

production de couches HR à partir d'analyse automatique multi-temporelle d'images

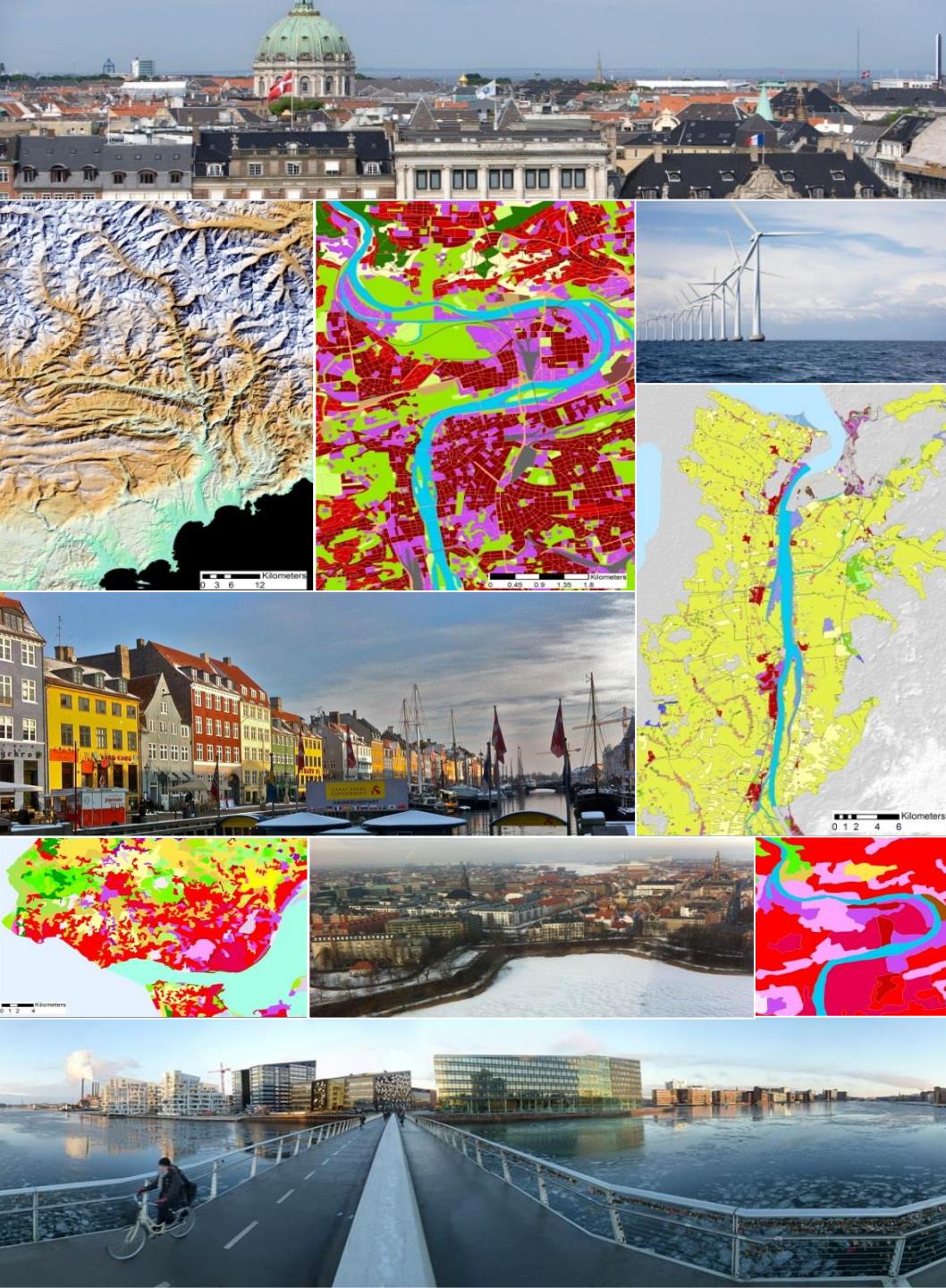
Christophe SANNIER
Directeur Scientifique

SIRS SAS

Paris La Défense, 14 Mars 2018



European Environment Agency





Land
Monitoring

Introduction – HRL 2015

Production High Resolution Layers (HRLs) 2015

Copernicus Land Monitoring Service

5 Lots – updated & new HRLs:

- Lot 1: Imperviousness (IMP)
- Lot 2: Forest (FOR)
- Lot 3: Grassland (GRA)
- Lot 4: Water/Wetness (WaW)
- Lot 5: Small Woody Features (SWF)

