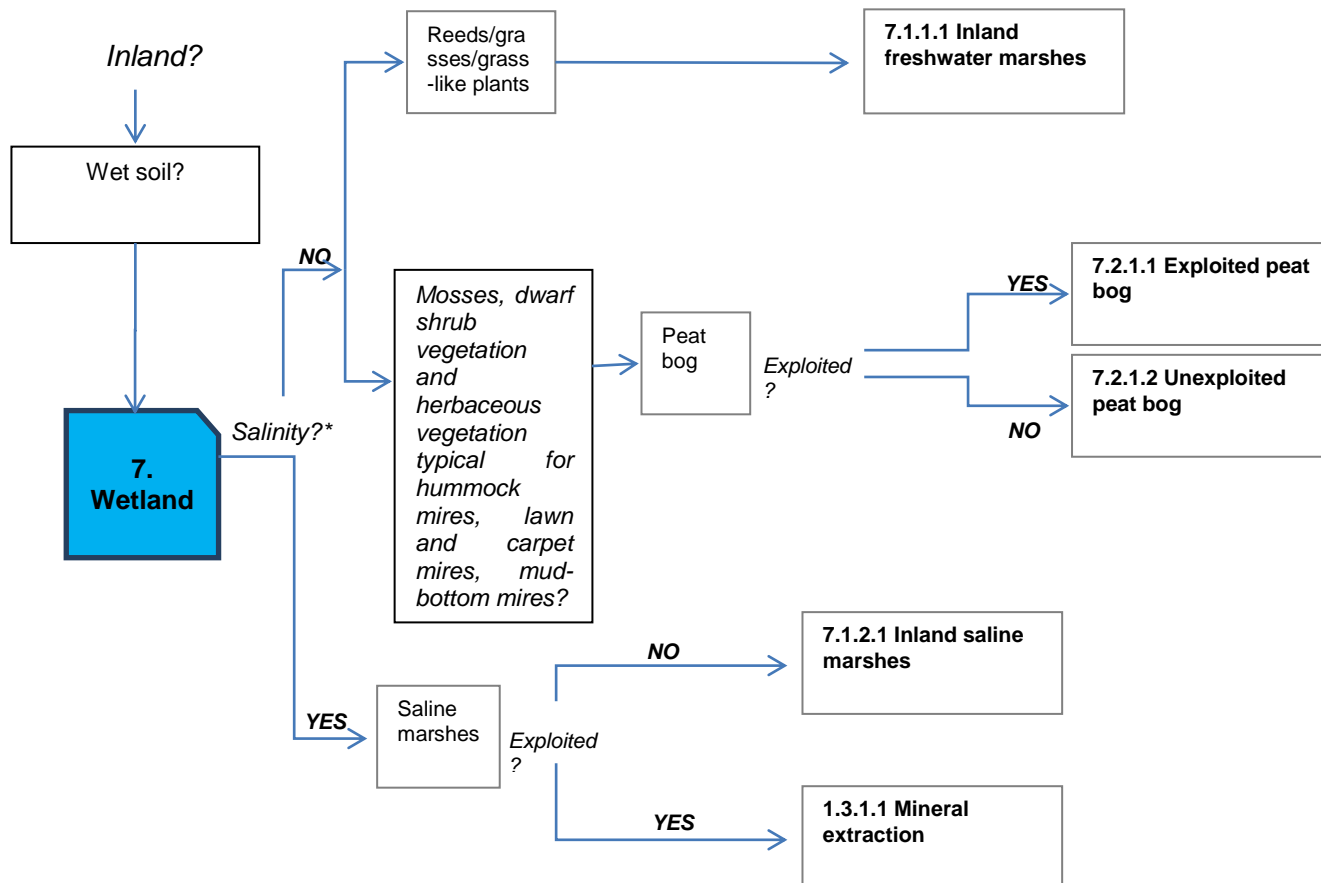
* To determinate the salinity of wetlands is necessary to use ancillary data.

This category includes:

7.1 Inland marshes
    7.1.1 Inland freshwater marshes
        7.1.1.1 Inland freshwater marshes
    7.1.2 Inland saline marshes
        7.1.2.1 Inland saline marshes

7.2 Peat bogs
    7.2.1 Peat bogs
        7.2.1.1 Exploited peat bog
        7.2.1.2 Unexploited peat bog

7.1.1.1 Inland freshwater marshes

Definition:

Inland wetlands without a direct connection to the open ocean with significant content of water.

This category corresponds to 4.1.1 CORINE Land Cover class (Inland marshes).

Inland freshwater marshes in Tablas de Daimiel Natura 2000 Site (Central Spain). Credits: M. Palacios

Include areas covered by reeds and not covered by reeds (basically mud areas and/or waterlogged grasses and grass-like plants). Grasslands highly wet and visible in the images are included here.

Reed is common name for several tall, grass-like plants of wetlands and rivers. They are all members of the order Poales: *Poaceae*, *Cyperaceae*, *Sparganiaceae*, *Typhacea* or *Restionaceae*. Reed in marshes groups basically two types of plants:

- Sedges (*Cyperaceae* family) are monocotyledon plants with solid and triangular stems; 3-ranked leaves; with flowers, and lenticular or triangular fruits. Sedges are common in wet habitats, including marshes, and in tundra habitats.
- Rushes (*Juncaceae* family) are monocotyledon plants with solid and mostly round stems; few leaves, only basal or reduced to sheaths; with flowers and fruits in capsules. Rushes are common in wet habitats.
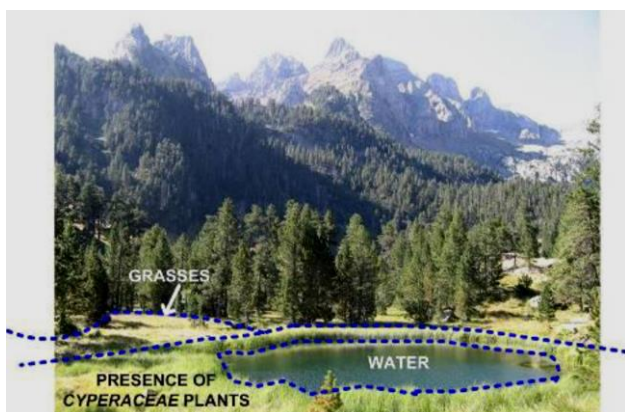
Interpretation of cyperaceae plants in a wetland. Credits of photography: M. Rodriguez

Juncaceae plants. Credits: M. Palacios

Lakes and ponds inside inland wetlands ≥ 0.5 ha are considered as 9.2. *Lakes and reservoirs*.

Floating aquatic vegetation (species such as *Nuphar* spp., *Nymphaea* spp., *Potamageton* spp. and *Lemna* spp.) are included in 9.2. *Lakes and reservoirs*.

This category includes:

- Areas flooded at least six months a year with low or no vegetation.
- Marshes with reed beds.
- Grasslands highly wet or flooded at least six months a year.
- Bare soils as results of previous presence of water will be also included within this category.
- It will be taken into account that the Baltic Sea has only brackish coastal waters, which qualify for inland freshwater marshes.
- Floating vegetation.
- Limestone mires.
- **In Nordic conditions:** 7.1.1.1 includes non-grazed/mowed and non-peat producing wetlands. These areas normally have a vegetation of tall grasses and sedges.
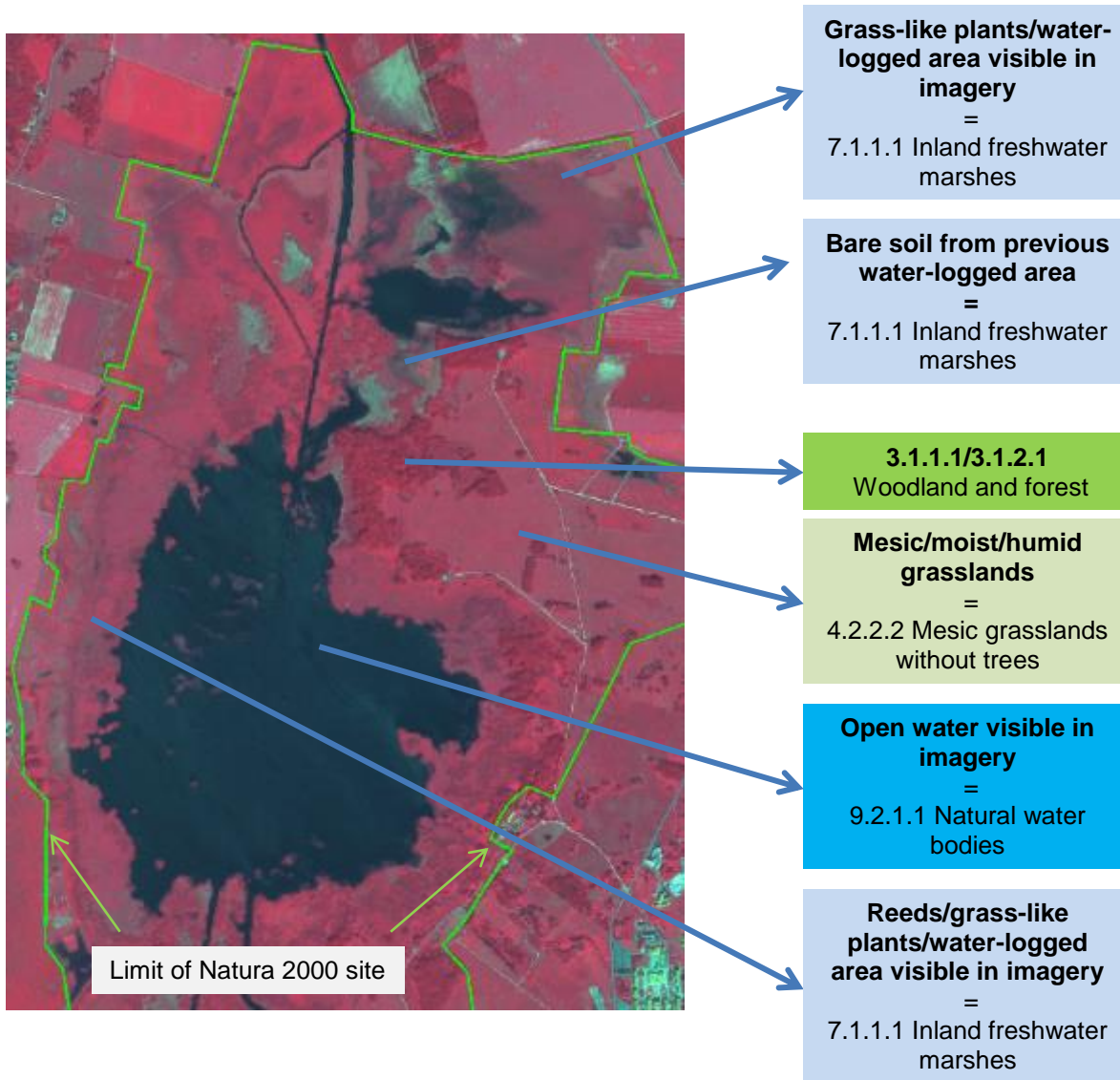
This category excludes:

- Grassland highly wet or flooded less than six months a year → 4.1.1.2/4.2.2.2 *Mesic grasslands*.
- Open water ≥ 0.5 ha in wetland areas (class 9.2.1.1 *Permanent natural water bodies*).
  - It will be considered as open water if the water table is visible in imagery. In case of doubt other ancillary information will be used, including HRL Water and Wetland.
- Rice fields → 2.1.3.1 *Irrigated arable land and rice fields*.
- Floating aquatic vegetation → Open water.
- Mesic/moist grasslands → 4.2.1.2/4.2.2.2 *Mesic grasslands*.
- Reeds mixed with scrub/trees in rivers banks → 3.4.1.1 *Transitional woodland and scrub*.

Attributes:

o   N/A

Appearance:

Examples of inland wetland interpretation rules:

Grass-like plants/water-logged area visible in imagery = 7.1.1.1 Inland freshwater marshes	
Bare soil from previous water-logged area = 7.1.1.1 Inland freshwater marshes	
3.1.1.1/3.1.2.1 Woodland and forest	
Mesic/moist/humid grasslands = 4.2.2.2 Mesic grasslands without trees	
Open water visible in imagery = 9.2.1.1 Natural water bodies	
Reeds/grass-like plants/water-logged area visible in imagery = 7.1.1.1 Inland freshwater marshes	

Araslövssjöområdet Natura 2000 site (limits in green), Sweden. SPOT-5 (2.5 m), (1/2/3 band combination). Date: 2011-06-28. Source: CNES 2011©, Distribution Airbus DS/Spot Image
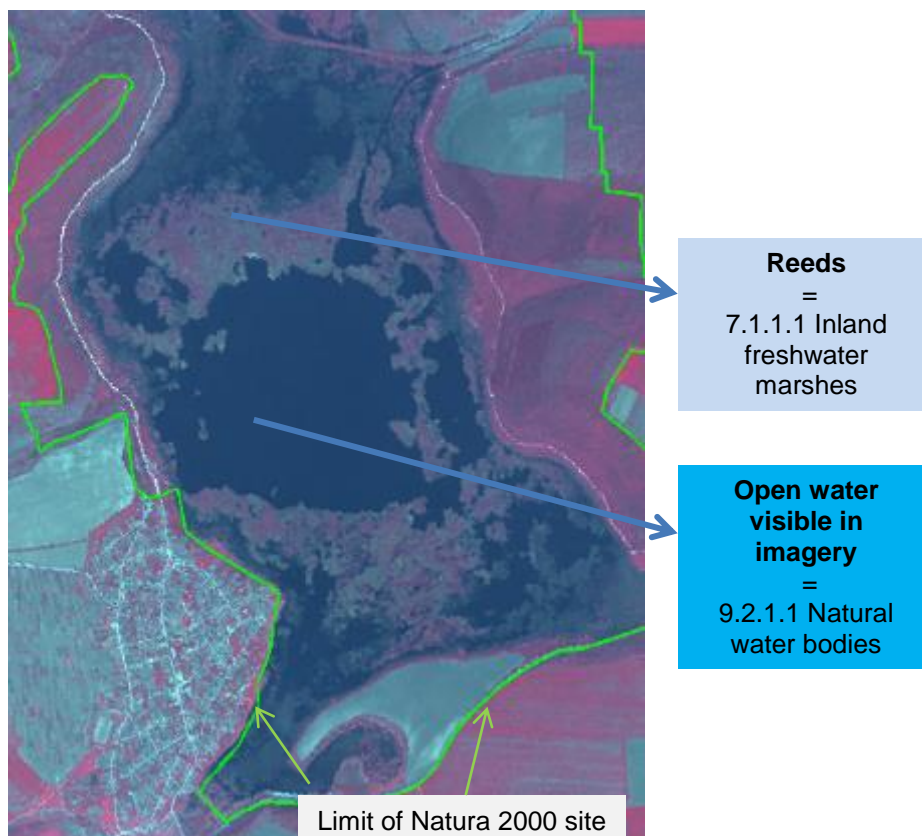
Srebarna Natura 2000 site (in green), Bulgaria. SPOT-5 2.5 m. (1/2/3 band combination). Date: 2011-04-26. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Wetlands with reeds examples:

