

New Agriculture Prototypes

The prototype for agriculture is a new product that is not yet present in the HRL 2015 portfolio or part of the HRL 2018 ITT. User requirements have been gathered throughout the runtime of the ECoLaSS project which showed that there is a great interest in an agricultural HRL product, however, there are no clear requirements yet from user or stakeholder side on the specifications of such a product. The ECoLaSS prototypes consist of **crop mask** and **crop type maps** and were produced for 2 European sites: “Central” and “West” (from which the “West” demo site was further split into a Belgian and French part due to the nature of different time frames of reference data availability), and for an African demo site in Mali (see **Fehler! Verweisquelle konnte nicht gefunden werden.**). The main requirements that are being addressed are as follows:

- **Input Data:** Complete Sentinel-1 and Sentinel-2 time series of the year 2017 (Central; West: Belgian part), full time series of Sentinel-2 for 2016 (West: French part); as well as Sentinel-2 time series of the year 2017 (Mali).
- **Production:** High level automation for the classification;
- **Product definition:** New status layers Crop Mask and Crop Type Map for a potential implementation in the frame of future HRLs on pixel level at 10m spatial resolution;
- **Methodology:** Design a fully integrated SAR/optical time series analysis approach to benefit from the multi-sensor characteristics.

Based on these requirements, **two prototypes** have been developed related to a potential future HRL Agriculture as part of WP 44: a **crop mask status layer at 10m** and an **crop type status layer at 10m**. See Table 1 for further information on the sites produced in phase 1 and 2.

Table 1: Demonstration sites for the agriculture prototypes

	Prototype Grassland – Demonstration Sites						
Site	NORTH	CENTRAL	WEST	SOUTH-WEST	SOUTH-EAST	MALI	SOUTH-AFRICA
Countries	Sweden	Germany, Austria, Switzerland	Belgium, France	France, Spain	Greece, Bulgaria, Macedonia, Serbia	Mali	South-Africa
Biogeographic Region	Boreal	Continental, Alpine	Atlantic, Continental	Atlantic, Alpine, Mediterranean, Continental	Mediterranean, Continental, Alpine	Mali	South-Africa
Phase 1		X	X			X	
Phase 2		X	X			X	X

CROP MASK AND CROP TYPES

As the Agriculture Prototypes have been produced in three different sites of which one has been additionally divided into two parts, both the **input** and the **in-situ data** (used for training and validation purposes) differ depending on the location.

Due to the fact that relevant LPIS in-situ data for the French part of the West site were only available for the reference year 2016 on short-term notice, the used Sentinel-2 data are restricted to 2016 as well. Only derived spectral indices were used in combination with their temporal statistics to feed into the classifier, in order to restrict the huge volume of data for the time series. Since no SAR images covering this time

window had been foreseen to be used in ECoLaSS, and a complete re-processing of the raw archive of S-1 images was deemed too time-consuming at that stage, the process only used optical data from 2016. For the Belgian part of the West site however, the relevant LPIS data were available for 2017 so the used satellite data time series refers to the period from January 3rd to November 15th 2017. Regarding the Sentinel-2 time series the used bands are 3-8 and 11-12. Besides the optical data also SAR (Sentinel-1) data for the same period have been taken into account, namely the polarizations VV and VH.

The classification for the Central site is also based on both Sentinel-2 and Sentinel-1 data for the year 2017. Regarding the optical data the bands 2-8 and 11-12 were used for the classification and from the SAR data the relevant polarizations were also VV and VH.

Regarding the Mali site a combination of Sentinel-2 and Landsat-8 data of 2017 was used for the classification whereas SAR data was not taken into consideration. Since there is no appropriate dataset like the LPIS in Europe available for that site a team of field operators collected geotrace (polylines) and identified and encoded the crop type as well as the relative position of the field with regards to the geotrace. This data collection was used for validation and training purposes.

The chosen **classification algorithm** for all the agriculture prototypes is the **Random Forest Classifier** based on different time features (spectral and temporal) calculated on a multitemporal set of input data.