Consortium:

- GAF: **Lead (FOR & GRA)**
- GeoVille: **Lead (IMP & WaW)**
- SIRS: **Lead (SWF)**
- e-Geos: Partner (GRA)

Framework:

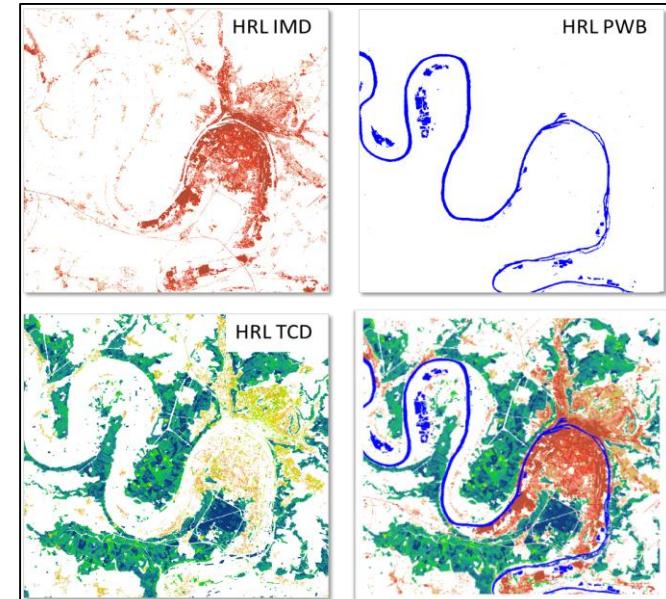
European Environment Agency (EEA) tender No EEA/IDM/R0/16/003:
"Copernicus Land monitoring services – High Resolution land cover characteristics for the 2015 reference year"

European Environment Agency



Time Plan:

Sep 2016 – Aug 2018



HRLs 2012: IMP, PWB, FOR (TCD)

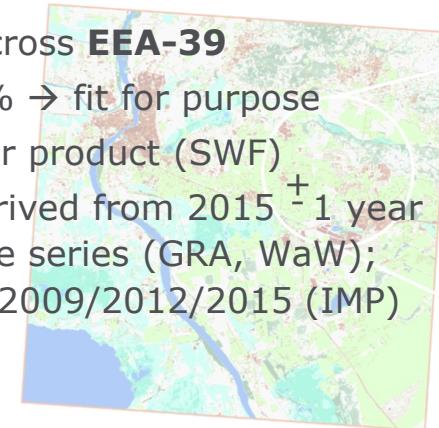


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Introduction – HRL 2015

Requirements:

- **Consistent and harmonized** products across **EEA-39**
- **Thematic accuracies:** exceeding 85–90% → fit for purpose
- **20 m** high spatial resolution/1:5000 vector product (SWF)
- **Reference year 2015 status layers:** derived from 2015 ± 1 year (IMP, FOR, GRA, SWF) and multi-year time series (GRA, WaW);
Change layers: 2012/2015 (FOR), 2006/2009/2012/2015 (IMP)



Key Challenges:

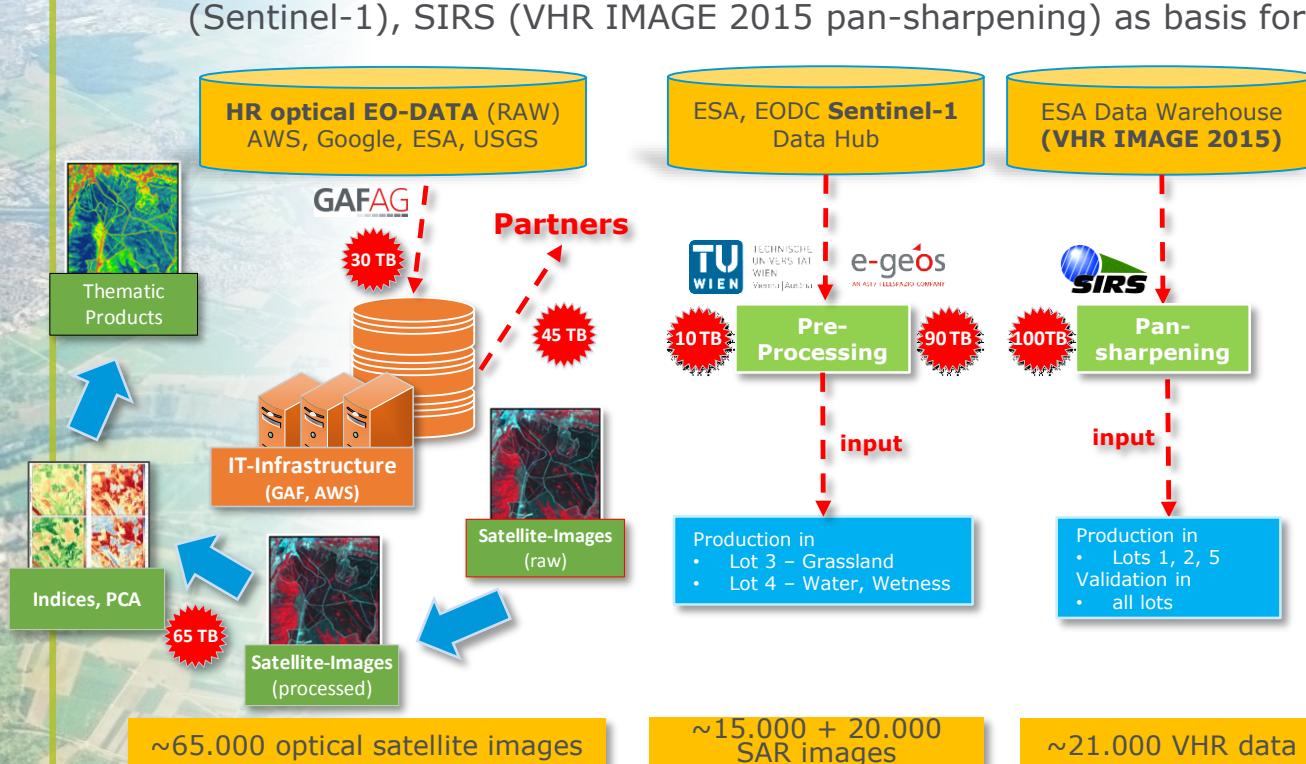
- **Multi-temporal** image processing → from bi-yearly to time series
- Large **data volumes** from different sensors (**8 x optical & 2 x SAR**)
- **Novel product** development, as well as **complex change** products
- Integration of **regional knowledge/in-situ data** while preserving European consistency
- High level of **automation** required for demanding quality & timing challenge
- Targeted production time frame: **1 to 1.5 years**





Pre-Processing

Automated pre-processing chains developed by GAF AG (optical HR data), e-Geos and TU Vienna (Sentinel-1), SIRS (VHR IMAGE 2015 pan-sharpening) as basis for production of the **five HRLs**



Highlights

Different automated pre-processing chains: e.g. for HR optical satellite data from various sensors (Sentinel-2, Landsat-5, -7, -8, SPOT-4, -5, Resourcesat-2, IRS-P6) incl. download, import, cloud/ shadow masking, ToA, geometric validation and correction, topographic normalization, image transformations, indices), parallelised and scalable processing in hybrid cloud environment



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Imperviousness (IMP)

Products (40):

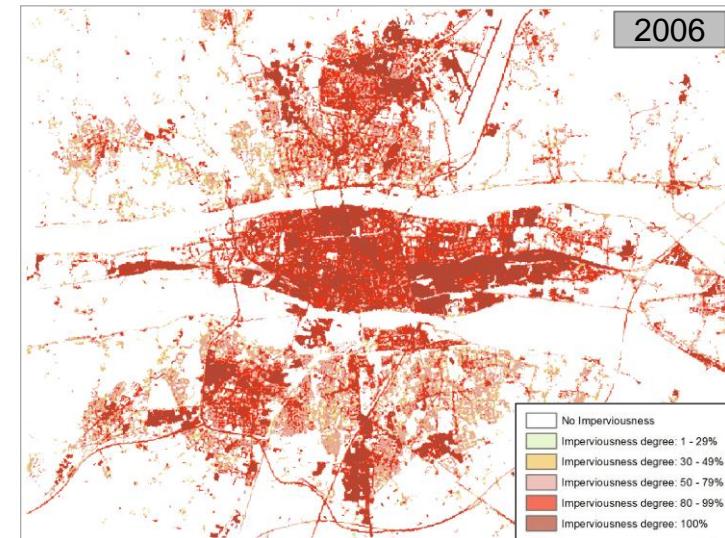
- Built-up area & Imperviousness Degrees 2015 (20m)
- Reprocessing of 2012-2009-2006 (20m)
- Imperviousness (classified) change
- Imperviousness reference database