Example of 7.1.1.1 in Umeå, Sweden. (1/2/3 band combination). SPOT-5 image. Date: 2011-07-08. Source: CNES 2011©, Distribution Airbus DS/Spot Image.
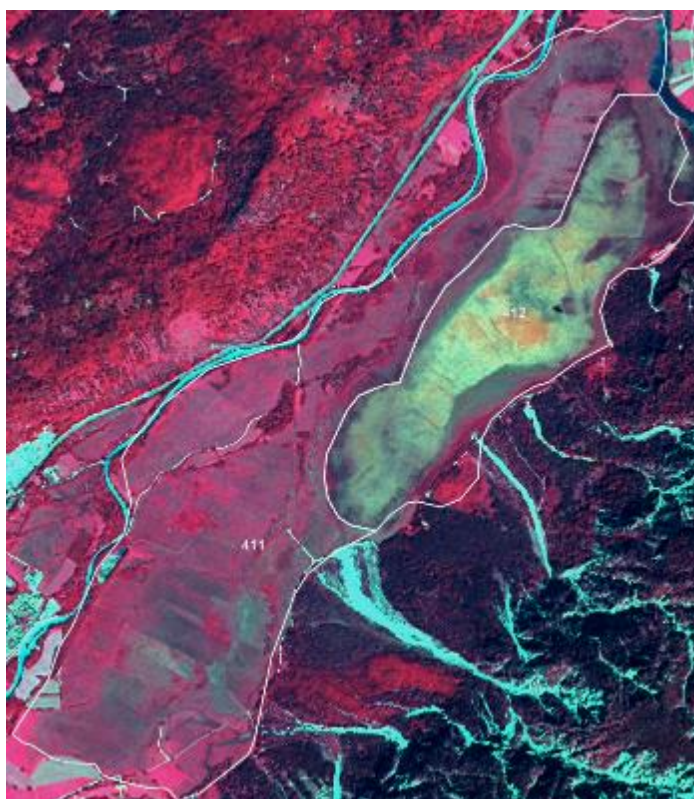
7.1.1.1 Inland freshwater marsh with reeds. Murnau, Southern Bavaria. SPOT-5 (2.5 m), (1/2/3 band combination). Date: 2011-06-28. Source: CNES 2011©, Distribution Airbus DS/Spot Image.
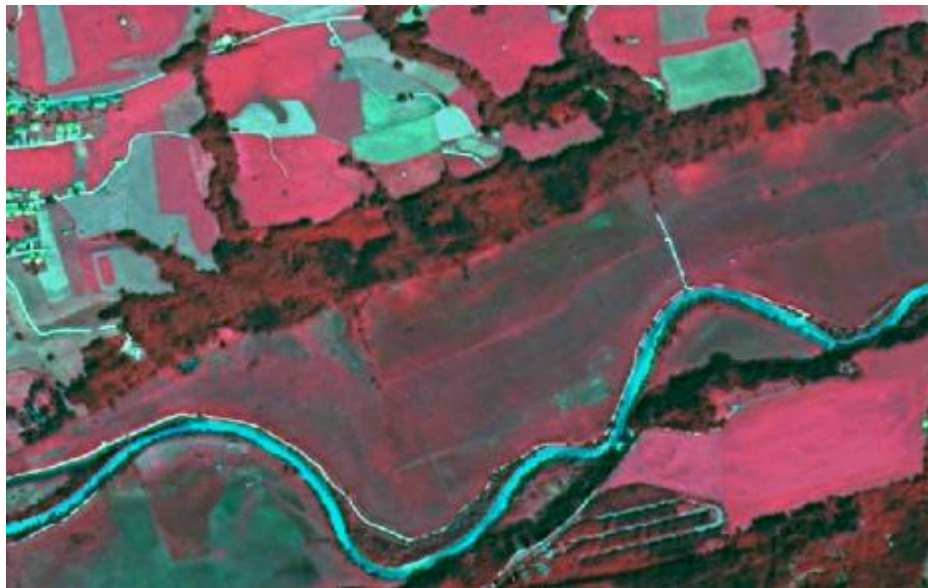
7.1.1.1 Inland freshwater marsh with reeds – but mowed and mixed with grassland. Murnau, Southern Bavaria. SPOT-5 (2.5 m. (1/2/3 band combination). Date: 2011-06-28. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Wetland and mesic grassland distinction example:

- Check GIO wetlands Layer
- Map orange brown-green/red-blue/Blue-grey areas as wetland 7.1.1.1
- Map other neighbouring grassland areas as 4.2.2.2 Mesic grassland

7.1.1.1 Inland freshwater marsh with CLC class 411 overlay. A neighbouring moorland shows yellow-green-spectral signatures. Location: South of Murnau, Southern Bavaria. SPOT-5 (2.5 m), (1/2/3 band combination). Date: 2011-06-28. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- Use of Corine Land Cover for first location of main sites.
- Freshwater status of the water bodies will be determined by location, assuming that considerable distance (up-stream) from the sea, restrains the salty water from mixing into the water bodies.
- The dividing line between the wetland and water classes is difficult to define without the contribution of images of different dates during the same year (in order to take into account the seasonality). The GIO-Land HR Water/Wetland Layers may help to identify the boundaries between those two classes, but it should be noted that the pixel size of GIO-Land HR Layers is 20m and the production of GIO-Land HR Layers is based on the analysis of imagery corresponding to different years (2006-2009-2012), not to different seasons.
- Other important datasets to detect these boundaries are Natura 2000 Network and Wetland Ramsar Sites databases. They are particularly relevant in the Mediterranean area and are highly recommended to use in the detection of Wetland Areas and Areas of Special Concern.
- It is also recommended to complement this information with other wetland layers available sources of information as Wetland Ramsar Sites

Special case in Nordic conditions:.

- In the case of Nordic countries, when typical mire/peat structures cannot be seen in the satellite image/orthographic photo, it is difficult to determine if an area is peat producing or not. Therefore the position in the terrain is used for guidance. Areas directly adjacent to bigger rivers or lakes are included in 7.1.1.1 when visual interpretation is insufficient. This is because of lower chances of peat production when oxygen from flowing water is supplied to the ecosystem as opposed to ecosystems adjacent to standing water.
- Non-peat producing wetlands with a low-growing vegetation of grasses and sedges are generally grazed/mowed. These areas are included in 7.1.1.1 *Inland freshwater marshes*.
- Non-grazed/mowed and non-peat producing wetlands normally have a vegetation of tall grasses and sedges and are included in 7.1.1.2 *Inland freshwater marshes*. Temporarily flooded areas with low grasses and sedges are included in 4.2.2.2 *Mesic grasslands*.

7.1.2.1 Inland saline marshes

Definition:

Inland salt marshes (also including reed coverage) are created where saline ground water rises to the surface, or in endorheic basins.

This class is located predominantly in Pannonic region (*Pannonic salt steppes*), Turkey, in Mediterranean specific locations and in endorheic basins across Europe.

Inland saline marsh in Central Spain. Credit: European Union, 2012, LUCAS.

This category includes:

- Reed beds in saline marsh with coverage less than 30%.
- Areas flooded at least six months a year with low or no vegetation.

This category excludes:

- Marine wetlands such as salt marshes or salines → 8.1 *Maritime wetlands*.
- Inland exploited salines and extraction of sodium minerals in salt marshes, salt lakes or other locations → 1.3.1.1 *Mineral extraction, dump and construction sites*.

Attributes:

- N/A

Appearance:

SPOT-5 (2,5 m). (1/2/3 band combination). Pannonic Salt Steppes example. Felső-kiskunsági szikes tavak és Miklapuszta Natura 2000 site, Hungary. Date: 2011-02-24. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Example of inland saline marshes interpretation rules:

Water-logged. Saline soil
=
7.1.2.1 Inland saline marshes

Open water visible in imagery
=
9.2.1.1 Natural water bodies**Open water visible in imagery**
=
9.2.1.1 (Permanent natural water bodies)

Limit of Natura 2000 site

Pannonic Salt Steppes example. Felső-kiskunsági szikes tavak és Miklapuszta Natura 2000 site, Hungary. SPOT-5 2.5 m (1/2/3 band combination). Date: 2011-02-24. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- The existing knowledge on locations of large inland salines (Southern Europe, Pannonian Region or Turkey) will be taken into account and their surrounding ecosystems will be analyzed in order to detect possible occurrences of Class 7.1.2.1.
- Main identification will be based on CORINE Land Cover class 4.1.1 and Soils Map of Europe
- Use of GIO-Land HR Water/Wetland Layers.
- Use of Natura 2000 Network.
- Use of Wetland Ramsar Sites.
- Any available ancillary or in-situ data sources will also be used.

7.2.1.1 Exploited peat bogs

Definition:

Open exploited peat-producing wetlands that are not greatly affected by lakes, sea water or water from water courses.

Exploited peat bog in Roscommon (Ireland). Credit: European Union, 2012, LUCAS.

This category includes:

- Extraction of peat in mires.

This category excludes:

- Abandoned peat extraction site with regrowth → Class 3 *Woodland and forest.*

Attributes:

- N/A

Appearance:
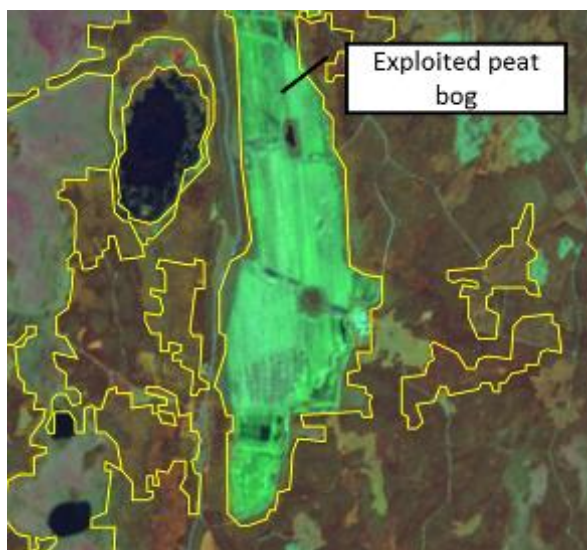
The delineation of the exploited peat bog (yellow polygons) is from CORINE Land Cover and corresponds fairly to a MAES delineation. Sweden. SPOT-5 data. Credit imagery: ESA

The same area as left but infrared orthophotos as image background. Credit imagery: Lantmäteriet

Exploited peat bog in northern Germany – right side: CLC overlay. Source: SPOT-5 (2.5m), CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- National supporting map data: vegetation map, topographical map, land cover map, Nature 2000 habitat map, CLC data.
- Supporting remote sensing data: other satellite data, national aerial orthophotos (often available as WMS-service), Google earth.
- Other supporting data: GIO HR layers, OpenStreetMap.
- Computer assisted visual interpretation of SPOT-5 data.

7.2.1.2 Unexploited peat bogs

Definition:

Open unexploited peat-producing wetlands that are not greatly affected by lakes, sea water or water from water courses.

In Nordic conditions this class is normally a heterogeneous vegetation type where mire vegetation dominates in a mosaic of heath vegetation, alpine grassland, alpine willow bushes and a rocky ground.

Alternative names are proposed for this class as "Peat producing land" or "Peat bog and other peat producing land".

Unexploited peat bog near Benderloch (Wester Scotland, United Kingdom). Credit: European Union, 2012, LUCAS.

This category includes:

- The mire types hummock, lawn, carpet mires and mud-bottom mires.
- Peat bogs in Alpine Sub-Alpine environment across Europe.
- Mosaics of complex distribution between the MAES classes 7.2.1.2 *Unexploited peat bog* and 9.2.1.1 *Natural waterbodies*, where the MAES class 7.2.1.2 cover at least 70% of the surface.

This category excludes:

- Areas with >10 % tree cover →Class 3 *Woodland and forest*.
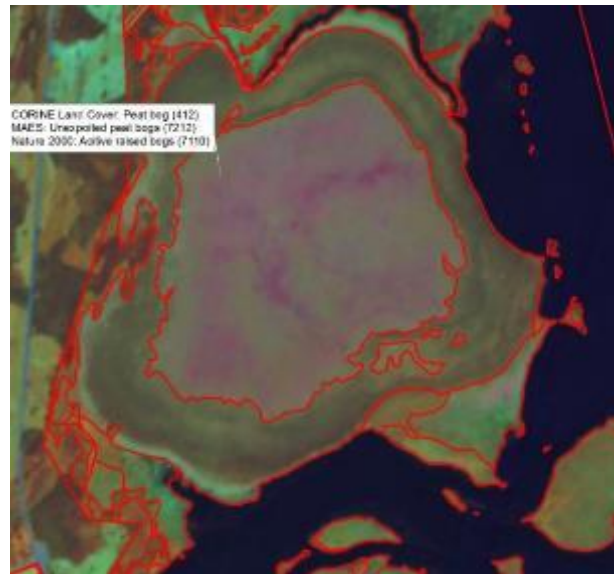- Peat extraction site → 7.2.1.1 *Exploited peat bog*.

Attributes:

- N/A

Appearance:
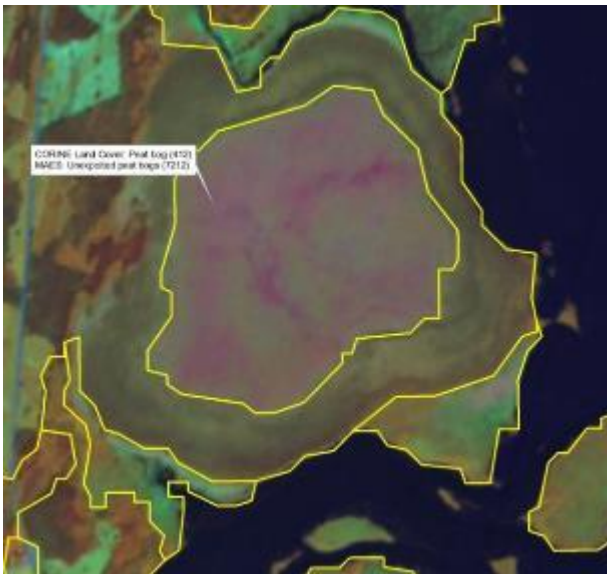
Unexploited peat bog. Typical raised peatbog. Jordbärsmuren-Albo Natura 2000 site, Sweden, SPOT-5 data. The delineation of the peat bog (yellow polygons) is from CORINE Land Cover and corresponds well to a MAES delineation. Credit imagery: ESA

Same area as left. The delineation of the peat bog (red polygons) is from Nature 2000 habitat map, also corresponding well to a MAES delineation. Credit imagery: ESA
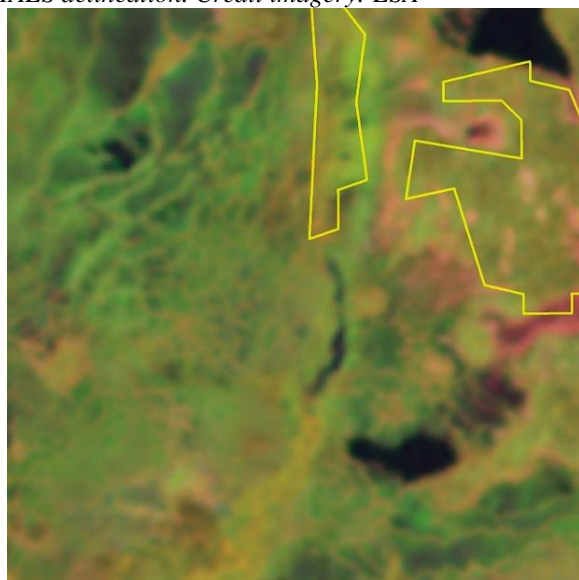
Area in the north of Sweden mapped as peat bog in CORINE LC. SPOT-5. Credit imagery: ESA
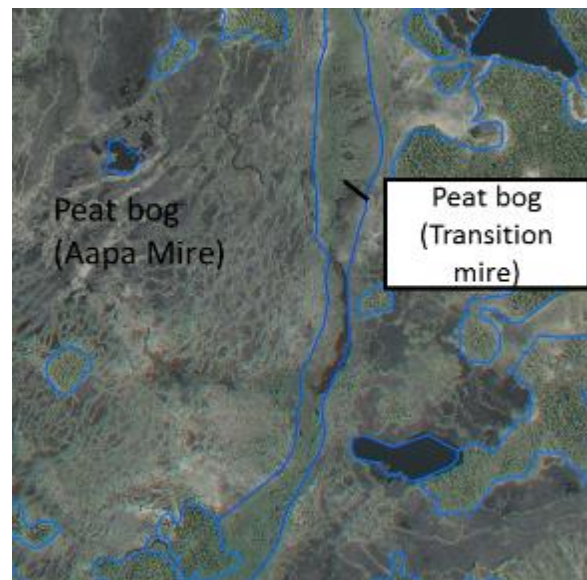
Same area as left. Aerial orthophoto with delineation MAES (based on Nature 2000 habitat map). Credit imagery: Lantmäteriet

In low lying areas or local depressions complex mire types include areas of open peat, small ponds and streaks of mosses/heath vegetation.

Methodological approach:

- CORINE Land Cover class 4.1.2 (Peatbogs) as indication.
- National supporting map data: vegetation map, topographical map, land cover map, Nature 2000 habitat map.
- Supporting remote sensing data: other satellite data, national aerial orthophotos (often available as WMS-service), Google earth.
- Other supporting data: GIO HR layers, OpenStreetMap.
- Computer assisted visual interpretation of SPOT-5 data.
- In Sweden classification is based on the Land survey Topographic map, where "wetland" and "open land" overlap. MAES wetland class is visually interpreted and adjusted manually. Adjustments of delineation are made only where obvious errors in ancillary are discernible in visual interpretation. When typical mire/peat structures cannot be seen in the image, it is difficult to determine if an area is peat producing or not. Therefore the position in the terrain is used for guidance. Areas directly adjacent to bigger rivers or lakes are included in 7.1.1.1 *Inland freshwater marshes* when visual interpretation is insufficient. This is because of lower chances of peat production when oxygen from flowing water is supplied to the ecosystem as opposed to ecosystems adjacent to standing water. Grazed areas from LPIS that overlap wetland from the Topographic map are included in 7.1.1.1 *Inland freshwater marshes*.