In the classification of the Belgian part of the West site optical indices (NDVI, NDWI, brightness) have been calculated in addition to the spectral Sentinel-2 bands B3-B8 and B11-B12. Regarding the Sentinel-1 input data backscattering was included. The time period considered most useful is from January to December 2017 in 2-monthly time steps.

For the French part of the West site, whose area exhibits a strong mix of cropland and intensive grasslands, NDVI, NDWI and brightness have been computed for each date, as well as their temporal statistics, among which the various percentile, the standard deviation and the median for example, over 3 periods covering 3 months each.

For the Central site, the time features have been both derived from the whole period covered by the input dataset as well as from specific time steps during this period. In order to reduce financial and timely efforts the number of time features has been reduced to a set of most relevant ones additionally by applying a forward feature selection. For the Central site the most important features are mainly derived from optical data (mostly related to the NDVI and NDWI) which were calculated over the whole period.

In contrary to the European sites the input data for the Mali site is Landsat-8 and Sentinel-2. The classification algorithm follows the Sen2Agri-system, which is based on a weighted linear interpolation performed in a first step. Afterwards 10 spectral bands of Sentinel-2 as well as the NDVI, NDWI, and brightness are calculated and used for the classification.

The classification **results** for the crop type classification within the West site (French part) have an overall accuracy of 77% with a PA of 46-96% and an UA of 49-96%. For the West site (Belgian part) the OA is approx. 92%. Regarding the Central site the OA is at 89% with an UA of 21-95% and a PA of 46-98%. The accuracies in the Mali site amount to an overall accuracy of 64-66% depending on the stratum (southern stratum, northern stratum).

Further improvements which are planned to be addressed within the second project phase are the following:

- Definition of a European classification key (~15-20 classes) which is meaningful and applied onto all the European prototype sites

- Testing of different time intervals for deriving crop types, i.e., from March until May (having winter crops in place), from March until July (having all crops in place), from March to October (covering the whole main growing season).
- Including SAR data also in the Mali and South African sites, as well as in the French part of the West site.
- Adding SAR coherence feature to the testing and determining if there is an added value or increase in accuracy, despite of the decreased spatial resolution of coherence products.

Prototype Specifications

Table 2: Product specifications for CRT_2016_010m_WE_03035_prototype_v01.tif and for CRM_2016_010m_WE_03035_prototype_v01.tif

Products	
Cropland types 2016 – CRT_2016_10m	Cropland mask 2016 – CRT_2016_10m
Extent	
Demo site West	
Geometric resolution	
Pixel resolution 10m, grid to fully conform to the EEA Reference Grid.	
Coordinate Reference System	
European ETRS89 LAEA projection	
Geometric accuracy (positioning scale)	
Less than one pixel, according to the quality report on S-2 products	
Thematic accuracy	
77% of overall accuracy	
Data type	
8bit unsigned Raster, compressed with LZW	
Minimum mapping unit (MMU)	
One pixel (10m)	
Necessary attributes	
Raster value, count, class name,	
Raster coding (Thematic pixel values)	
Cropland types 2016 – CRT_2016_10m 0: Other Land cover (settlements, forest, grassland and water) 11: Winter Wheat 31: Winter Barley 40: Spring Cereals 61: Peas 71: Winter Rape 81: Maize 91: Agrarian grassland 101: Beets 131: Potatoes 141: Fallow 151: Linen 161: Chicory	Cropland mask 2016 – CRM_2016_10m 0: Non-cropland 1: Cropland mask 254: unclassifiable (no satellite image available, or clouds, shadows, or snow) 255: outside Area





