Input Data:

- Multi-temporal optical HR composites (Sentinel-2, Landsat, SPOT-4 & -5, IRS-P6, ResourceSat-2) for 2015 +/-1 year plus HR IMAGE 2012/2009/2006
- VHR images & in-situ data (via CORDA)

Highlights:

High-quality information on imperviousness change in Europe (2006/2009/2012/2015).





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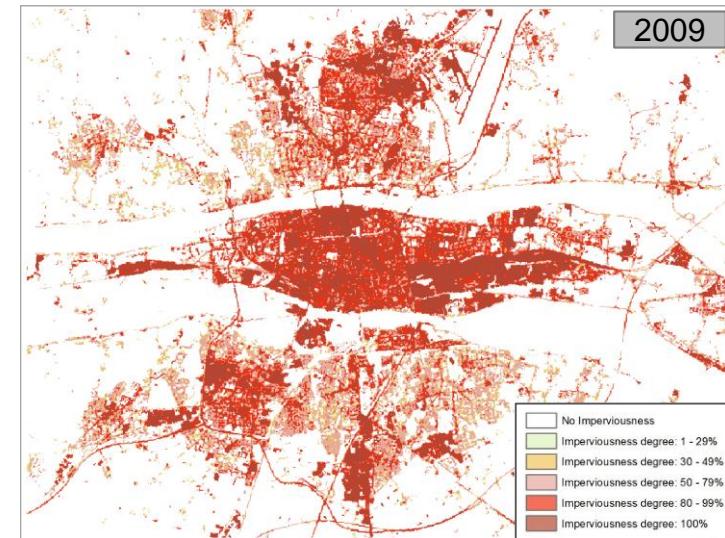
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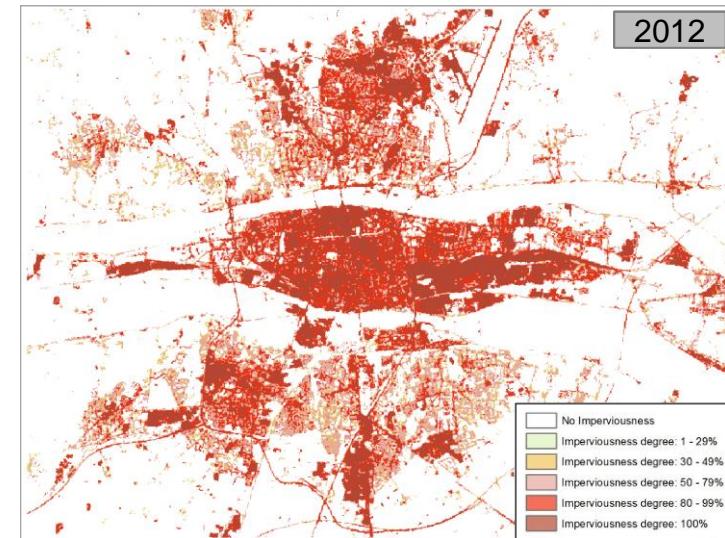
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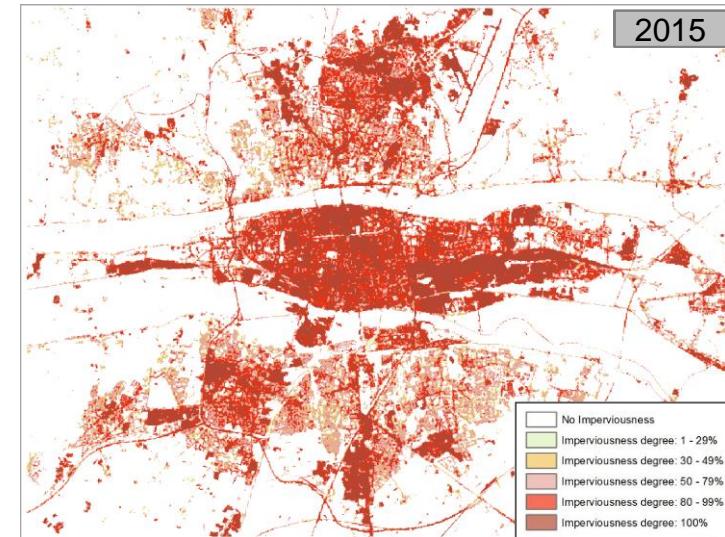
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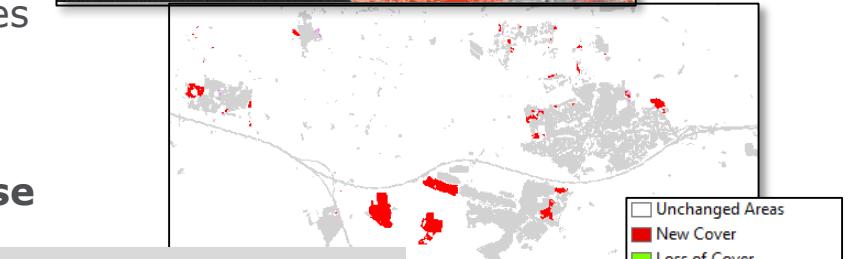
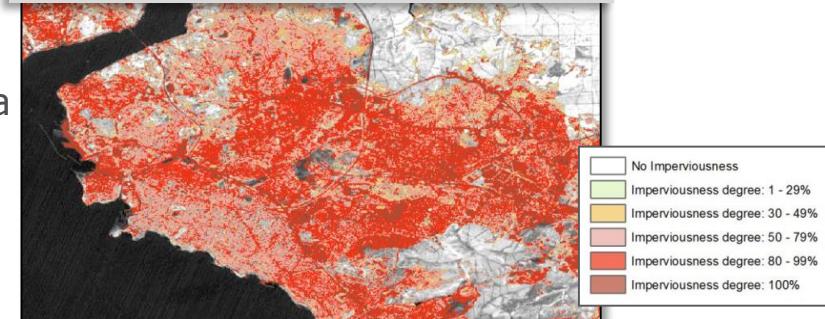
Imperviousness (IMP)