8. Lagoons, coastal wetlands and estuaries

Marine inlets and transitional waters are ecosystems on the land-water interface under the influence of tides and with salinity higher than 0.5 ‰. They include coastal wetlands, lagoons, estuaries and other transitional waters, fjords and sea lochs as well as embayments ([30]).

Coastal waters are distinguished into maritime wetlands (coastal salt marshes according to the EUNIS habitat classification, salines and intertidal flats) and marine waters (coastal lagoons and estuaries).

Coastal salt marshes, according to the EUNIS habitat description, are dominated by sediments and salt-tolerant stands of vegetation, occurring on the extreme upper shore of sheltered coasts and periodically covered by high tides. According to the definition of CLC class 5.2, Marine waters are oceanic and continental shelf waters, bays and narrow channels including sea lochs, fiords and straits.

These classes include according EUNIS habitat types: salt marsh driftlines, upper salt marshes, mid-upper salt marshes and saline brackish reed, rush and sedge beds and littoral sediments not included in 8.1.2.1 *Intertidal flats* or 6.2.1.1 *Beaches* and 6.2.1.2 *Dunes*. Salines (active ones and in process of abandonment) will be also identified, based on CORINE land cover and computer assisted visual interpretation. Intertidal flats are un-vegetated areas covered by mud, sand and rock and not included in classes such as 8.1.1.1 *Salt marshes*, 8.2.2.1 *Estuaries*, 6.2.1.1 *Beaches* and 6.2.1.2 *Dunes*.

Coastal lagoons (8.2.1.1/8.2.1.2) are, according to the EUNIS habitat classification, characterized by their chemical composition (presence of salt water) and their morphology (partially separated from the sea by sand banks or shingle, or, less frequently, by rocks). Coastal lagoons are vegetated (reed bed and salt marsh plants) or un-vegetated.

The Estuaries class (8.2.2.1) includes marine waters not included in class 10 Marine (other) or other lagoons and coastal wetlands classes.

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[30] European Commission (2013): Mapping and Assessment of Ecosystems and Their Services. An Analytical Framework for Ecosystem Assessment under Action 5 of the EU Biodiversity Strategy to 2020. Discussion Paper, Final, April 2013.

This category includes:

8.1 Maritime wetlands
    8.1.1 Salt marshes & salines
        8.1.1.1 Salt marshes
        8.1.1.3 Salines
    8.1.2 Intertidal flats
        8.1.2.1 Intertidal flats
8.2 Marine waters
    8.2.1 Coastal lagoons
        8.2.1.1 Coastal lagoons
    8.2.2 Estuaries
        8.2.2.1 Estuaries

8.1.1.1 Salt marshes

Definition:

Low-lying coastal areas, above the high-tide line, susceptible to flooding by seawater.

Salt marshes with salt tolerant plants in Camargue (Southern France). Credits: European Union 2012, LUCAS.

Reeds (foreground) and salt tolerant plants (background) in marshes of Foz do Rio Miñor Natura 2000 site (Galicia, Spain). Credit: M. Palacios

On the date of the EO data of reference these areas may be covered or not by water. In this category, all the marsh area will be considered as class 8.1.1.1, regardless if it is covered by water or not on the date of the image.

Salt marsh in Foz do Rio Miñor Natura 2000 site during low tide (Galicia, Spain). Credit: M. Palacios

Salt marsh in Foz do Rio Miñor Natura 2000 site during high tide (Galicia, Spain). Credit: M. Palacios

This category includes:

- Muddy areas covered by water in coastal salt marshes.
- Vegetated beds in salt marshes including reed coverage.
- Salt marshes in delta areas, estuaries, intertidal flats and coastal lagoons.

This category excludes:

- Inland salt marshes → 7.1.2.x *Inland saline marshes.*
- Coastal lagoons → 8.2.1.x *Coastal lagoons.*
- Salines → 8.1.1.3 *Salines.*
- Intertidal flats → 8.1.2.1 *Intertidal flats.*
- Estuaries → 8.2.2.1 *Estuaries.*

Attributes:

- N/A

Appearance:

Flat areas covered by water or mud or moist soil in/near the coastline or in estuaries and other coastal :

Marshes in Doñana Natura 2000 site, Spain and estuary of the Guadalquivir river SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-01. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Vegetated flat areas in/near the coastline or in estuaries and other coastal landscapes:
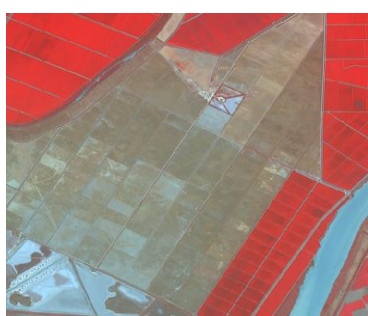

Marais at Gironde estuary (France) SPOT-5 (25 m) (1/2/3 Band Combination). Date: 2011-08-01. Source: CNES 2011©, Distribution Airbus DS/Spot Image

In the case of salt marshes transformed to agriculture, classification rules are applied as follows:

Rice fields in Doñana National Park (Spain). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

- Agricultural activity is evident → 2.1 *Arable land*, generally 2.1.3.1 *Irrigated arable land and rice fields*.
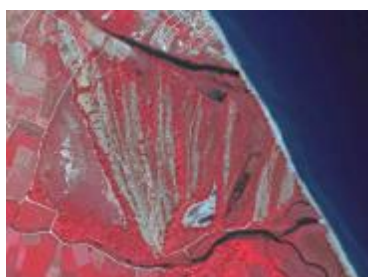

Transformed salt marsh in Doñana National Park (Spain) without agricultural use. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

- Parcels and drainage channels are visible but agricultural activity is abandoned → 6.1.1.1 *Sparsely vegetated area* if is covered by sparsely vegetated with a field cover between 10 % and 50 % at the phonological mature stage. If the area is water- logged → 8.1.1.1 *Salt marshes*


Pineiou Delta, Natura 2000 site (Greece). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- Parcels and drainage channels are visible but the area is covered by grassland or scrubland → 4.2.x *Natural grassland*/5. *Heathland and scrub*.

Pineiou Delta, Natura 2000 site (Greece). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- The area is invaded by scrubs and trees → 3.4.1.1 *Transitional woodland and scrub*.

These rules for transformed salt marshes also apply to 8.2.1 *Coastal lagoons*.

The treatment of water inside salt marshes is based on the following rules:

- Water-logged areas (having water or not at the date of the image) are classified as 8.1.1.1 *Salt marshes*
- Relevant ponds and channels visible in the image (containing water or clear surface depressions) will be classified as 8.2.1.1 *Coastal lagoons*
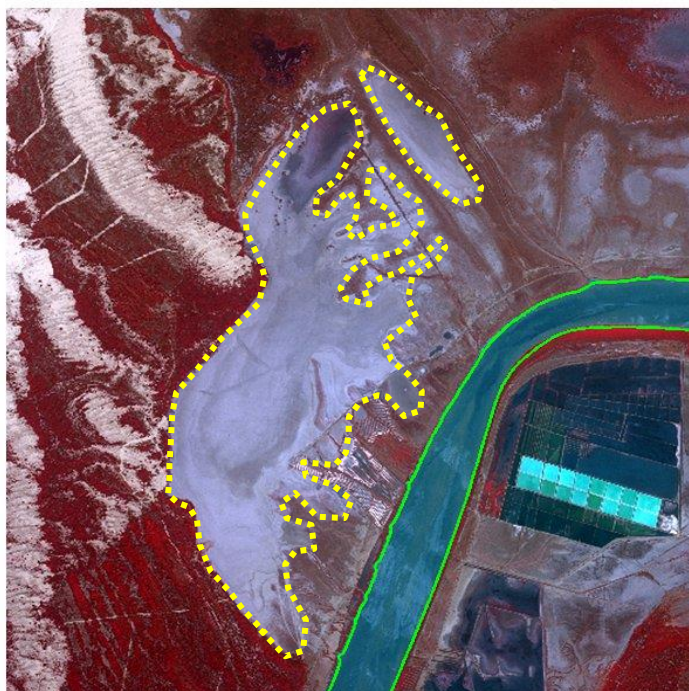
Relevant and clear ponds and channels in salt marshes are classified as 8.2.1.1 Coastal lagoons. SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-01. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- Computer assisted visual interpretation complemented by Natura 2000 database and CORINE Land Cover class 421.
- Main identification will be based on CORINE Land Cover class 421 and Soils Map of Europe
- Use of Transitional Water layer (European Framework Directive) to identify general limits of coastal waters.
- Use of ancillary information:
  - GIO-Land HR Water/Wetland Layers
  - Natura 2000 database
  - Wetland Ramsar Sites
  - Soils map of Europe
  - Any available ancillary or in-situ data sources.

8.1.1.2 Salines

Definition:

CORINE Land Cover 4.2.2 S*alines* class definition is adopted: "*Salt-pans, active or in process of abandonment. Sections of salt marsh exploited for the production of salt by evaporation. They are clearly distinguishable from the rest of the marsh by their parcellation and embankment systems*"[31].

Salines des Pesquieres (Southern France). Credits: European Union 2012, LUCAS.

Salt marshes in Lanzarote (Canary island, Spain). Credit: C. Alonso

This category includes:

- Exploited coastal salines.
- Salinas organized to breed fish in coastal areas and any type of fish farms in maritime environments (including inland oyster fish farms).

This category excludes:

- Saline coastal lagoons → 8.1.1.1 *Salt marshes*.
- Salines not exploited (irregular forms, presence of vegetation in ponds, barriers covered by vegetation) will be classified in other classes as 8.2.1.x *Coastal lagoons* or 8.1.1.1 *Salt marshes*
- Freshwater fish ponds → 9.2.1.4 *Intensively managed fish ponds*.
- Inland salines → 1.3.1.1 *Mineral extraction, dump and construction sites*.
- Floating fish farms → 10.1.1.1 *Marine (other)*.

Attributes:

- N/A

Appearance:

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[31] Bossard, M., Feranec, and J. Otahel, J. (2000): CORINE land cover technical guide – Addendum 2000, Technical report No 40, European Environment Agency.

Water ponds with regular shape, close quarters and many small ponds in or near the coastline. Different colours of ponds according their level of water. Without vegetation. In many cases, associated to buildings.

Santa Pola salines (Spain) SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-12. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- Computer assisted visual interpretation complemented by Natura 2000 database and CORINE Land Cover class 422 Saline.
- Use auxiliary data sets to identify salines.
- Use of Transitional Water layer (European Framework Directive) to identify general limits of coastal waters.

8.1.2.1 Intertidal flats

Definition:

CORINE Land Cover 423 *Intertidal flats* class definition is adopted: "*Generally unvegetated expanses of mud, sand or rock lying between high and low water marks*"[32].

Intertidal flat in Étel (Bretagne, France). Credits: European Union, 2012, LUCAS

Intertidal flat (Nissum Bredning, Denmark). Credits: European Union, 2012, LUCAS

This category includes:

- Area between tide marks, basically composed by mud, rocks or boulders.

This category excludes:

- Coastal lagoons and marshes → 8.2.1.x *Coastal lagoons*/8.1.1.1 *Salt marshes.*
- Estuaries (rivers meet the sea and salt water is diluted by fresh river water) → 8.2.2.1 *Estuarie*s.
- Beaches and dunes →6.2.1.x *Beaches, dunes, sands.*

Attributes:

- N/A

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[32] Bossard, M., Feranec, and J. Otahel, J. (2000): CORINE land cover technical guide – Addendum 2000, Technical report No 40, European Environment Agency.

Appearance:

Generally, mud flats and water channels in the coastline.

Waddenzee (Netherlands). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-10-24. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Difference between intertidal flats and estuaries:

Intertidal flats are characterized by the influence of the sea and the presence of tidal channels. 8.2.2.1 Estuaries are characterized by the influence of the river.
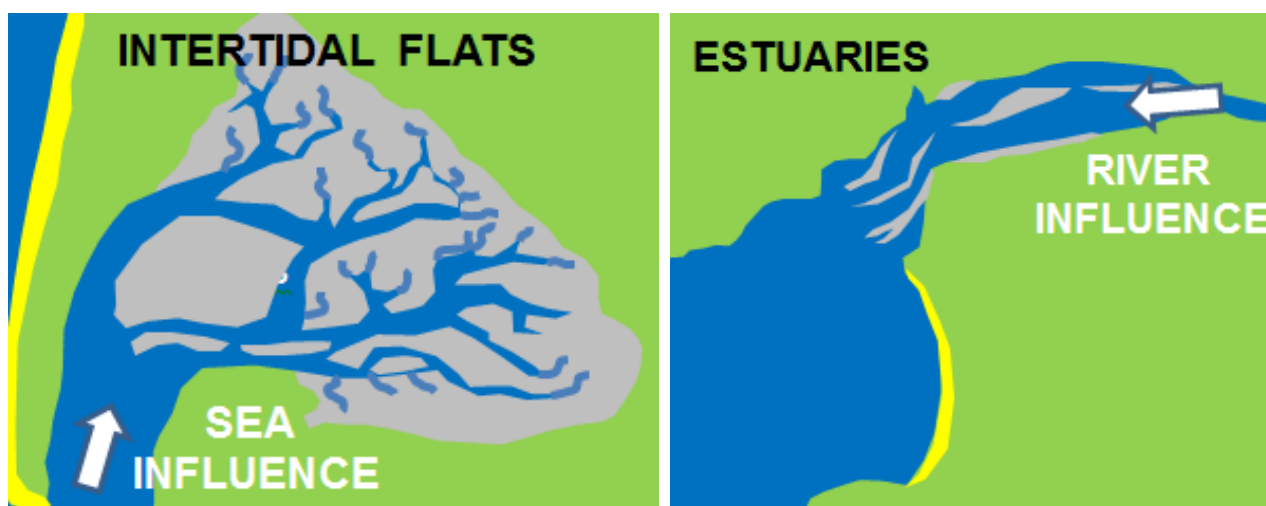
Schematic differentiation 8.1.2.1 Intertidal flats/8.2.2.1 Estuaries

Methodological approach:

- Use of EU-DEM (0 m altitude line) to indentify the exterior border of intertidal flat.
- The outer border will be defined by the supratidal zone (zone regularly splashed, but not submerged by sea water).
- Use of Transitional Water layer (European Framework Directive) to identify general limits of coastal waters.
- Computer assisted visual interpretation complemented by Natura 2000 database and CORINE Land Cover class 4.2.3 *Intertidal flats*.
- Ancillary information is needed in case of confusion with 8.1.1.1 *Salt marshes*.

8.2.1.1 Coastal lagoons

Definition:

CORINE Land Cover 521 *Coastal lagoons* is adopted: "*Stretches of salt or brackish water in coastal areas which are separated from the sea by a tongue of land or other similar topography. These water bodies can be connected to the sea at limited points, either permanently or for parts of the year only*"[33].

Coastal lagoons are considered as a water ecosystem composed by water and specific adapted vegetation (reeds).

This category is relevant in Mediterranean coastal areas. This class is also present in Baltic sea and are a scarce habitat in the Atlantic coast.

Coastal lagoon at Golfo di Signo (Sardinia, Italy). Credits: European Union 2012, LUCAS.

Orbetello Lake (Grosseto, Italy). Credits: European Union 2012, LUCAS.

This category includes:

- Open water of coastal lagoons.
- Tidal mud flats and muddy areas in coastal lagoons.
- Tidal channels.
- Reed beds in coastal lagoons.
- Floating aquatic vegetation in coastal lagoons
- Areas separated by barriers in coastal lagoons and not included in salines or fish farms.
- Coastal lagoons separated from the sea by rocks if they are distinguishable from fjords and other related features. This type is usual in the coasts of Scotland, Wales and Ireland (silled or chocked coastal lagoons).
- Percolation lagoons if they are clearly separated from sea by sand banks or shingle.
- Coastal lagoons separated from the sea by artificial structures, as roads.