254: unclassifiable (no satellite image available, or clouds, shadows, or snow)					
255: outside Area					
Metadata					
XML metadata files are to be produced according to INSPIRE metadata standards					
Delivery format					
GeoTIFF					
Cropland type 2016 – CRM_2016_10m					
Class Code	Class Name	Red	Green	Blue	
0	Other Land Cover	240	240	240	
11	Winter Wheat	195	160	215	
31	Winter Barley	115	70	165	
40	Spring Cereals	255	125	125	
61	Peas	0	170	135	
71	Winter Rape	255	255	0	
81	Maize	255	175	0	
91	Agrarian Grassland	150	230	0	
101	Beets	115	0	75	
131	Potatoes	255	215	100	
141	Fallow	75	115	0	
151	Linen	115	75	0	
161	Chicory	205	105	155	
254	unclassifiable (no satellite image available, or clouds, shadows, or snow)	153	153	153	
255	outside Area	0	0	0	
Cropland mask 2016 – CRM_2016_10m					
Class Code	Class Name	Red	Green	Blue	
0	Non- Cropland	240	240	240	
1	Cropland Mask	245	225	45	
254	unclassifiable (no satellite image available, or clouds, shadows, or snow)	153	153	153	
255	outside Area	0	0	0	

Table 3: Product specifications for CRT_2017_010m_WE_03035_prototype_v01.tif

Products
Cropland types 2017 : CRT_2017_010m_WE_03035_prototype_v01.tif
Extent
Demo site West
Geometric resolution
Pixel resolution 10m, grid to fully conform to the EEA Reference Grid.
Coordinate Reference System
European ETRS89 LAEA projection

Geometric accuracy (positioning scale)					
Less than one pixel, according to the quality report on S-2 products					
Thematic accuracy					
More than 90% of Overall Accuracy					
Data type					
8bit unsigned Raster, compressed with LZW					
Minimum mapping unit (MMU)					
One pixel (10m)					
Necessary attributes					
Raster value, count, class name,					
Raster coding (Thematic pixel values)					
Cropland types 2017 – CRT_2017_10m					
0: Other Land cover		13: Peas			
1: Grassland		14: Summer Barley			
2: Winter Wheat		15: Summer Cereals			
3: Maize		16: Chicory			
4: Winter Barley		17: Winter Cereals			
5: Sugar Beet		18: Summer Wheat			
6: Spelt		19: Hemp			
7: Rapeseed		20: Green Beans			
8: Potato		21: Onions			
9: Flax		22: Fruit Crops			
10: Summer Oat		23: Other Crops			
11: Other Vegetables		24: Grape Vines			
12: Other Fodder					
Metadata					
XML metadata files are to be produced according to INSPIRE metadata standards					
Delivery format					
GeoTIFF					
Cropland type 2016 – CRM_2016_10m					
Class Code	Class Name	Red	Green	Blue	
0	Other Land Cover	240	240	240	
1	Grassland	150	230	0	
2	Winter Wheat	195	160	215	
3	Maize	255	175	0	
4	Winter Barley	115	70	165	
5	Sugar Beet	115	0	75	
6	Spelt	91	91	180	
7	Rapeseed	255	255	0	
8	Potato	255	215	100	
9	Flax	115	75	0	
10	Summer Oat	255	203	203	
11	Other Vegetables	104	147	21	
12	Other Fodder	192	29	136	
13	Peas	0	170	135	
14	Summer Barley	164	39	39	
15	Summer Cereals	255	125	125	










16	Chicory	205	105	155	
17	Winter Cereals	245	227	255	
18	Summer Wheat	220	79	79	
19	Hemp	210	135	35	
20	Green Beans	0	103	83	
21	Onions	193	150	27	
22	Fruit Crops	108	162	194	
23	Other Crops	52	80	0	
24	Grape Vines	23	86	123	

Table 4: Product specifications and color palette for CRT_2017_010m_ML_32630_prototype_v01.tif

Products
Cropland types 2017 – CRT_2017_10m CRT_2017_010m_ML_32630_prototype_v01.tif
Extent
Demo site MALI
Geometric resolution
Pixel resolution 10m, grid to fully conform to the EEA Reference Grid.
Coordinate Reference System
WGS84 – UTM zone 30 South
Geometric accuracy (positioning scale)
Less than one pixel, according to the quality report on S-2 products
Thematic accuracy
>90% of overall accuracy
Data type
8bit unsigned Raster, compressed with LZW
Minimum mapping unit (MMU)
One pixel (10m)
Necessary attributes
Raster value, class name
Raster coding (Thematic pixel values)
0: Non-Cropland 1: Millet 2: Sorghum 3: Cotton 4: Maize 5: Other Crops 6: Groundnuts 7: Rice
Metadata
XML metadata files are to be produced according to INSPIRE metadata standards
Delivery format
GeoTIFF
Cropland type 2016 – CRM_2016_10m









