Improved Imperviousness Prototypes

The prototypes for IMP are based on the existing HRL2015 IMP product definitions with further improvements taking into account the user requirements, that have been addressed as follows:

- **Input data:** Use of one-year coverage only, from optical (combination of S-2A and S-2B) and SAR (combination of S-1A and S-1B) data for 2017, to head towards a yearly update
- **Production:** Improved level of automation for faster production, related to the latter point
- **Product definition:** Improved thematic accuracy; full use of the spatial resolution of S-1 and S-2 sensors, from 20 to 10m; refined change detection to capture the omission of the previous layers – expected with such improvement on spatial resolution – for the change layer;
- **Methodology:** Integration of SAR data into the time series analysis, in particular to tackle the issue of cloud coverage.

Two prototypes have been developed as part of the WP 42: an **improved imperviousness binary mask (IMP) status layer at 10 m**, and an **incremental change layer** between the HRL2015 status layer at 20m resolution and the new status layer for 2017 at 10m resolution, forcing the production of the change layer at 20m. The respective sites used for testing and demonstration are listed in **Fehler! Verweisquelle konnte nicht gefunden werden.** below.

Table 1: Demonstration sites for the imperviousness prototypes

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

Improved Imperviousness binary mask (IMP) based on a computation of the Imperviousness Degree (IMD):

This layer is already well integrated into the HRL portfolio, but for the year 2017, a 10m spatial resolution has been produced over the South-West site in Phase I, while a new iteration with the same characteristics over the same site will be produced in Phase II as well as over the Central site and the South-East site.
As **input data**, S-1 and S-2 time series were used to create the layer both spanned from January 2017 to November 2017. **Ancillary data** from Open Street Map, the HRL 2015 and Google Earth have been incorporated in the processing chain. **Temporal statistics** have been computed for the SAR time series based on the polarization bands VV and VH, from which monthly means and yearly maximum, minimum, mean and standard deviation have been derived. For the optical time series, the yearly maximal NDVI as well as the Haar attribute profiles and the results of a Soble filtering have been computed based on all spectral bands. An automated **supervised classification using active learning** has produced the initial built-up mask for 2017 based solely on S-2 datasets. An attempt at merging those results with S-1 classifications using **SVM algorithms** has led to a degraded result. Therefore, SAR data has been set aside for the 2017 production, whose producer´s accuracy (PA) reached 92.37% and user´s accuracy (UA) 85.07% without any manual enhancement.

In **Phase 2,** further investigations are undertaken to enhance the results and the efficiency of the classifiers. A multi-sourcing approach will be explored with not only one sensor, Sentinel-2, but also other sensors including Sentinel-1. New metrics related to the SAR time series could be introduced to this end.

THE IMPERVIOUSNESS CHANGE (IMC) LAYER:

This layer is well integrated into the HRL portfolio. In Phase 1, a first improvement on the spatial resolution has been undergone from 100 m to 20 m over the South-West site, while a new iteration will be produced in Phase 2 for the sites South-West, Central and South-East to demonstrate the transferability of the automated production. The change detection procedure has been refined as well.
The **datasets used for change detection** were the IMP 2015 layer and the IMP 2017. The dataset applied for the **calibration** has been produced using photo-interpretation done with Google Earth. A **reclassification** of the change stratum based on spatial statistics and probability map led to the creation of the pixel-based change layer for 2015-2017.

In **Phase 2**, it is envisioned to apply this change detection procedure to generate a new change layer that will quantify the loss or gain in imperviousness degree, between 2017 and 2018.

Prototype Specifications

Table 2: Detailed specifications for the improved primary status layer Imperviousness 2017

Imperviousness Degree 10m	**Acronym** IMD	**Product category** Improved Primary Status Layer
Reference year 2017		
Extent Demonstration site South-West		
Geometric resolution Pixel resolution 10m x 10m, fully conform with the EEA reference grid		
Coordinate Reference System European ETRS89 LAEA projection		
Geometric accuracy (positioning scale) Less than half a pixel. According to ortho-rectified satellite image base delivered by Theia.		
Thematic accuracy Minimum 90% user's / producer's accuracy in general for status layers for a (derived) built-up/non built up map. Threshold to be applied in transforming imperviousness to built-up mask at 1%.		
Data type 8bit unsigned integer raster with LZW compression		
Minimum Mapping Unit (MMU) Pixel-based (no MMU)		
Necessary attributes Raster value, count, class name		
Raster coding (thematic pixel values) 0: all non-impervious areas		

1-100: imperviousness values

254: unclassifiable (no satellite image available, or clouds, or shadows)

255: outside area

Metadata

XML metadata files according to INSPIRE metadata standards

Delivery format

GeoTIFF

Colour table

ArcGIS *.clr format

Class Code	Class Name	Red	Green	Blue	
0	all non-impervious areas	240	240	240	
1	1% imperiousness value	255	237	195	
50	50% imperiousness value	175	74	51	
100	100% imperiousness value	113	12	2	
254	unclassifiable (no satellite image available, or clouds, or shadows)	153	153	153	
255	outside area	0	0	0	

Table 3: Detailed specifications for the Incremental Update Layer Imperviousness Change Classified

Imperviousness Change Classified 20m	**Acronym** IMC	**Product category** Incremental Update Layer

Reference year

2015/16-2017

Extent

Demonstration site South-West

Geometric resolution

Pixel resolution 20m x 20m, fully conform with the EEA reference grid

Coordinate Reference System

European ETRS89 LAEA projection

Geometric accuracy (positioning scale)

Less than half a pixel. According to ortho-rectified satellite image base delivered by Theia.

Thematic accuracy

90% user's / producer's accuracy for derived IMD changes

Data type

8bit unsigned integer raster with LZW compression

Minimum Mapping Unit (MMU)

Pixel-based (no MMU)

Necessary attributes

Raster value, count, class name

Raster coding (thematic pixel values)

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

Metadata

XML metadata files according to INSPIRE metadata standards

Delivery format

GeoTIFF

Colour table

ArcGIS *.clr format

Class Code	Class Name	Red	Green	Blue	
0	unchanged areas with imperviousness degree of 0	240	240	240	
1	new cover - increased imperviousness density, zero IMD at first reference date	255	0	0	
2	loss of cover - decreasing imperviousness density, zero IMD at second reference date	0	100	0	
10	unchanged areas, IMD>0 at both reference dates	156	156	156	
11	increased imperviousness density, IMD>0 at both reference dates	255	191	0	
12	decreased imperviousness density, IMD>0 at both reference dates	64	178	0	
254	unclassifiable in any of parent status layers	153	153	153	
255	outside area	0	0	0	