This category excludes:

- Beaches and dunes → 6.2.1.1 *Beaches and dunes*.
- Fjords and other coastal lagoons not separated from the sea by a visible tongue of land, are not included → 10.1.1.1 *Marine*

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[33] Bossard, M., Feranec, and J. Otahel, J. (2000): CORINE land cover technical guide – Addendum 2000, Technical report No 40, European Environment Agency.
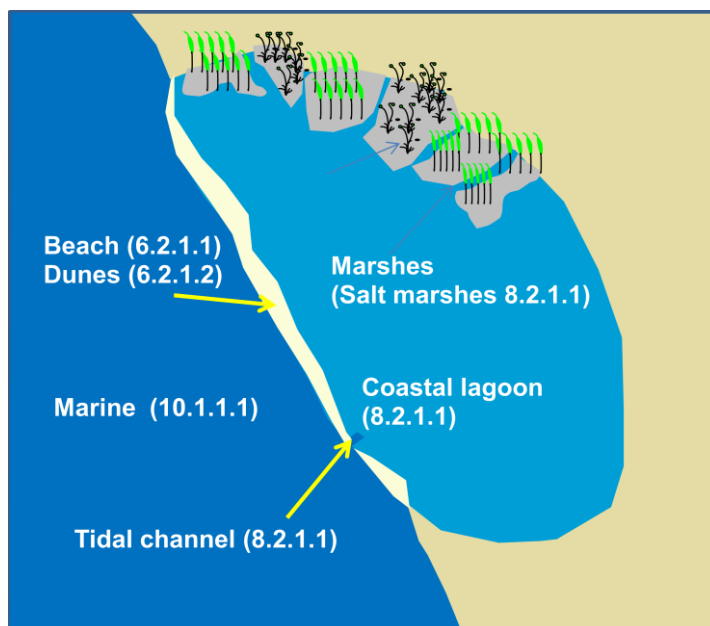
Attributes:

- N/A

Appearance:

Unvegetated (water coverage) bodies of water generally separated from the sea for a land barrier (usually sand).

SPOT-5 (2.5 m) (1/2/3 band combination). Limnes Voulkaria Kai Saltini Natura 2000 site, Greece. Date: 2011-02-05. Source: CNES 2011©, Distribution Airbus DS/Spot Image. In green, limits of Natura 2000 site.

*Schematic representation of typical coastal lagoon landscape.*

Muddy areas in coastal lagoons will be considered also as 8.2.1.1 *Coastal lagoons* (including muddy areas separated from the main lagoons by barrier and not included in salines or fish farms).

Schematic view of the treatment of bare soils in coastal lagoons

The following types of coastal lagoons are considered according their main morphological characteristics:

- **Isolated lagoons**: These are shallow bodies of water separated from the sea by a sand barrier (dunes and beaches). These lagoons are connected to the sea at limited points. Typical of Mediterranean coastal areas. In Spain called *Albuferas*.
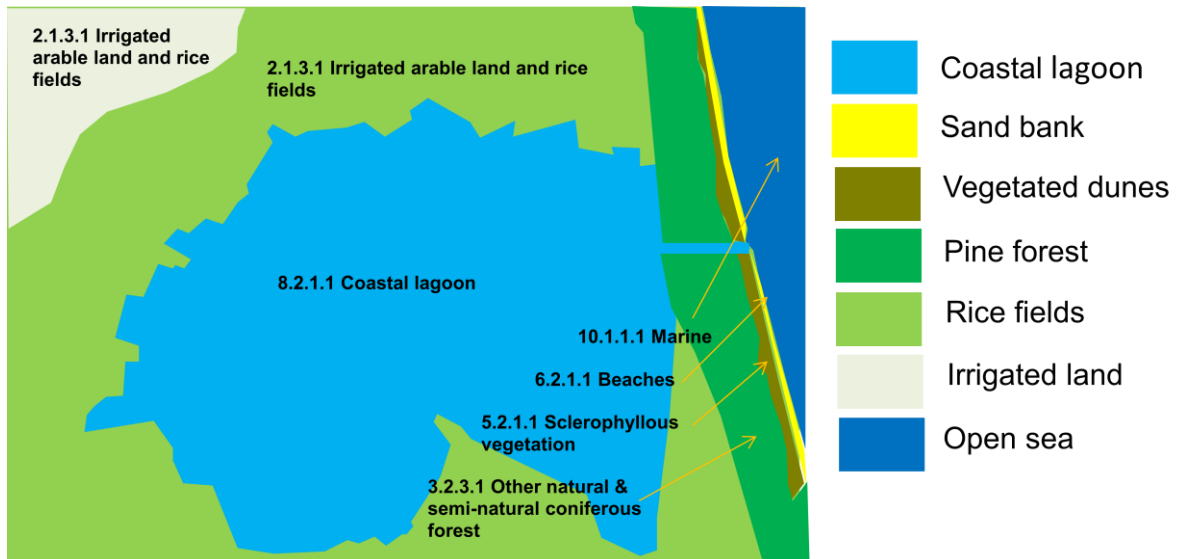
*Schematic view of La Albufera coastal lagoon (Valencia, Spain)*

- In many cases, these coastal lagoons separated from sand barriers are open to the sea due to sea erosion or other processes (**leaky, restricted or open type lagoons**). In other cases they are rounded completely by sand banks. Many of these lagoons are man-made transformed (especially by the construction of roads on the sand barriers).
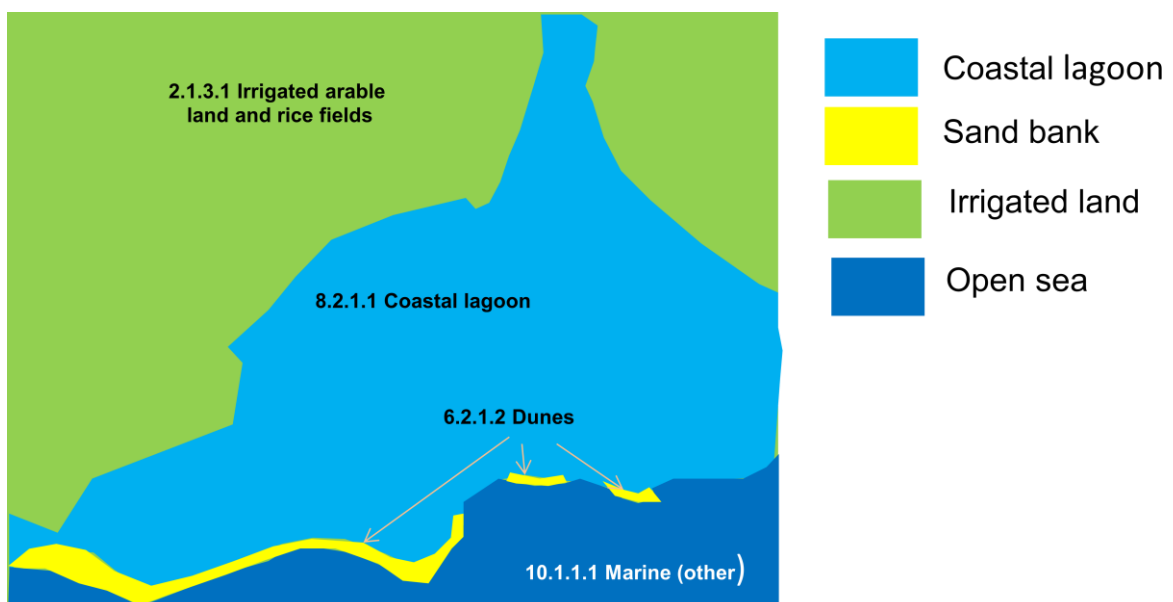
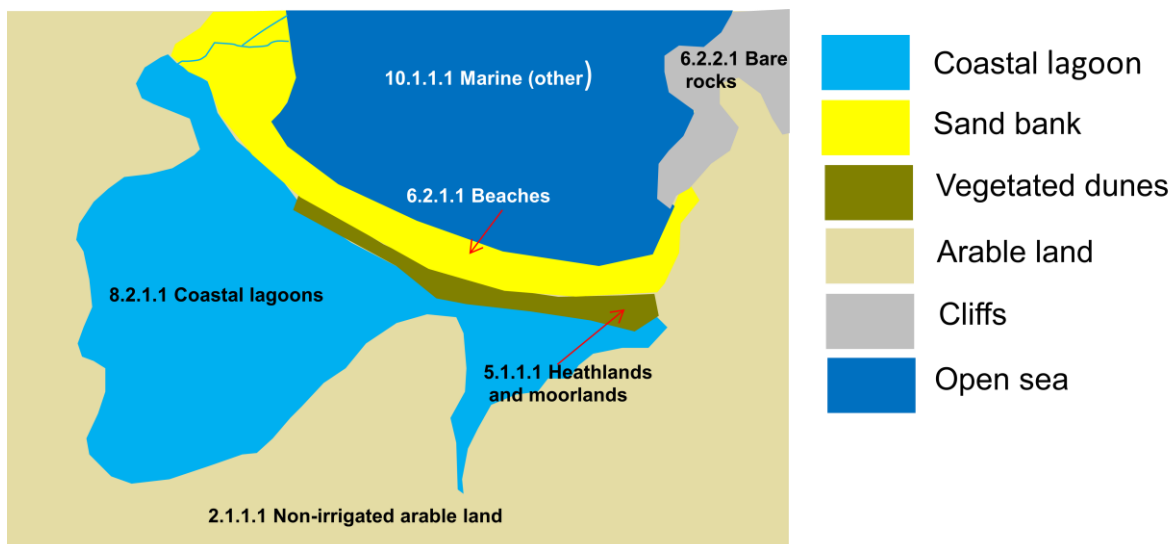*Schematic view of open coastal lagoon. Limni Kiknolakka (Greece).*

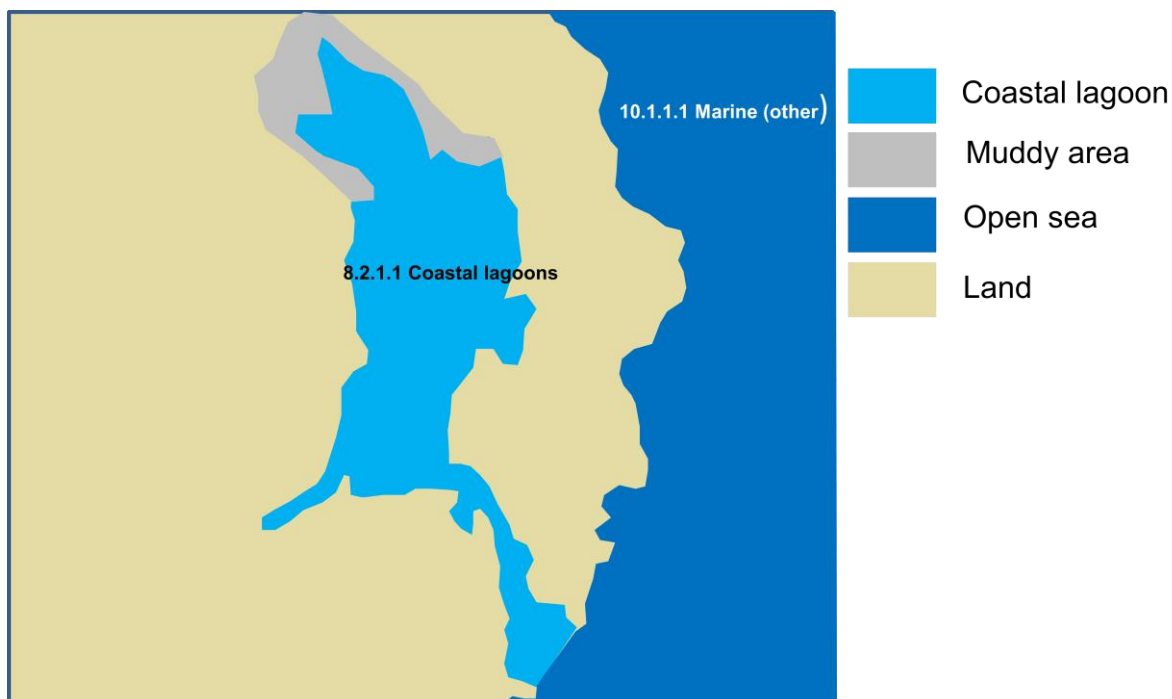*Schematic view of Falsterbo coastal lagoons complex (Scania Province, Sweden*
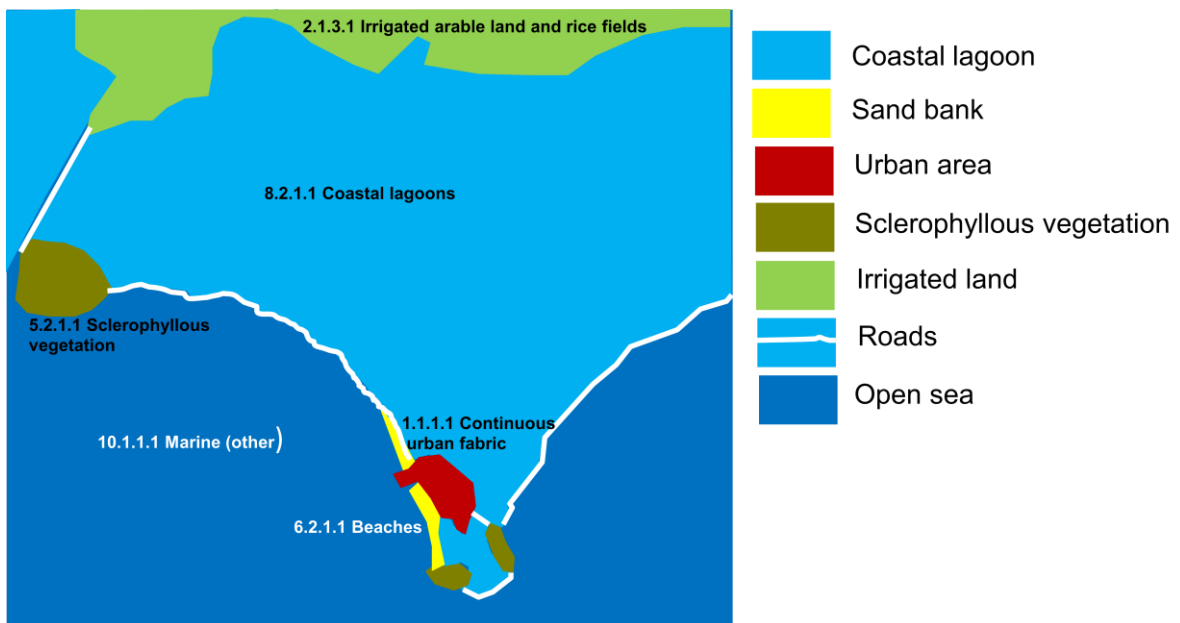
Schematic view of a transformed coastal lagoon. Logarou lake (Greece).

- **Percolation lagoons**[34]: These are normally separated from the sea by sand or shingle banks. Seawater enters by percolating through the bank.

Schematic view of percolation Cemlyn lagoon (north Wales, United Kindgdom)

A specific case of coastal lagoons are **silled or choked lagoons**. These coastal lagoons are open to the sea, but the water is retained by a rock barrier (in many cases not visible in the satellite images) or by a long narrow entrance channel. Fjords are the same landform but in this case the difference from choked coastal lagoons is the water depth.