Class Code	Class Name	Red	Green	Blue	
0	Non-Cropland	0	0	0	
1	Millet	164	89	20	
2	Sorghum	139	26	26	
3	Cotton	151	255	255	
4	Maize	255	76	0	
5	Other Crops	163	163	163	
6	Groundnuts	162	205	90	
7	Rice	95	158	160	



Table 5: Product Specifications an color palette for CRT_2017_010m_CE_03035_prototype_v01.tif

Crop Type 10m	Acronym	Product category
	CRT	Primary Status Layer
Reference year 2017		
Extent Demonstration site Central		
Geometric resolution Pixel resolution 10m x 10m, fully conform to the EEA reference grid.		
Coordinate Reference System European ETRS89 LAEA projection		
Geometric accuracy (positioning scale) Less than one pixel. According to ortho-rectified satellite image base delivered by ESA.		
Thematic accuracy 85%		
Data type 8bit unsigned Raster, with LZW compression		
Minimum mapping unit (MMU) Pixel-based (no MMU)		
Necessary attributes Raster value, count, class name, area (in km2), area percentage (taking outside area not into account)		
Raster coding (Thematic pixel values) 0: Non-cropland 1: Agrarian Grassland 3: Fallow 5: Fruit Trees 8: Legume 9: Maize 10: Others 11: Potatoes		

13: Strawberries 14: Sugar Beets 15: Summer Crop 16: Summer Rape 17: Sunflowers/Topinambour 18: Vegetables 19: Winegrowing 20: Winter Crop 21: Winter Rape 255: Outside area						
Metadata XML metadata files are to be produced according to INSPIRE metadata standards						
Delivery format GeoTIFF						
Colour Table ArcGIS *.clr format						
Class Code	Class Name	Red	Green	Blue		
0	Non-cropland	240	240	240		
1	Agrarian Grassland	0	82	0		
3	Fallow	97	184	255		
5	Fruit Trees	171	63	204		
8	Legume	112	81	75		
9	Maize	255	255	0		
10	Others	38	38	38		
11	Potatoes	196	188	179		
13	Strawberries	255	46	46		
14	Sugar Beets	0	247	206		
15	Summer Crop	255	0	255		
16	Summer Rape	255	149	0		
17	Sunflowers/Topinambour	255	250	204		
18	Vegetables	128	255	0		
19	Winegrowing	250	145	180		
20	Winter Crop	204	179	102		
21	Winter Rape	114	115	80		
255	Outside Area	0	0	0		

Table 6: Product Specifications and color palette for CRM_2017_010m_CE_03035_prototype_v01.tif

Crop Mask 10m	Acronym CRM	Product category Primary Status Layer
----------------------	-----------------------	---

Reference year						
2017						
Reference year						
2017						
Extent						
Demonstration site Central						
Geometric resolution						
Pixel resolution 10m x 10m, fully conform to the EEA reference grid.						
Coordinate Reference System						
European ETRS89 LAEA projection						
Geometric accuracy (positioning scale)						
Less than one pixel. According to ortho-rectified satellite image base delivered by ESA.						
Thematic accuracy						
90%						
Data type						
8bit unsigned Raster, with LZW compression						
Minimum mapping unit (MMU)						
Pixel-based (no MMU)						
Necessary attributes						
Raster value, count, class name, area (in km2), area percentage (taking outside area not into account)						
Raster coding (Thematic pixel values)						
0: Non-cropland						
1: Cropland						
255: Outside area						
Metadata						
XML metadata files are to be produced according to INSPIRE metadata standards						
Delivery format						
GeoTIFF						
Colour Table						
ArcGIS *.clr format						
Class Code	Class Name	Red	Green	Blue		
0	Non-cropland	240	240	240		
1	Cropland	0	82	0		
255	Outside Area	0	0	0	