Advanced Methods/Techniques:

- **Multi-sensor & multi-resolution data** to increase observation frequency and reduce data gaps
- **Multi-temporal analysis** of seasonal image composites and cross-calibration of time-series imperviousness values (2006–2015)
- Extensive **in-situ reference knowledge base** for absolute calibration and validation

First Results:

Degree of Imperviousness 2015



Imperviousness Classified
Change 2012-2015



Products (17):

- Dominant Leaf Type (DLT) (20m)
- Tree Cover Density (TCD) (20m)
- DLT Change (20m)
- TCD Change (100m)
- Forest reference database

Input Data:

- Sentinel-2, Landsat 8, HR Image 2015 (2015+/-1)
- HR IMAGE 2012, Landsat-8
- VHR IMAGE 2012 & 2015

Highlights:

Very high thematic accuracy, including change products (OA > 90%).

Change products 2012-2015 with up to 14 thematic classes.

Tree Cover Density Change Layer 2012-2015 (100m)



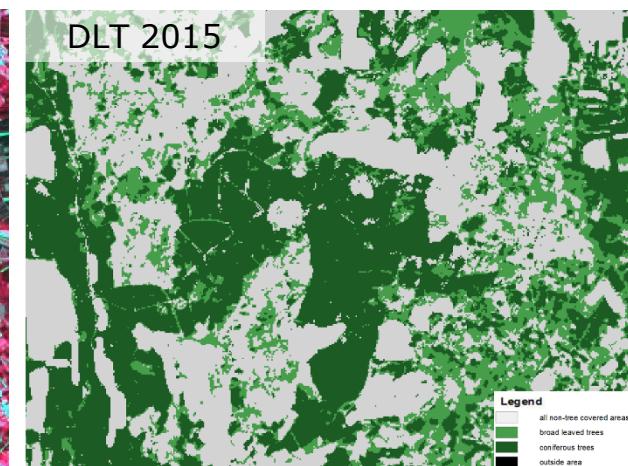


Advanced Methods/Techniques:

- **Automized** training data **sampling** (EEA39)
- Classification performed in the **Cloud**: Apache Spark Framework (high **parallelization**)
- **Rule-based** improvement of classification results using **multi-temporal data stacks**
- **Forest reference database** for calibration and validation
- **Improved DLT/TCD** classification

First Results:

- 20m DLT2015 (Spain)
- 20m TCD2015 (Spain)



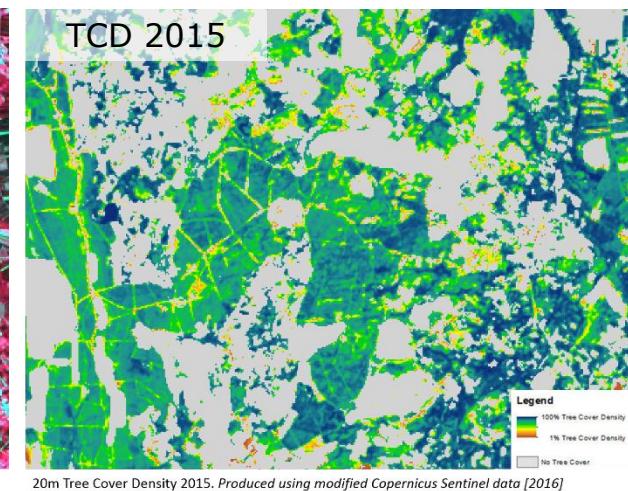


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Grassland (GRA)

Products (3):

- Permanent Grassland Mask (20m)
- Grass Vegetation Probability Index
(additional product for expert users, 20 m)
- Ploughing Indicator
(additional product for expert users, 20m)

Input Data:

- Sentinel-1: (2015+/-1: 30 amplitude & short-term coherence images)
- Sentinel-2/Landsat8 (2015+/-1)
- Landsat 5-8/HR IMAGE 2012 (2008-2013)

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GeoVille
Information Systems

SIRS

e-geos
AN EIGER TELECOM COMPANY

Highlights:

- First high-resolution retrieval of both managed and (semi-)natural grasslands on continental scale.
- Optical-SAR multi-temp/multi-seasonal evaluation.
- New multi-year product (ploughing indicator).

First Results:





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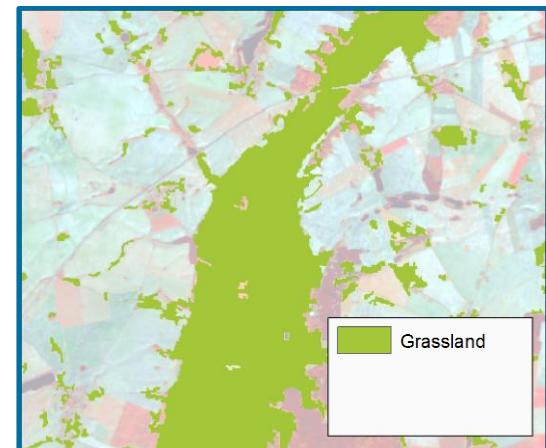
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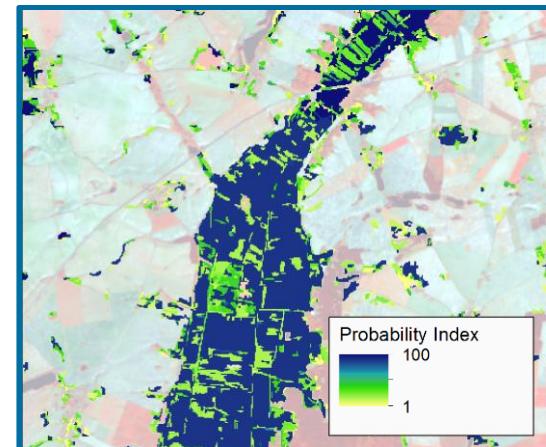
SIRS