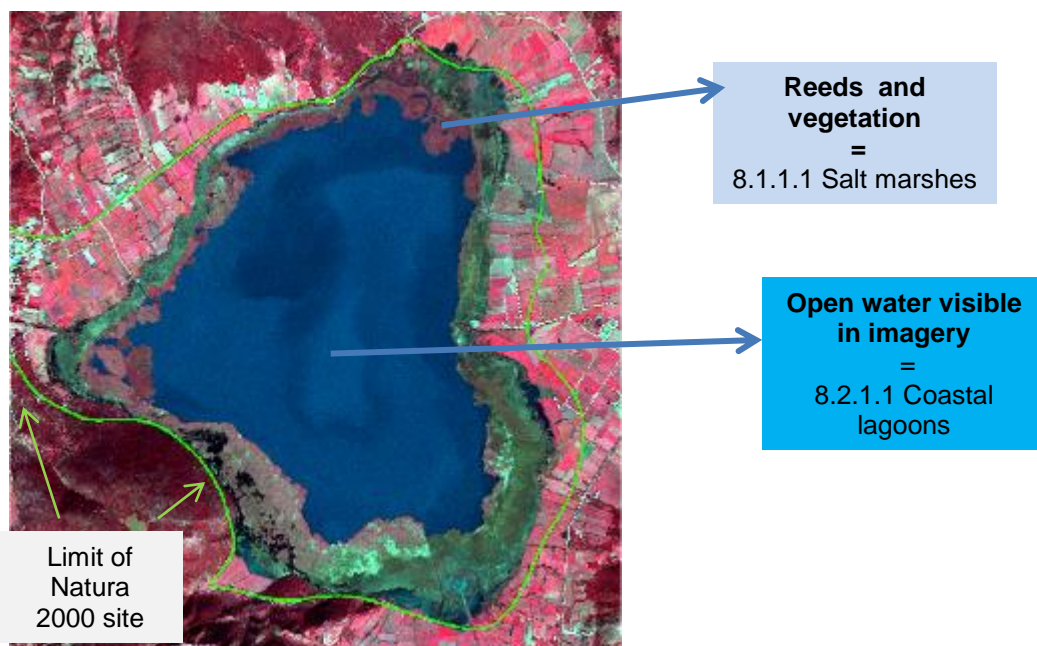*Schematic view of silled lagoon of Strangford Lough (Northern Ireland, United Kindgdom)*

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[34] http://jncc.defra.gov.uk/protectedsites/sacselection/habitat.asp?FeatureIntCode=H1150

Methodological approach:

- Computer assisted visual interpretation complemented by ancillary information.
- CORINE Land cover class 521 *Coastal lagoon.*
- Use of Transitional Water layer (European Framework Directive) to identify general limits of coastal waters.
- Use of ancillary information:
    - GIO-Land HR Water/Wetland Layers
    - Natura 2000 database
    - Wetland Ramsar Sites
    - Any available ancillary or in-situ data sources.

Discrimination of marshes in coastal lagoons areas:

Reed and vegetated areas in coastal lagoons areas are considered as 8.1.1.1 *Salt marshes*.

Reeds and vegetation
=
8.1.1.1 Salt marshes

Open water visible in imagery
=
8.2.1.1 Coastal lagoons

Limit of Natura 2000 site

Limnes Voulkaria Kai Saltini Natura 2000 site, Greece. SPOT-5 (2.5 m) (1/2/3 band combination). Date: 2011-02-05. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Marshes could be located in following situations in coastal lagoons:

A. Reed beds and marsh plants inside coastal lagoons.
B. Reed beds and marsh plants located in the shoreline of coastal lagoons.
C. Reed beds and marsh plants dividing two coastal lagoons.
D. Reed beds and marsh plants separated from coastal lagoons not related with estuaries or coastal lagoons.

Coastal lagoon

Sand bank

Reedbeds and marsh plants

Open sea

Irrigated land
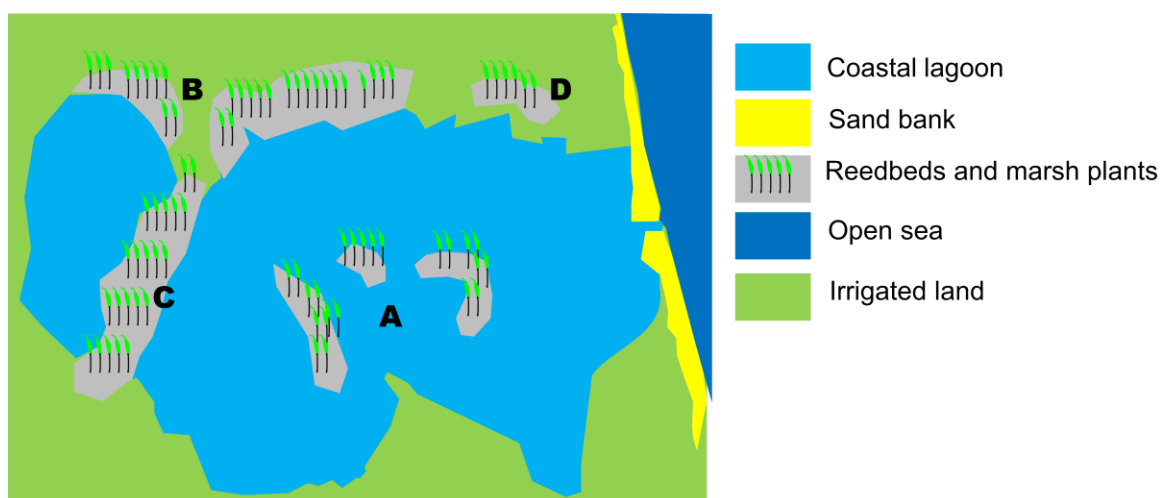
Concept of coastal marshes: A, B,C and D situations are considered as 8.2.1.1 Salt marshes

In the case of complex coastal lagoons (costal lagoons related to coastal wetlands and estuaries) vegetation (reed beds and marsh plants) will be classified as 8.1.1.1 *Salt marshes*.
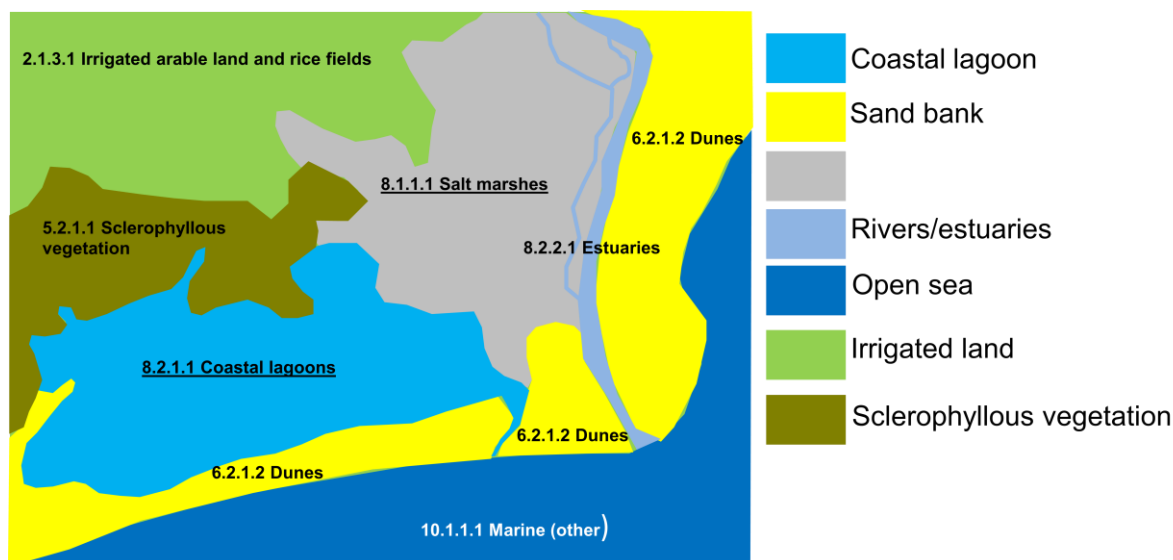
Schematic concept for differentiation between 8.2.1.1/8.1.1.2 classes

Special cases are coastal lagoons covered by reed bed and marsh plants and the presence of tidal channel. In these cases the tidal channels will be classified as 8.1.1.1 *Salt marshes.*
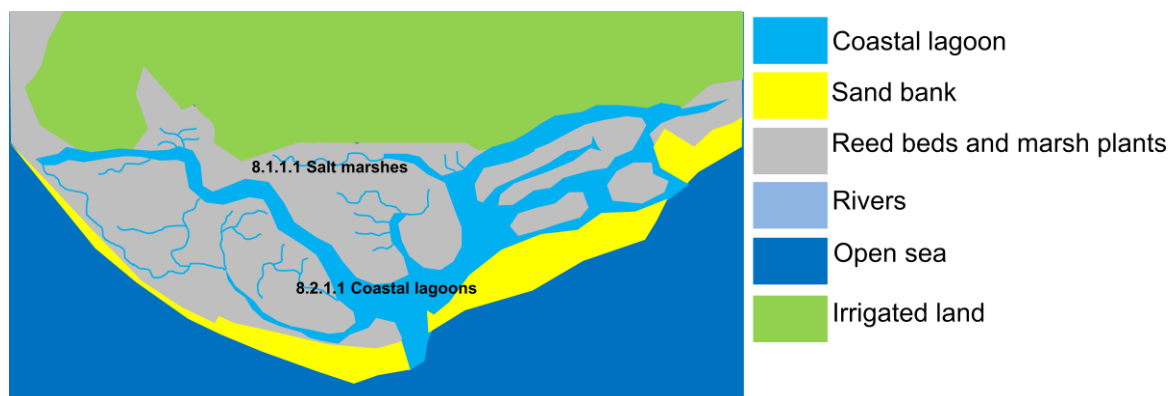
Schematic concept of coastal lagoons with reed beds and tide channels (Leaky coastal lagoon of Ria Formosa in Portugal)

Methodological approach:

- Computer assisted visual interpretation complemented by ancillary information.
- CORINE Land cover class 521 *Coastal lagoons*
- Use of Transitional Water layer (European Framework Directive) to identify general limits of coastal waters.
- Use of ancillary information:
    - GIO-Land HR Water/Wetland Layers
    - Natura 2000 database
    - Wetland Ramsar Sites
    - Any available ancillary or in-situ data sources.

8.2.2.1 Estuaries

Definition

CORINE Land Cover 522 *Estuaries* class is adopted: "*The mouth of a river within which the tide ebbs and flows, either permanently or for parts of the year only*"[35].

In many cases, estuaries are associated with marshes.

Estuary of Guadalquivir River (Southern Spain). Credits: E. Mazón

This category includes:

- Estuaries.

This category excludes:

- Marshes in estuaries→ 8.1.1.1 *Salt marshes*.
- Open sea → 10.1.1.1 *Marine (other)*.
- Coastal lagoons→ 8.2.1.1 *Coastal lagoons*.
- Rivers ending in highly artificial harbors will not be categorized as 8.2.2.1 *Estuaries*.
- Fjords, *rias* (in Northwestern Spain) and straits → 10.1.1.1 *Marine (other)*.

Attributes:

- N/A

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[35] Bossard, M., Feranec, and J. Otahel, J. (2000): CORINE land cover technical guide – Addendum 2000, Technical report No 40, European Environment Agency.

Appearance:

Ending of rivers which flow into the sea.
Estuaries are influenced by tides and in small rivers sand/mud appears when low tide occurs.
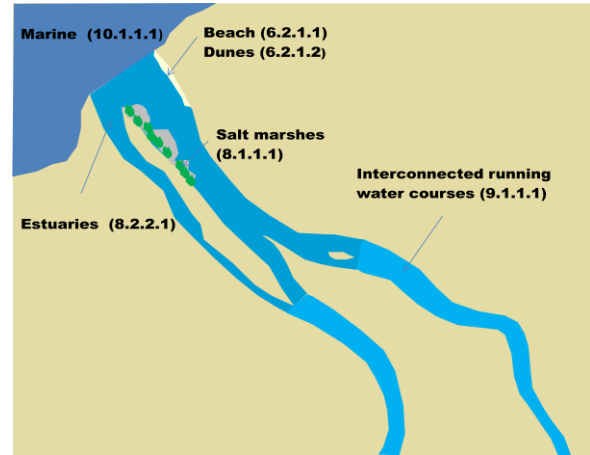
Gironde Estuary delineated (France). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-01.Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Schematic representation of typical estuary morphology

In delta rivers, the area where the river meets the sea is classified as 8.2.2.1 *Estuaries*. The area affected by tides (presence of mud in the image) inside the deltaic system and not covered by vegetation is also classified as 8.2.2.1 *Estuaries.*


Axios Delta (Greece). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-09-17. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

8.2.2.1 Estuaries
8.1.1.2 Salt marshes
**10.1.1.1 Marine**
6.1.1.1 Sparsely vegetated areas
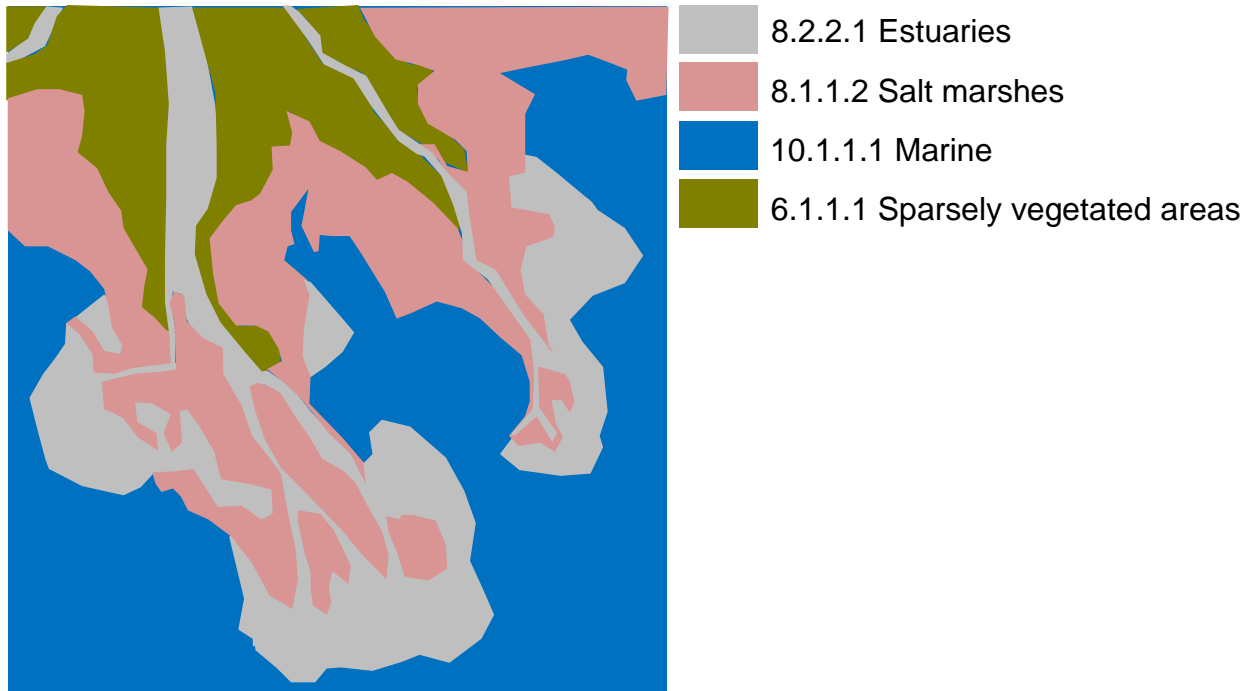
*Schematic representation of MAES L4 classification of Axios Delta (Greece)*

The limits between 9.1.1 *Interconnected running water courses* and 8.2.2.1 *Estuaries* is based in the following practical visual rules:
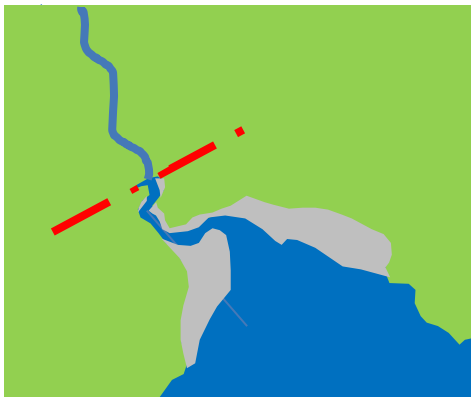
- There is a clear narrowing of the river channel → the limits is established where the river begins to be wider. Usually, there are muddy areas from this point.
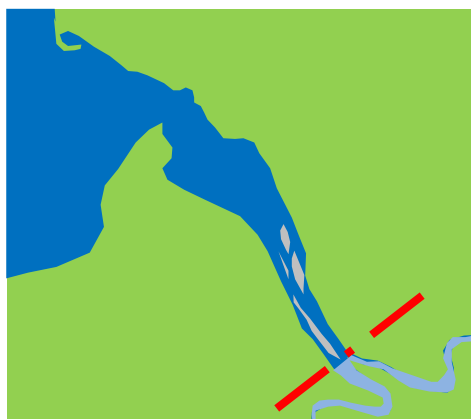
- The estuary is formed by a river and a major tributary and the river begins to be wider → the limit is the confluent of two rivers.
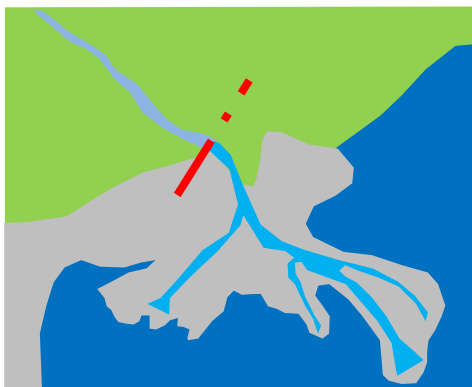
- In deltas and at big rivers where no difference in the width of the channel is apparent and salt marshes or complex coastal systems are present → the limit is the point where wet mud banks forming salt marshes or old wetlands transformed by agriculture appear.

