

## Horizon 2020

Space Call - Earth Observation: EO-3-2016: Evolution of Copernicus services

Grant Agreement No. 730008

# ECoLaSS

Evolution of Copernicus Land Services based on Sentinel data



## Technical Document

### Comparison of Copernicus Land Monitoring Service HRLs and ECoLaSS Prototypes

#### ECoLASS CONSORTIUM:



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Table 1: Comparison of Technical Specifications for the Imperviousness Status Layer (HRL2015, HRL2018, ECoLaSS)

Technical Specifications for IMPERVIOUSNESS Status Layer			
	HRL2015	HRL2018	ECoLaSS
<b>Input Data</b>	IRS-P6/Resourcesat-2 LISS-III, SPOT 5 and Landsat 8	Sentinel-1/-2, IMAGE2018 VHR	Sentinel-1/-2
<b>Reference Year</b>	2015 +/- 1 year	2017 and 2018	2017 (2018 in second project phase)
<b>Geometric resolution</b>	20m x 20m	10m x 10m	10m x 10m
<b>MMU</b>	20m	10m	10m
<b>MMW</b>	20m	10m	10m
<b>Thematic Classes</b>	Thematic classes:  0: all non-impervious areas 1-100: imperviousness values 254: unclassifiable 255: outside area	Thematic classes:  0: all non-impervious areas 1-100: imperviousness values 254: unclassifiable 255: outside area	Thematic classes:  0: all non-impervious areas 1-100: imperviousness values 254: unclassifiable 255: outside area
<b>Format</b>	GeoTIFF	GeoTIFF	GeoTIFF
<b>Thematic accuracy</b>	Minimum 90% user's / producer's accuracy	Minimum 90% user's / producer's accuracy	90% user's / producer's accuracy
<b>Applied methodology</b>	Supervised classification of built-up/non built-up areas with subsequent visual improvement of classification results and derivation of degree of imperviousness based on continuous multi-temporal seasonal image composites (see Technical Specifications of HRL2015 product).	tbd	Application of supervised machine learning methods.

**Table 2: Comparison of Technical Specifications for the Imperviousness Change Layer (HRL2015, HRL2018, ECoLaSS)**

Technical Specifications for IMPERVIOUSNESS Change Layer			
	HRL2015	HRL2018	ECoLaSS
<b>Input Data</b>	IRS-P6/Resourcesat-2 LISS-III, SPOT 5 and Landsat 8	Sentinel-1/-2, IMAGE2018 VHR, IRS-P6/Resourcesat-2 LISS-III, SPOT 5 and Landsat 8	Sentinel-1/-2
<b>Reference Year</b>	2012 - 2015	2015 and 2018	2015/16 – 2017 (2018 in second project phase)
<b>Geometric resolution</b>	20m x 20m	20m x 20m	20m x 20m
<b>MMU</b>	20m	20m	20m
<b>MMW</b>	20m	20m	20m
<b>Thematic Classes</b>	Thematic classes (3 years):  0-99: decrease (0 = 100% decrease, 99 = 1% decrease) 100: stable built-up 101-200: increase (101 = 1% increase, 200 = 100% increase) 201: stable non built-up 254: unclassifiable 255: outside area	8 thematic classes (3 years):  0: unchanged areas with imperviousness degree of 0 1: new cover - increased imperviousness density, zero IMD at first reference date 2: loss of cover - decreasing imperviousness density, zero IMD at second reference date 10: unchanged areas, IMD>0 at both reference date 11: increased imperviousness density, IMD>0 at both reference date 12: decreased imperviousness density, IMD>0 at both reference date 254: unclassifiable in any of parent status layers 255: outside area	8 thematic classes (yearly):  0: unchanged areas with imperviousness degree of 0 1: new cover - increased imperviousness density, zero IMD at first reference date 2: loss of cover - decreasing imperviousness density, zero IMD at second reference date 10: unchanged areas, IMD>0 at both reference dates 11: increased imperviousness density, IMD>0 at both reference dates 12: decreased imperviousness density, IMD>0 at both reference dates 254: unclassifiable in any of parent status layers 255: outside area
<b>Format</b>	GeoTIFF	GeoTIFF	GeoTIFF
<b>Thematic accuracy</b>	90% user's / producer's accuracy of derived IMD changes	90% user's / producer's accuracy of derived IMD changes	90% user's / producer's accuracy for derived IMD changes
<b>Applied methodology</b>	To derive the Imperviousness 2012-2015 layers, the respective IMD status layers are subtracted from each other after considering a rule based adaptation of the historical layers. The classified change is derived by aggregating the	tbd	The change based on HRL IMD 2017 resampled to 20m and IMD 2015 from HRL 2015; direct subtraction of the 20m imperviousness values; spatial filtering to take into account the different specifications; conversion of the derived