Methodological approach:

- Computer assisted visual interpretation complemented by ancillary information. The delimitation 5.2.2 *Estuaries* / 9.1 *Water courses* will be determined by the photo-interpreter according to morphological characteristics as e.g. river junctions or other geographic elements as bare or sandy capes.
- CORINE Land cover class 522 *Estuaries.*
- Use of Transitional Water layer (European Framework Directive) to identify general limits of coastal waters.
- Use of ancillary information:
    - o GIO-Land HR Water/Wetland Layers
    - o Natura 2000 database
    - o Wetland Ramsar Sites
    - o Any available ancillary or in-situ data sources.

9. Rivers and lakes

This level comprises all rivers and lakes, which are the permanent freshwater inland surface waters. This includes water courses and water bodies (MAES[36]).

Water courses are separated according to their morphology into the riparian systems: interconnected rivers, streams or springs and separated water bodies belonging to the river systems (oxbow lakes or dead side-arms, flood ponds, etc.)

MAES Level 4 proposal is based on:

- Temporary or intermittent water courses (interconnected and separated water bodies), covering EUNIS habitat type C2.5 *Temporary running waters*.
- Identification of highly artificial modified water courses (navigation, irrigation, water regulation, flood protection and land drainage).
- Identification of main artificial or highly transformed water bodies: ponds and lakes with completely man-made structure for irrigation and water supply, intensively managed fish ponds and pools associated with extractive sites.

As general for this category, the water level visible in the EO data use for interpretation will be mapped. Where the water is missing, the current land cover seen in the image will be mapped. This general principle is valid for lakes (especially reservoirs), rivers, oxbows, fishponds, etc.

This category includes:

9.1 Water courses
    9.1.1 Interconnected running water courses
        9.1.1.1 Permanent interconnected running water courses
        9.1.1.2 Intermittently running water courses
        9.1.1.3 Highly modified natural water courses and canals
    9.1.2 Separated water bodies belonging to the river system (dead side-arms, flood ponds)
        9.1.2.1 Permanent separated water bodies belonging to the river system

9.2 Lakes and reservoirs
    9.2.1 Lakes and reservoirs
   9.2.1.1 Natural water bodies
        9.2.1.3 Pond and lakes with completely man-made structure
        9.2.1.4 Intensively managed fish ponds
        9.2.1.4 Standing water bodies of extractive mineral sites

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[36] European Commission (2013): Mapping and Assessment of Ecosystems and Their Services. An Analytical Framework for Ecosystem Assessment under Action 5 of the EU Biodiversity Strategy to 2020. Discussion Paper, Final, April 2013.

A specific decision tree has been elaborated to distinguish between 9.2 lakes and reservoirs classes.
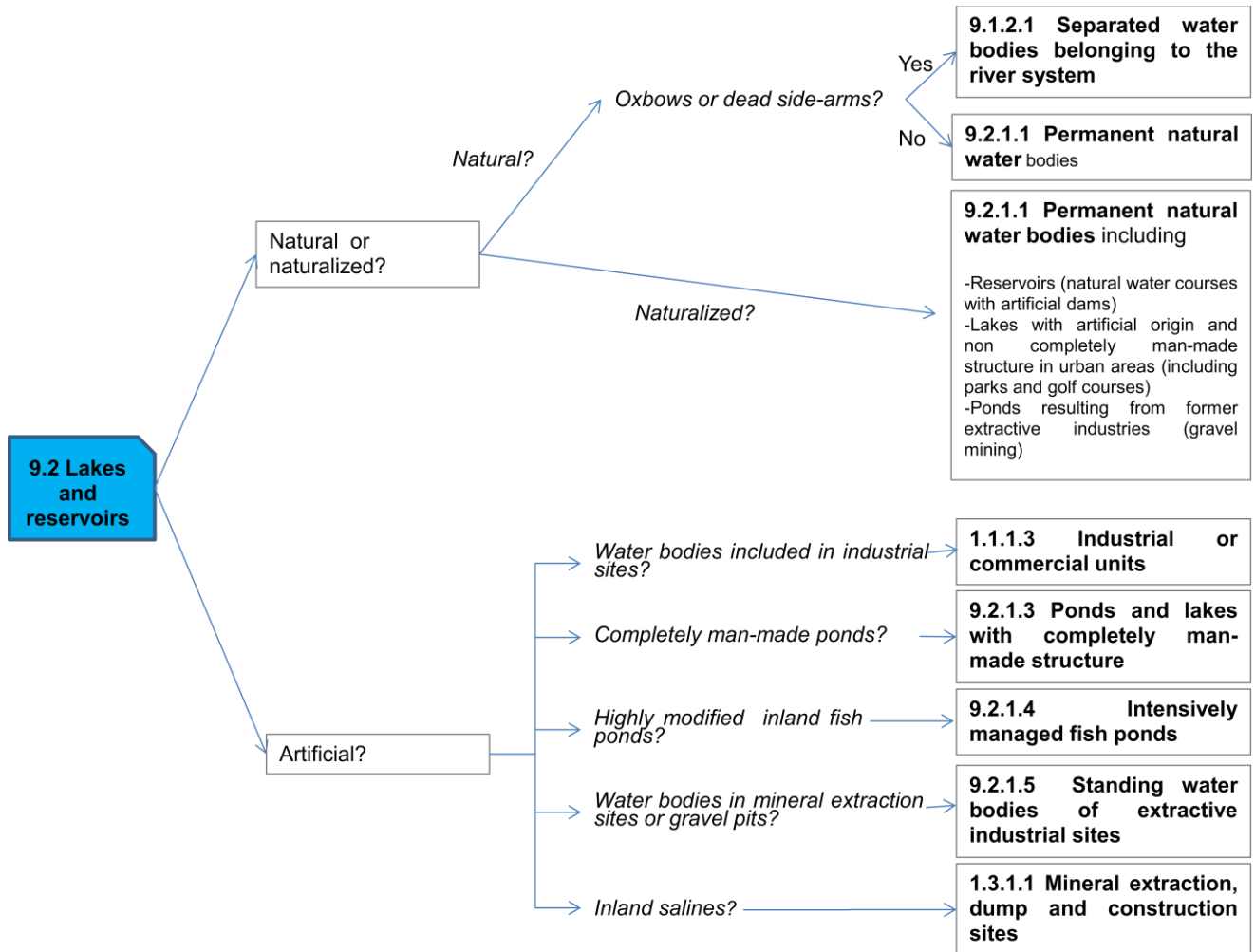
9.1.1.1 Permanent interconnected running water courses

Definition

Permanent natural stream of water that empties into another body of water or into the sea.

Permanent running water courses occurs throughout Europe, but is characteristic of well-watered areas as Atlantic and Continental biogeographical regions. In Mediterranean region is restricted to large water courses.

Permanent interconnected running water course in Antalya Province (Southern Turkey). Credits: M. Escobar

River in Northern Wales (United Kingdom). Credits: European Commission 2012. LUCAS

This category includes:

- Permanent natural streams of water with more than 10 m wide.
-

This category excludes:

- Highly modified natural water courses and canals → 9.1.1.3 *Highly modified natural water courses and canals.*
- Reservoirs and other water bodies → 9.2.1.1 *Natural water bodies*
- Water bodies belonging to the river system → 9.1.2.x *Separated water bodies belonging to the river system (dead side-arms, flood ponds.*
- Small rivers completely covered by vegetation (trees, scrub, hedges)→ map current land cover.
- And bank within a river that is covered by scrub is not considered as inland wetlands will be classified as 3.4.1.1 *Transitional woodland and scrub.*
- Lakes that are connected to the river systems are mapped as *9.1.2.1 Separated water body belonging to the river system.*
- Small marinas in rivers: Marina water surface: 9.2.1.1 *Natural water bodies/*Sports facilities around water 1.4.2.1 *Sport and leisure facilities.*

Attributes:

- In the cases of braided fluvial systems the main channels will be extracted (> 10 m) and the adjacent area of bare soils will be extracted and classified as 6.2.1.3 *River banks* with the attribute "*braided river*".

Appearance:

River Weser in Bodenwerder (Lower Saxony, Germany). SPOT-5 (2.5 m) (1/2/3 band combination). Date: 2011-02-05. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- If possible, water objects extraction by automated pixel-based classification of imagery. If not, computer assisted visual interpretation will be applied.
- Main channel identification using EU-HYDRO and/or OSM data.
- Use of ancillary information:
    - GIO-Land HR Water/Wetland Layers
    - Water Framework Directive data (large rivers and lakes)
    - Any available ancillary or in-situ data sources.

Approach for differentiation between 9.1.1.1 *Permanent interconnected running water courses* and flooded areas:

Map main river as 9.1.1.1
- Use EU-Hydro or other adequate data sources for identification)

Map bordering flooded areas as 7.1.1.1 (*Inland freshwater marshes*) or 4.2.1.2 (*Mesic grasslands with trees*) – depending on surrounding landscape

Reason: the connected river is needed for the RZ modelling

Approach for differentiation between 9.1.1.1 *Permanent interconnected running water courses* and neighbouring (flooded) areas:

- Map main river as 9.1.1.1
  - River is needed for RZ modelling

- Use auxiliary data (e. g. EU-Hydro) to map river and permanent water bodies

- Flooded / wet grassland: 4.2.2.2 (*Mesic grasslands without trees*) or 4.1.1.1/2 (*Managed grasslands*) according to auxiliary data or additional satellite data

9.1.1.2 Intermittently running water courses

Definition:

Watercourses that cease to flow for part of the year, leaving a dry bed or pools (EUNIS definition class C2.5).

Different classes of temporary rivers are considered[37]: snowmelt and glacial meltwater; perched and semi-perched alluvial; non-perched in arid and semi-arid regions and karstic non-permanent streams. Zero-order and headwater streams, permafrost and temporary lakes are not included here.

Intermittently running water course (Ribeira de Odeleite, Algarve, Portugal). Credits: Eurostat LUCAS 2013.

This category includes:

- Non-permanent natural streams of water with more than 10 m. width.

This category excludes:

- Permanent interconnected running water courses → 9.1.1.1 *Permanent interconnected water running courses.*
- Separated water bodies belonging to the river system → 9.1.2.1 *Temporary separated water bodies belonging to the river system.*
- Temporary small rivers (due to summer drought) with large river beds in areas with perennial rivers → 6.2.1.3 *River Bank* for the river beds
- Dry river beds → 6.2.1.3 *River Bank.*

Attributes:

- N/A

---

[37] Larned, S.T., Daltry, T., Arscott, D.B. and. Tockner, K. (2010). Emerging concepts in temporary-river ecology. *Freshwater Biology* 55, 717–738

Appearance:
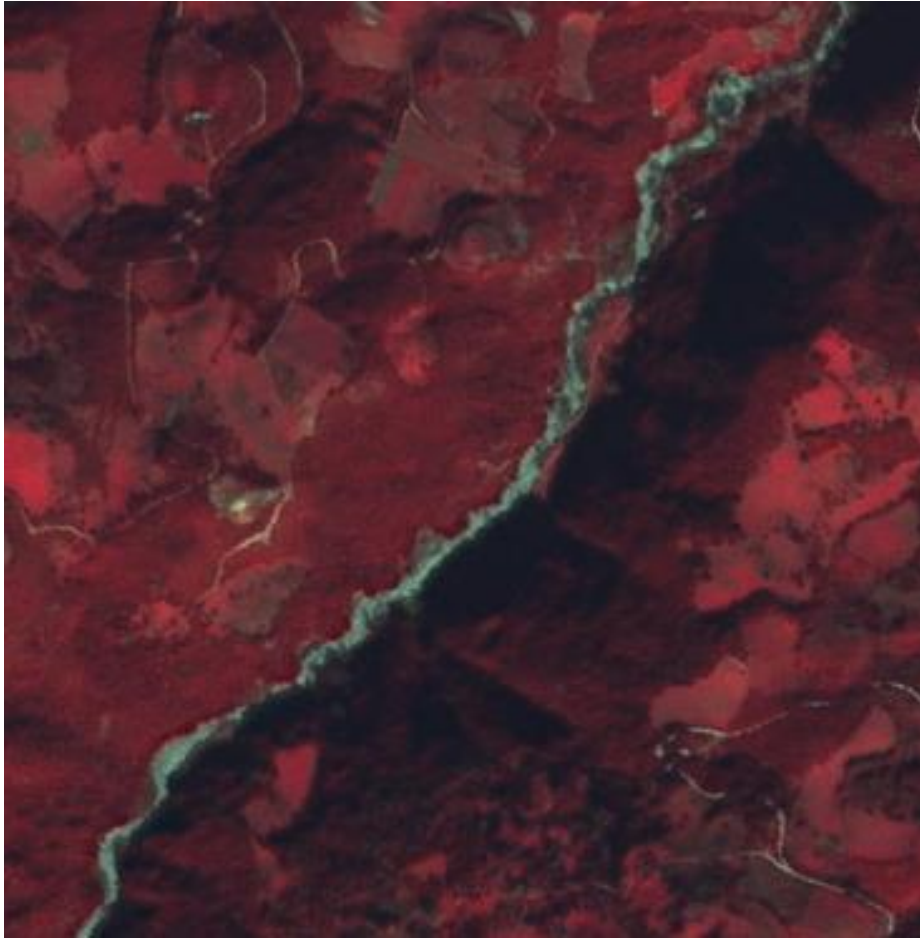
Intermittent river in Aetolia-Acarnania region (Greece). SPOT-5 (2.5 m) (1/2/3 band combination). Date: 2011-02-05. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- If possible, water objects extraction by automated pixel-based classification of imagery. If not, computer assisted visual interpretation will be applied.
- Intermittent water status will be obtained by visual interpretation (e.g. is summer-imagery are available in arid zone) or attending climatic zonification.
- Main channel identification will be obtained by visual interpretation using as auxiliary data EU-HYDRO and/or OSM data)
- Use of ancillary information:
    - GIO-Land HR Water/Wetland Layers
    - Water Framework Directive data (large rivers)
    - Any available ancillary or in-situ data sources, especially cartography where rivers are qualified as intermittent or permanent.

- Regarding the identification of main channel/channels in images where the river water is not present, the following rules are applied:

    - Dry channel in rivers banks → delineation of main visible dry channel/s (> 10 m.) as 9.1.1.2 *Intermittently running water courses*.
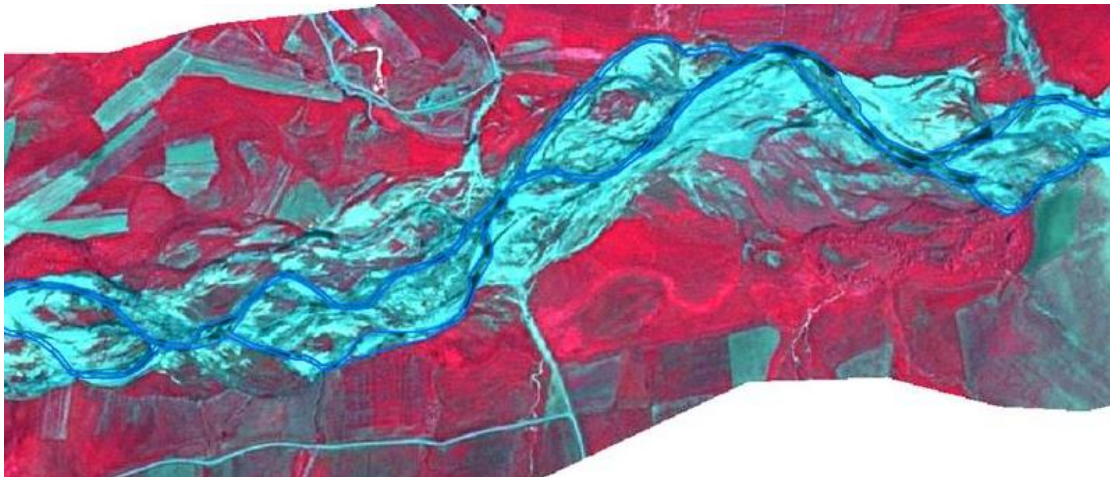
Example of delineation of dry braided rivers. Euphrates River (Turkey). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-06-25. Source: CNES 2011©, Distribution Airbus DS/Spot Image

    - Rivers banks without presence of channels > 10 m. → classification of all area as 6.2.1.3 *Rivers banks*.

River system where it is not possible to delineate water channels > 10 m. Tributary of the Euphrates River (Turkey). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-06-29. Source: CNES 2011©, Distribution Airbus DS/Spot Image

- Special definition for intermittently running water courses in the Alps:

  - Rivers > Strahler level 3 are "permanent" rivers

  - Rivers <= Strahler 3 are checked, if they are intermittently running. If those rivers are braided rivers and/or the river bed is partially fallen dry, the water area of those rivers is mapped as 9.1.1.2 intermittently running water courses

9.1.1.3 Highly modified natural water courses and canals

Definition

Natural water courses highly modified due man-made interventions (usually concrete bedding and or straightened river shores)

Artificial water courses according Water Framework Directive[38] definition: "*water bodies which have been created in a location where no water body existed before and which have not been created by the direct physical alteration, movement or realignment of an existing water body*".

Highly modified natural water course (Río Manzanares crossing Madrid city). Credits: M. Palacios.

Canal in Lingen (Lower Saxony, Germany). Credits: Eurostat LUCAS 202.

This category includes:

- Highly modified natural water courses and artificial water courses > 10 m width.
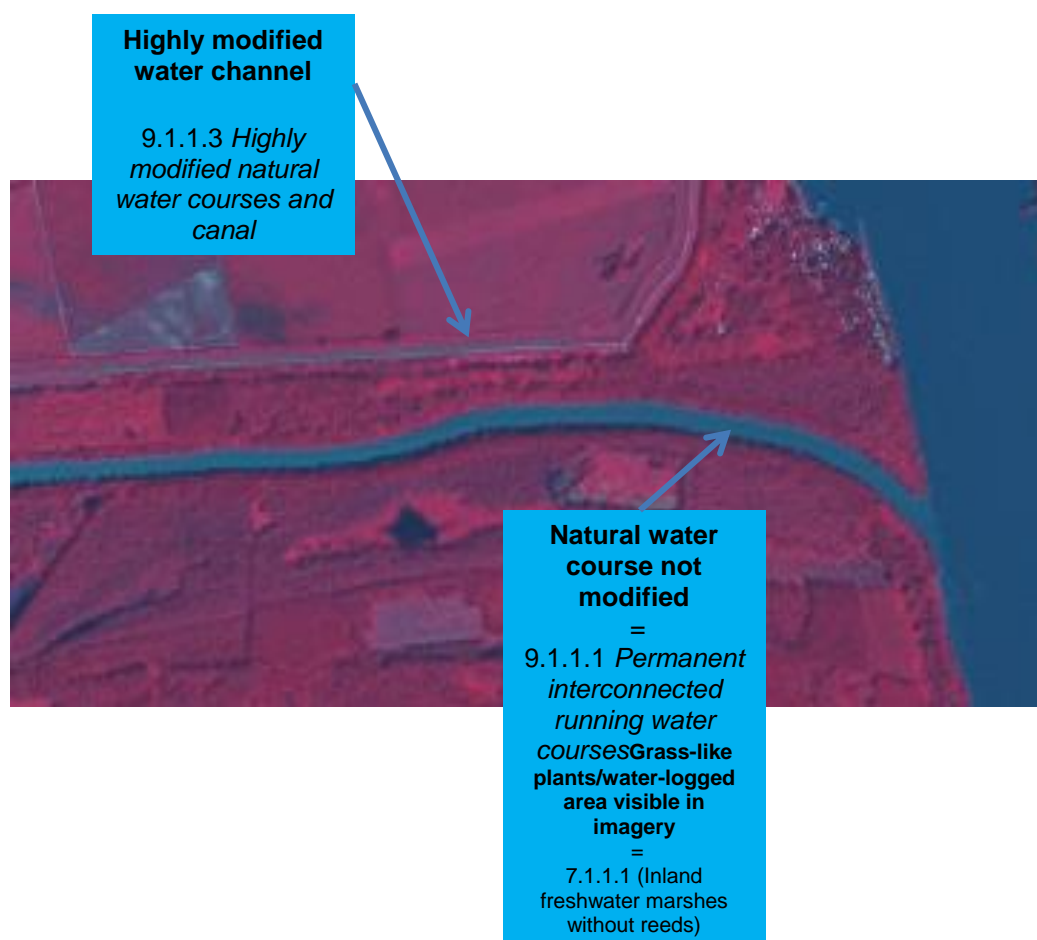
This category excludes:

- Natural water courses partially modified (e.g. flood control structures as bank modification). → *Other river classes*

Attributes:

- o N/A

---

[38] *Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy*

Appearance:

Highly modified water channel

9.1.1.3 *Highly modified natural water courses and canal*

Natural water course not modified
=
9.1.1.1 *Permanent interconnected running water courses***Grass-like plants/water-logged area visible in imagery**
=
7.1.1.1 (Inland freshwater marshes without reeds)

Danube river in Gemenc Ramsar Site, Hungary. SPOT-5 2.5 m. (1/2/3 band combination). Date: 2011-02-24. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- If possible, water objects extraction by automated pixel-based classification of imagery. If not, computer assisted visual interpretation will be applied.
- Main channel identification using EU-HYDRO and/or OSM data.
- Use of ancillary information:
  - GIO-Land HR Water/Wetland Layers
  - Water Framework Directive data (large rivers)
  - Any available ancillary or in-situ data sources.
- In case the situation is unambiguous, 9.1.1.1 *Permanent interconnected water running courses* will be mapped.

9.1.2.1 Separated water bodies belonging to the river system

Definition

Lentic backwaters as oxbow lakes, dead side-arms, abandoned braid, etc. separated from the main rivers channels.

Intermittent oxbow lake in Scandinavia. Source: Bjørn Ove Finseth.
http://es.wikipedia.org/wiki/Brazo_muerto#mediaviewer/File:Finna2.JPG Creative Commons BY 2.5

This category includes:

- Permanent and temporarily separated water bodies belonging to the river system

This category excludes:

- Oxbow lakes, dead side-arms, meander scar, abandoned braid, etc. not water-logged at the date of the image. → map according to current land cover.
- Secondary river channels. → 9.1.1.1 *Permanent interconnected water running courses.*

Attributes:

- N/A

Appearance:

Permanent dead side-arms of Danube river (Tolna, Hungary). SPOT-5 (2.5 m) (1/2/3 band combination). Date: 2011-02-24. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Treatment of permanent/temporary separated water bodies belonging to the river system:

In order to prevent mapping exceptional events such as floods is apply the non-distinction of permanent/temporally in separated water bodies belonging to the river system is to. Temporary separated water bodies belonging to the river system mainly correspond to riverine flooding covering old oxbows and other terrain depressions. In those areas, land may be covered with shallow, slow-moving floodwater for days or even weeks as exceptional situations. In these cases of temporary flooded areas, *permanent* land cover will be mapped (e.g. grasslands, wetlands or agricultural features)


Temporary flood ponds in Danube River in Borcea (Romania). SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-04-21. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Approach to separate 9121 (*Separated water bodies belonging to the river system*) from 9111 (*Permanent interconnected running water courses*) in case of high water level:
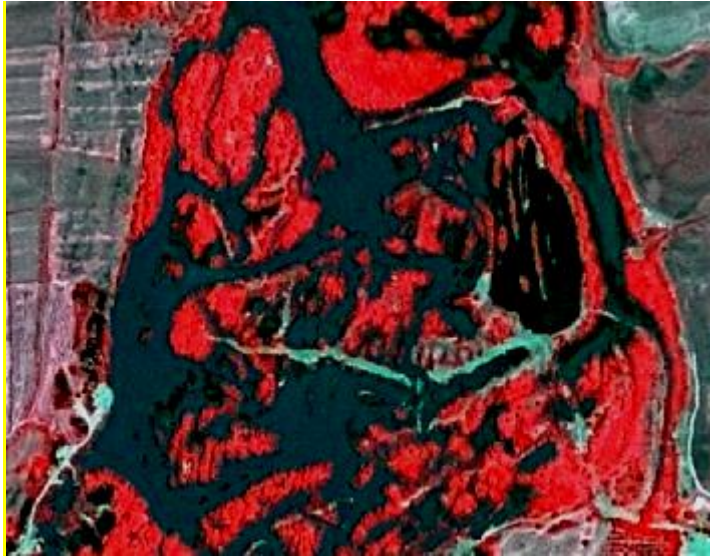
SPOT-6, 2013

- No separation visible and situation unclear – flooded or normal water level?
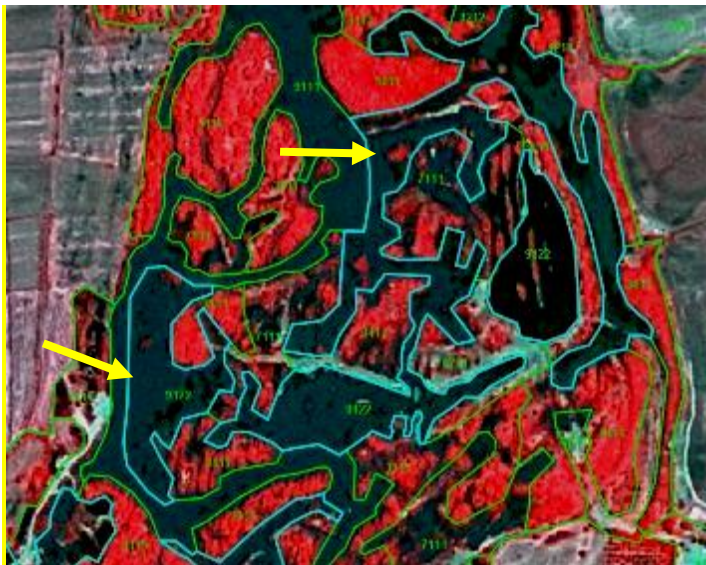
Map water course from auxiliary data; separate 9121 from 9111

- if high water level, use auxiliary data to define river course, insert comment: „high water level" – classified according to auxiliary data sets"

- If „normal" water level: extend 9111 and include 9121 into 9111

For complicated areas an experienced photo-interpreter should make an analysis and propose a mapping strategy in order to ensure a more or less „homogeneous" mapping of those areas

Methodological approach:

- If possible, water objects extraction by automated pixel-based classification of imagery. If not, computer assisted visual interpretation will be applied.
- Use of ancillary information:
  - GIO-Land HR Water/Wetland Layers
  - Water Framework Directive data (large rivers)
  - Any available ancillary or in-situ data sources.

9.2.1.1 Natural water bodies

Definition

Natural permanent and temporary lakes, including reservoirs. Included are also lakes with artificial origin in urban environments and lakes resulting from former extractive industries (gravel mining, open cast pit) after restoration.

Permanent natural water body in the Bavarian Alps (S-Germany). Credits: M. Probeck

Lake in a green area in Madrid city (Spain). Credits: M. Palacios

This category includes:

- Lakes, ponds and pools of natural origin containing fresh water.
- Lakes, ponds and pools of artificial origin but with natural structure.
- Reservoirs (including their tails).
- Lake with artificial origin in urban environments.
- Lakes resulting from former extractive industries (gravel mining, open cast pit) after restoration.
- Temporary natural water bodies
- Actual water surface. Areas fallen dry due to low water level are not included.

This category excludes:

- Fish ponds → 9.2.1.4 *Intensively managed fish ponds.*
- Ponds and lakes with completely man-made structure → 9.2.1.3 *Ponds and lakes with completely man-made structure.*
- Dams and related sealed areas at reservoirs will be classified as 1.1.1.3 *Industrial and commercial units*. Soil removed in these sites for industrial purposes will be classified as 1.3.1.1. *Mineral extraction, dump and construction sites*.
- Those parts of watercourses that pass through a power dam will be classified as 9.1.1.3 *Highly modified natural water courses and canals.*
- Areas fallen dry due to low water level → 6221 Bare rock

Attributes:

- N/A

Appearance:

Tail of a reservoir in Euphrates river near Kasaba (Turkey). SPOT-5 (2.5 m.) (1/2/3 Band Combination). Date: 2011-05-07. Source: CNES 2011©, Distribution Airbus DS/Spot Image

Methodological approach:

- If possible, water objects extraction by automated pixel-based classification of imagery. If not, computer assisted visual interpretation will be applied.
- Use of ancillary information:
    - GIO-Land HR Water/Wetland Layers
    - Water Framework Directive data (large rivers)
    - CORINE Land Cover
    - Any available ancillary or in-situ data sources.

Delimitation of water level in reservoirs:

The current water level visible in the image will be used to delineate the limits of the reservoirs.

*Delimitation of reservoirs using the maximum water lever. This is the **wrong interpretation**. Reservoir in Canary Island (Spain). Credit: M. Palacios*


*Delimitation of reservoirs using the current water level. This is the **correct interpretation**. Reservoir in Canary Island (Spain). Credit: M. Palacios*

Treatment of small temporary natural water bodies in special cases:

The category 9.2.1.1 *Natural water bodies* includes small temporary water bodies outside of the river bed and river flood plain. These temporary water ponds are affected by a recurrent dry phase or are located in specific geomorphological sites as karstic formations (e.g. turloughs in Scotland and Ireland or ponds in poljes and dolines in Balcanic countries and other karst sites in Europe). Here are not included temporary natural water bodies (ponds and lakes) related to wetland and coastal systems, temporal ponds within the river system, boreal snow-melt pools and ponds from abandoned or restored quarries.

Temporary Mediterranean ponds in Castilla-La Mancha (Spain) SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-07-22. Source: CNES 2011©, Distribution Airbus DS/Spot Image.
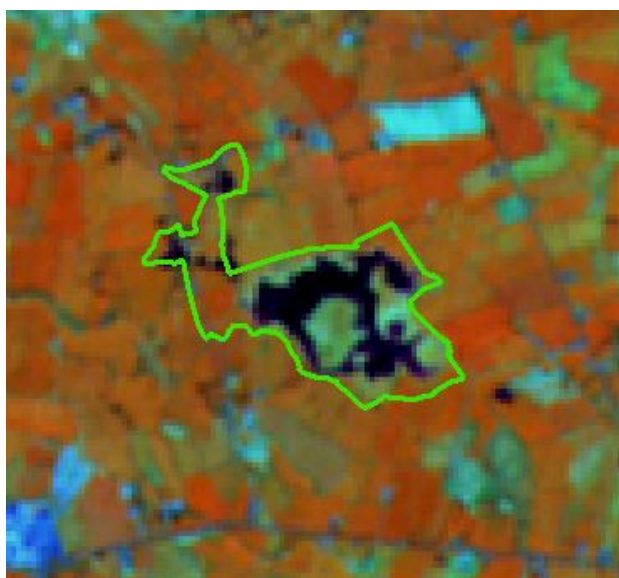
Croaghill Turlough Natura 2000 site, Ireland (outlined Natura 2000 site limit). IRS 20 m. (3/4/2 band combination). Date: 2011-04-29. Credits: CNES 2011©, Distribution Airbus DS/Spot Image.

These temporary ponds are characterized by their small size, inherently shallow and their variability related to the water permanency (in many Mediterranean locations these ponds contain water only during very humid years). Many of these ponds have been converted to arable land. New small ponds have been created across Europe for cattle watering using rainfall or underground water.

9.2.1.3 Ponds and lakes with completely man-made structure

Definition:

Pond with completely man-made structure. Water reservoirs, especially in Mediterranean countries, used for irrigation and located in agricultural surroundings. This category includes ponds and water basins for industrial use/sewage not connected with building and other facilities as buildings and storage tanks.
Main characteristic are rectangular shape, concrete border, sometimes fenced.

Irrigation pond with completely man-made structure (Canary Islands, Spain). Credits: M. Palacios

Irrigation pond in Sicily (Italy. Credits: European Commission, 2012, LUCAS

This category includes:

- Completely artificial ponds used for irrigation or industrial use deposits (sedimentation ponds, sewage ponds, storm water ponds or water ponds near ski areas used to make artificial snow).
- Other man-made liquid pools not connected with buildings or tanks.