	<p>IMD change values in specified change classes. The final result are raster datasets of imperviousness degree change including change values from -100 to 100 and raster datasets of classified imperviousness change including defined classes as unchanged areas, new cover, loss of cover, and imperviousness degree increase and decrease (see Technical Specifications of HRL2015 product).</p>		<p>change layer into a 'classified change' layer. Continuous change values are thematically aggregated into the defined change classes.</p>
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**Table 3: Comparison of Technical Specifications for the Forest Status Layer (HRL2015, HRL2018, ECoLaSS)**

<b>Technical Specifications for FOREST Status Layer (Dominant Leaf Type)</b>			
	<b>HRL2015</b>	<b>HRL2018</b>	<b>ECoLaSS</b>
<b>Input Data</b>	Sentinel-2, Landsat 8, SPOT-5, ResourceSat-2, HR_IMAGE_2015	Sentinel-1/-2 (Landsat)	Sentinel-2
<b>Reference Year</b>	2015 +/- 1 year	2017 and 2018	2017 (2018 in second project phase)
<b>Geometric resolution</b>	20m x 20m	10m x 10m	10m x 10m
<b>MMU</b>	20m	20m	10m
<b>MMW</b>	20m	20m	10m
<b>Thematic Classes</b>	5 thematic classes:  0: all non-tree covered areas 1: broad leaved trees 2: coniferous trees 254: unclassifiable (no satellite image available, or clouds, shadows, or snow) 255: outside area	5 thematic classes:  0: all non-tree covered areas 1: broad leaved trees 2: coniferous trees 254: unclassifiable (no satellite image available, or clouds, shadows, or snow) 255: outside area	5 thematic classes:  0: all non-tree covered areas 1: broadleaved trees 2: coniferous trees 254: unclassifiable (no satellite image available, or clouds, or shadows) 255: outside area
<b>Format</b>	GeoTIFF	GeoTIFF	GeoTIFF
<b>Thematic accuracy</b>	Minimum 90% user's / producer's accuracy for both, broadleaved and coniferous class	Minimum 90% user's / producer's accuracy for both of broadleaved / coniferous class	Minimum 90% user's / producer's accuracy
<b>Applied methodology</b>	Supervised classification and manual enhancement.	tbd	Random Forest (RF) based classification; application of spatio-temporal input features capturing important time series properties and patterns.

**Table 4: Comparison of Technical Specifications for the Forest Change Layer (HRL2015, HRL2018, ECoLaSS)**

Technical Specifications for FOREST Change Layer (Tree cover change)			
	HRL2015	HRL2018	ECoLaSS
<b>Input Data</b>	Sentinel-2, Landsat 8, SPOT-5, ResourceSat-2, HR_IMAGE_2015	Sentinel-1/-2 (Landsat 8, SPOT-5, ResourceSat-2, HR_IMAGE_2015)	Sentinel-2
<b>Reference Year</b>	2012 (+/- 1 year) to 2015 (+/- 1 year)	2015-2018	2015/16 – 2017 (2018 in second project phase)
<b>Geometric resolution</b>	20m x 20m	20m x 20m	20m x 20m
<b>MMU</b>	1 ha (25 pixels) for detected changes; plus additional 1 ha (25 pixels) boundary filter	20m	3 ha
<b>MMW</b>		20m	
<b>Tree cover density threshold</b>	30%		
<b>Thematic Classes</b>	<p><b>Dominant Leaf Type Change (3 years):</b></p> <p>0: unchanged areas with no tree cover</p> <p>1: new broadleaved cover - increased tree cover density</p> <p>2: new coniferous cover - increased tree cover density</p> <p>3: loss of broadleaved cover - decreased tree cover density</p> <p>4: loss of coniferous cover - decreased tree cover density</p> <p>10: unchanged areas with tree cover</p> <p>11: increased broadleaved cover density</p> <p>22: increased coniferous cover density</p> <p>33: decreased broadleaved cover density</p> <p>44: decreased coniferous cover density</p> <p>120: broadleaved changed to coniferous</p> <p>210: coniferous changed to broadleaved</p> <p>254: unclassifiable in any of parent</p>	<p><b>Tree Cover Change Mask (3 years):</b></p> <p>0: unchanged areas with no tree cover</p> <p>1: new tree cover</p> <p>2: loss of tree cover</p> <p>10: unchanged areas with tree cover</p> <p><b>Dominant Leaf Type Change (3 years):</b></p> <p>0: unchanged areas with no tree cover</p> <p>1: new broadleaved cover - increased tree cover density</p> <p>2: new coniferous cover - increased tree cover density</p> <p>3: loss of broadleaved cover - decreased tree cover density</p> <p>4: loss of coniferous cover - decreased tree cover density</p> <p>10: unchanged areas with tree cover</p> <p>120: broadleaved changed to coniferous</p> <p>210: coniferous changed to broadleaved</p> <p>254: unclassifiable in any of parent status layers</p> <p>255: outside area</p>	<p><b>Forest Cover Change mask (yearly):</b></p> <p>0: all non-tree covered areas in 2015</p> <p>10: unchanged tree cover in 2015</p> <p>11: forest regrowth (not relevant for this implementation of the TCC)</p> <p>12: forest loss</p> <p>254: unclassifiable (no satellite image available, or clouds, or shadows)</p> <p>255: outside area</p>