This category excludes:

- Natural or naturalized ponds. → 9.2.1.1 *Permanent natural water bodies*
- Lakes in urban areas (parks, recreational and sport lakes) with artificial origin → 9.2.1.1 *Permanent natural water bodies*
- *Water ponds/lakes in industrial sites → 1.1.1.3 Industrial or commercial units.*
- Lakes that originate from former extractive industries→ 9.2.1.5 *Standing water bodies of extractive industrial sites*
- Fish ponds→9.2.1.4 *Intensively managed fish ponds*

Attributes:

> o   N/A

Appearance:

Artificial ponds/lakes with regular shape.
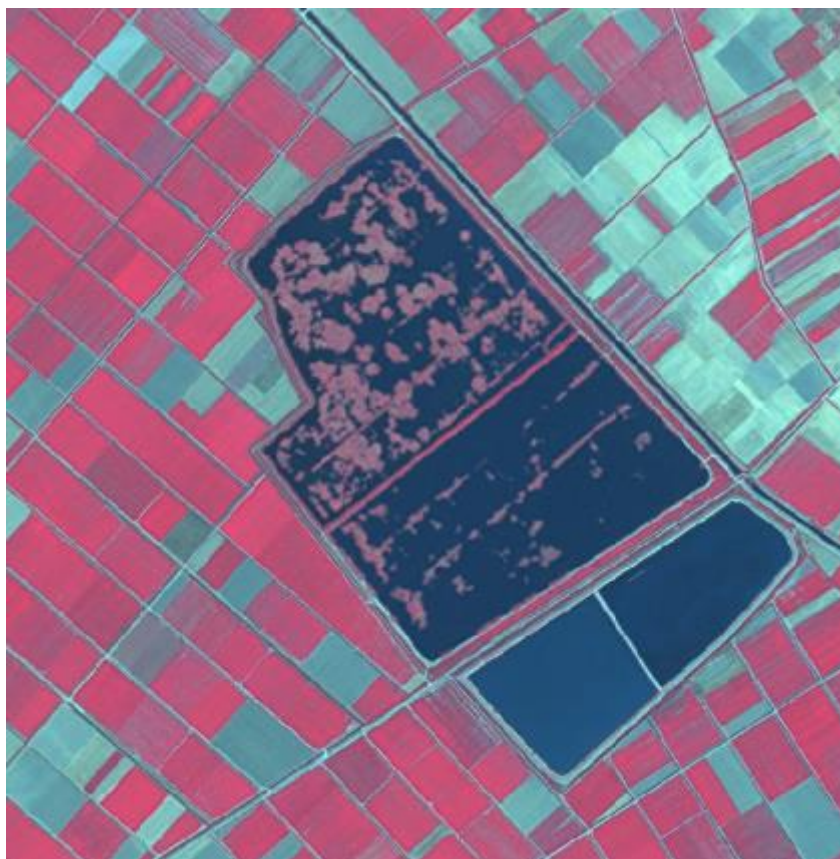
Irrigation water pond in Thessaly (Greece) SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-08-23. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Methodological approach:

- Delineation and identification using computer assisted visual interpretation HRL Water.
- Use on CLC as ancillary information

If there is no water in this completely man-made ponds, they will be mapped also as 9.1.2.3, considering their completely artificial structure and not the presence of water.

9.2.1.4 Intensively managed fish ponds

Definition:

Highly transformed controlled fresh-water ponds, artificial lakes or reservoir that is stocked with fish and is used in aquaculture for fish farming.

Fish ponds in Lubusz (Poland). Credits: Eurostat, LUCAS, 2009

This category includes:

- Highly transformed fresh-water ponds used as fish farming.

This category excludes:

- Natural water bodies used as fish farming. → 9.2.1.1 *Permanent natural water bodies.*
- Coastal water surfaces highly transformed used mainly for fish-breeding activities → 8.1.1.3 *Salines* or 8.2.1.1 *Coastal lagoons without reeds* if fish farming is included in coastal lagoons.
- Class 9.2.1.3 *Ponds and lakes with completely man-made structure.*
- Silted basins that are not used any more → map current land cover.
- Fish cages systems in lakes, reservoirs or in the sea.

Attributes:

- N/A

Water ponds with regular shape, close quarters and many small ponds. Differentiable for salines ponds due the presence in the waters of algae and the related characteristic water colour.
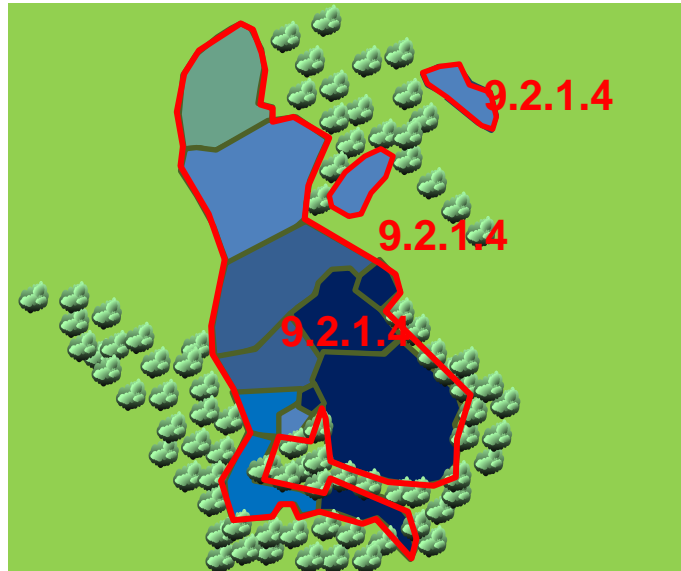
Typical pattern of fish ponds in the region of Třeboňsko (Czech Republic)

Methodological approach:

- Delineation and identification using computer assisted visual interpretation.

9.2.1.5 Standing water bodies of extractive industrial sites

Definition:

Water bodies related to active quarries, due to leaking from groundwater or rain accumulation.

Mining pond near Tornitz (Saxony-Anhalt, Germany). European Union, 2012, LUCAS

This category includes:

- Water bodies in active gravel pits.
- Water bodies associated with open pit extraction of gravel
- Decanting pools associated with mining activities.
- Toxic lake, used for disposal → 9.2.1.5 Standing water bodies of extractive industrial sites (if additional information is available indicating that the lake is used for industrial purposes – if no information is available: 9211 or 9213)

This category excludes:

- Mineral treatment pools in mine facilities whit industrial liquids and mud. → *Ponds and lakes with completely man-made structure*
- Water bodies associated to waste treatment plants. → 1.1.1.3 *Industrial or commercial units*
- *Liquid pools in industrial facilities*→ 1.1.1.3 *Industrial or commercial units*
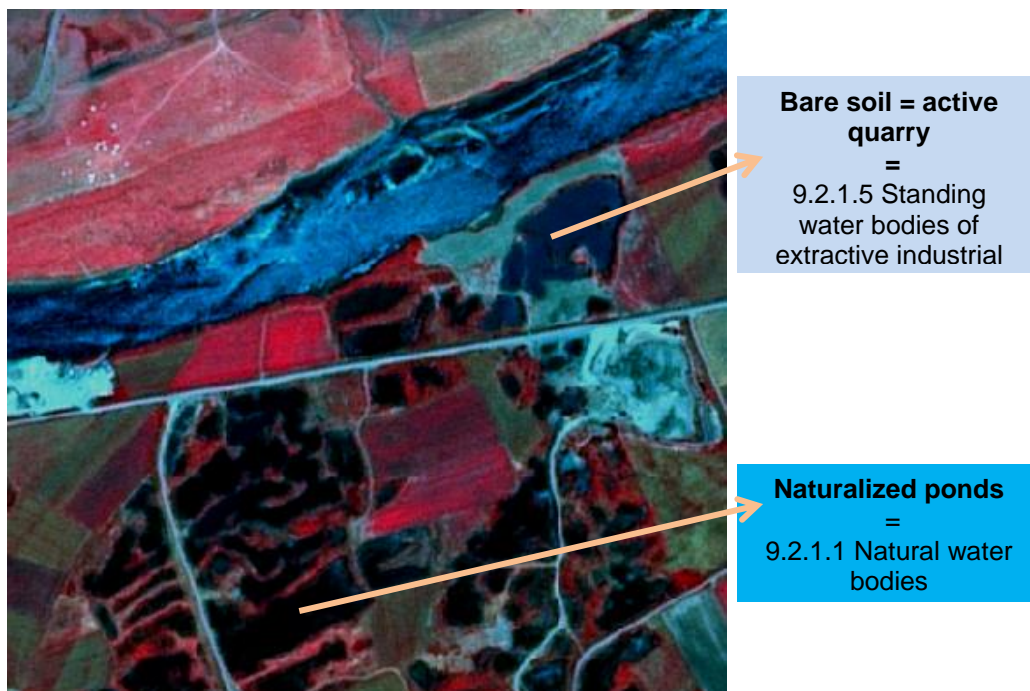
Attributes:

- N/A

*Appearance***:**

Ponds with regular shape and related with soil removal.
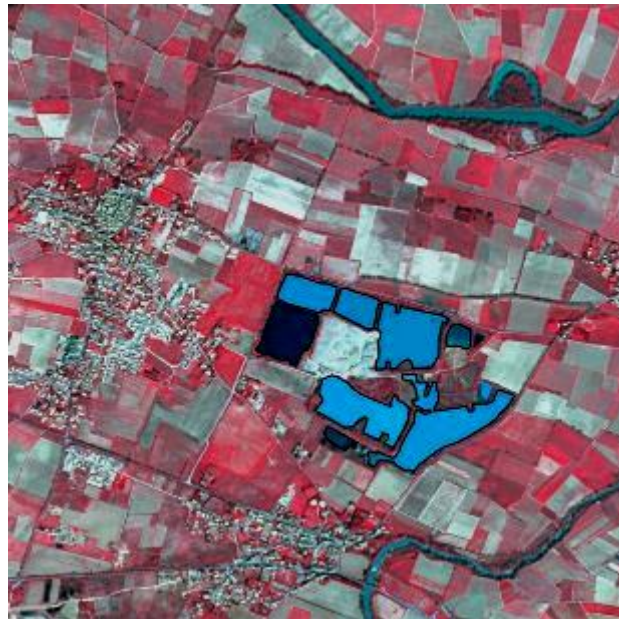
Water bodies in extraction area - Villedaigne (France) Credit: SPOT-5 (2.5 m.) (1/2/3 Band Combination). Date: 2011-03-20. Source: CNES 2011©, Distribution Airbus DS/Spot Image.

Water bodies from restored or naturalized or non-active quarries are not included in this category. The main differentiation active/non-active is based in the presence of recent removed soil around the water bodies.

Bare soil = active quarry
=
9.2.1.5 Standing water bodies of extractive industrial

Naturalized ponds
=
9.2.1.1 Natural water bodies

Water bodies in a gravel pits area - Bozbulut (Turkey) Credit: SPOT-5 (2.5 m) (1/2/3 Band Combination). Date: 2011-07-05. Source: CNES 2011©, Distribution Airbus DS/Spot

Methodological approach:

- Delineation and identification using computer assisted visual interpretation.
- Use on CLC as ancillary information.

Marine (other) consists of open sea and thus includes all marine water that is not included in the MAES class 8.2 *Marine waters* which are considered as transitional waters (8.1 *Maritime wetlands and* 8.2 *Marine waters)*. It is separated from MAES class 8.2 by the absence of fine sediment deposits (*Intertidal flats* and *Estuaries*) and is not separated from the sea (*Coastal lagoons*).

Freshwater influx deposits fine sediments that in the area between high and low watermarks form 8.1.2.1 *Intertidal flats,* and below low watermarks form 8.2.2.1 *Estuaries*. Marine (other) is located outside these fine deposits.

The Baltic Sea, the Bothnia Sea and the Gulf of Bothnia are considered Marine despite low salinity.

This category includes:

10.1 Marine (other)
      10.1.1 Marine (other)
            10.1.1.1 Marine (other)

10.1.1.1 Marine (other)

Definition

Open water areas outside the coastline.

Marine Others (Fjärdlång, Sweden). Credit: K. Larsson

Marine Others (Grinda, Sweden). Credit: K. Larsson

This category includes:

- Open water outside the coastline, including the Baltic Sea, the Bothnia Sea and the Gulf of Bothnia
- Fjords, *rias* (in Northwestern Spain) and small straits.

This category excludes:

- Sea area that is within a geometry classified as port area → 1.2.1.3 *Port areas*
- Estuaries. Estuaries are areas greatly affected by freshwater influence (> 20 m³/s) or variations of water level → 8.2.2.1 *Estuaries*
- Intertidal flats → 8.1.2. *Intertidal flats*.
- Coastal lagoons. Coastal lagoons are areas separated from the sea. These water bodies can be connected to the sea at limited points, either permanently or for parts of the year only. → 8.2.1 *Costal lagoons*

Attributes:

- N/A

Marine (other) is delineated using CLC 522 as indication and computer assisted visual interpretation. Credit imagery: Lantmäteriet, Sweden.

MAES class 10.1.1.1. Marine (other) separates from the other marine classes by the presence of fine sediment deposition (8.2.2.1) and Intertidal flats (8.1.2.1.) that are in between high and low water marks. (Sweden) (1/2/3 Band Combination). Date: 2013-07-11. Source: CNES 2011©, Distribution Airbus DS/Spot Image.
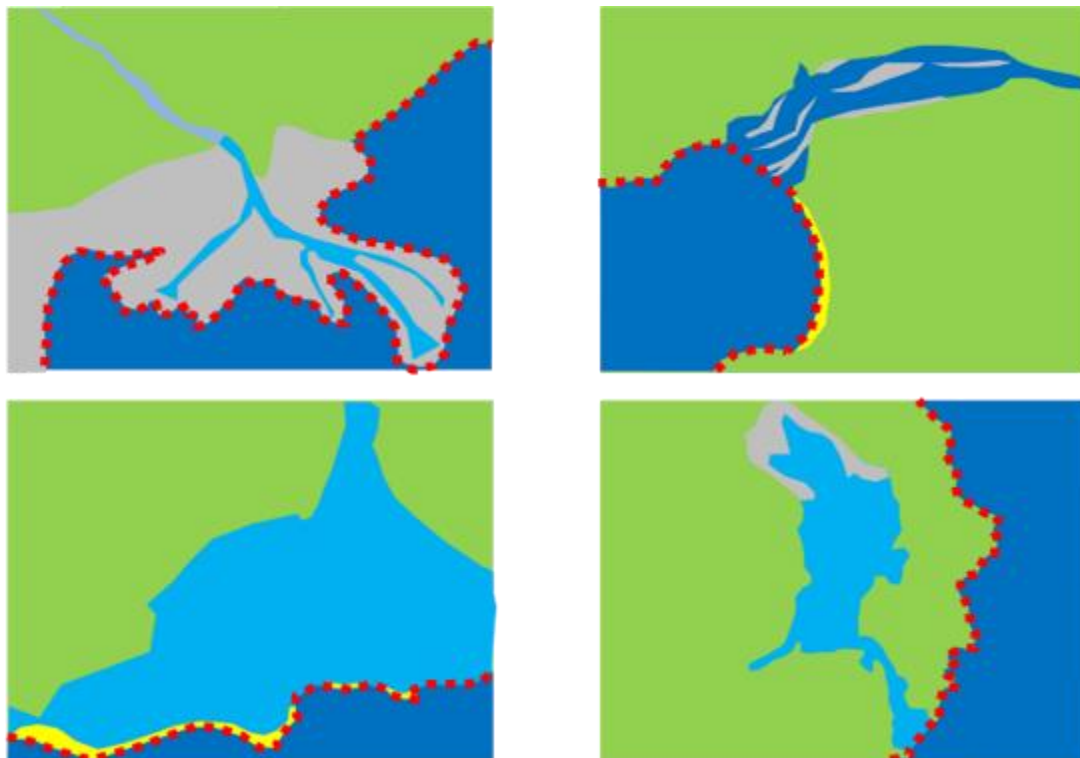
Schematic representation of 10.1 Marine class (red dot line)

Methodological approach:

- CLC class 523 (CLC 521, 522) as indication.
- Use of EU DEM as indication of coastal line.
- Use of Transitional Waters layer (European Union Framework Directive) as indication of limits between open sea and coastal wetlands/coastal lagoons/intertidal flats.
- National data (coastal line from national supporting data such as topographical maps is used as a support to define the borderline between water courses and coastal sea).
- Supporting remote sensing data and depth data to delineate from 8.2.x.x. classes.
- Computer assisted visual interpretation of SPOT-5 data.