	status layers 255: outside area		
<b>Format</b>	GeoTIFF	GeoTIFF	GeoTIFF
<b>Thematic accuracy</b>	85% per biogeographic region	90% user's / producer's accuracy of derived changes	80-85% overall accuracy
<b>Applied methodology</b>	The layer is derived based on the primary status layers Tree Cover Density and Dominant Leaf Type for both time steps. It has a noise filter applied to address geometric, radiometric as well as phenological differences between the reference years 2012 and 2015. Changes in the tree cover extent and leaf type are indicated, if the difference between TCD 2012 and 2015 products is exceeded by the defined significance threshold of 30% within the MMU.	tbd	Comparison of a pre- and post-change tree cover mask by map-to-map change detection.

**Table 5: Comparison of Technical Specifications for the Grassland Status Layer (HRL2015, HRL2018, ECoLaSS)**

Technical Specifications for GRASSLAND Status Layer			
DATA SET	HRL2015	HRL2018	ECoLaSS
<b>Input Data</b>	Sentinel-1/-2, Landsat	Sentinel-1/-2, Landsat	Sentinel-1/-2,
<b>Reference Year</b>	2015 +/- 1 year	2017 and 2018	2017 (2018 in second project phase)
<b>Geometric resolution</b>	20m x 20m	10m x 10m	10m x 10m
<b>MMU</b>	1 ha	10m	1 ha
<b>MMW</b>		10m	
<b>Thematic Classes</b>	4 thematic classes:  0: all non-grass areas 1: grassy and non-woody vegetation 254: unclassifiable (no satellite image available, or clouds, shadows, or snow) 255: outside area	4 thematic classes:  0: all non-grass areas 1: grassy and non-woody vegetation 254: unclassifiable (no satellite image available, or clouds, shadows, or snow) 255: outside area	4 thematic classes:  0: all non-grass areas 1: Grassy and non-woody vegetation 254: unclassifiable (no satellite image available, or clouds, or shadows) 255: outside area
<b>Format</b>	GeoTIFF	GeoTIFF	GeoTIFF
<b>Thematic accuracy</b>	85% per biogeographic region	85% per biogeographic region	85% overall
<b>Applied methodology</b>	Automated iterative image segmentation of the pre-selected image data base; semi-automatic land cover classification with supervised and unsupervised elements; rule-based intersection of optical and SAR-based grassland classification results and bare soil masks to derive the final grassland mask (see Technical Specifications of the HRL2015 product).	Full use of Sentinel-1/2 data base; semi-automatic land cover classification with supervised and unsupervised elements; application of time-series analysis.	Multi-sensor data integration; multi-temporal SAR and optical metrics; multi-seasonal features; application of machine learning algorithms (Random Forest).



**Table 6: Comparison of Technical Specifications for the Grassland Change Layer (HRL2015, HRL2018, ECoLaSS)**

Technical Specifications for GRASSLAND Change Layer			
DATA SET		HRL2018	ECoLaSS
<b>Input Data</b>		Sentinel-1/-2, Landsat	Sentinel-1/2
<b>Reference Year</b>		2014/15/16 and 2018	tbd
<b>Geometric resolution</b>		20m x 20m	tbd
<b>MMU</b>		20m	tbd
<b>MMW</b>		20m	tbd
<b>Thematic Classes</b>		Thematic classes (3 years):  0: all non-grass areas 1: new grassland 2: loss of grassland 10: unchanged grassland in both years 254: unclassifiable (no satellite image available, or clouds, shadows, or snow) 255: outside area	Thematic classes (yearly):  tbd
<b>Format</b>		GeoTIFF	GeoTIFF
<b>Thematic accuracy</b>		tbd	tbd
<b>Applied methodology</b>		tbd	tbd