e-geos

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e-geos
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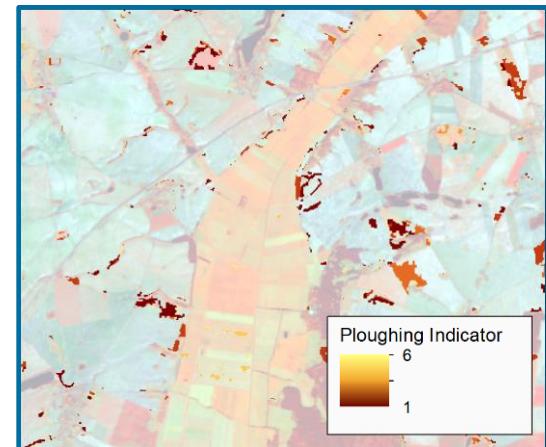
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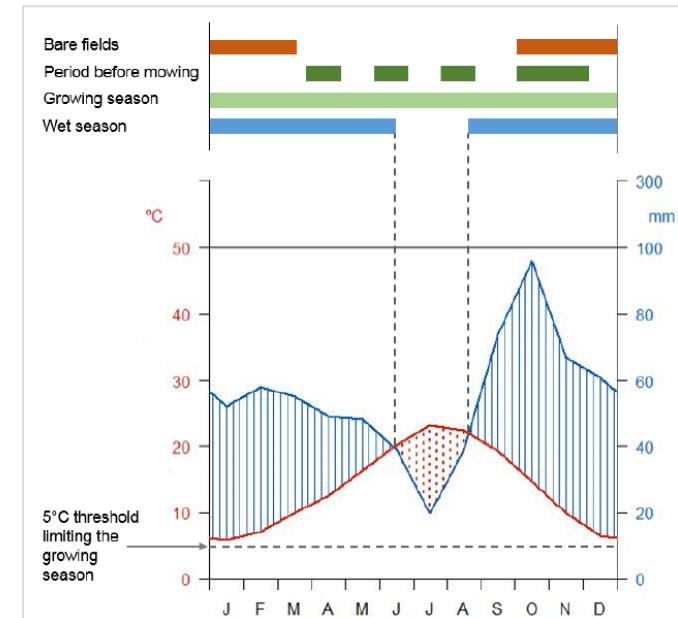
First Results:





Advanced Methods/Techniques:

- Complex LC/LU classification of **highly dynamic** grassland requiring expert knowledge:
Careful **selection** of optimal set of optical images of reference year for classification: wet/dry season, growing season, grassland types, grassland use, main crops, agricultural practices, altitude
- Integrated use of **optical** & **SAR** time series (rule-based evaluation)



Products (2):

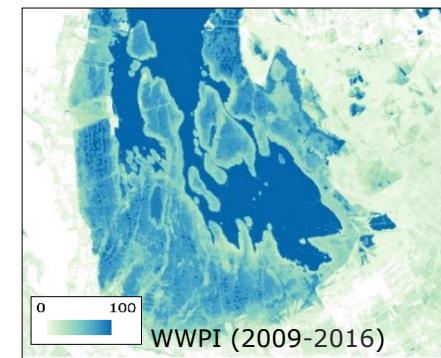
- Classified Water & Wetness product (20m)
- Water Wetness Probability Index from...
...2009 to 2015 (20m)
(additional product for expert users, 20m)

Input Data:

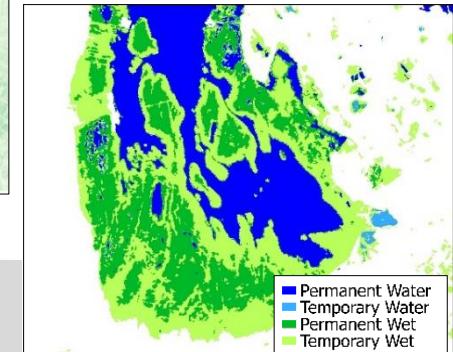
- Multi-temporal optical HR composites:
SPOT, ResourceSat, Sentinel-2, Landsat
(2009-15)
- Multi-temporal SAR data: Sentinel-1
(since 2014), ENVISAT-ASAR, METOP-
Ascot (since 2004)
- Soil moisture calibration database
- VHR images & in-situ data (via CORDA)

Highlights:

New high-quality information on water & wetness presence in Europe on HR scale
(2009-2016 multi-year products)



Water Wetness
Probability Index



Water & Wetness
(classified product)



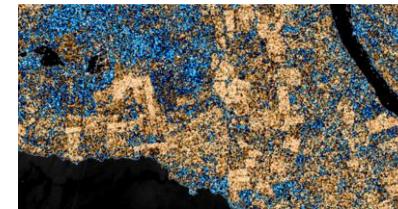
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Water / Wetness (WaW)

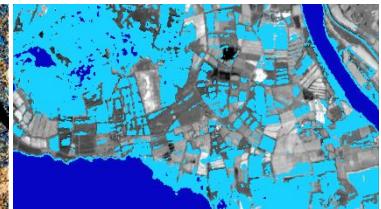
Advanced Methods/Techniques:

- **Integrated use of optical & SAR** provides superior level of detail and increased observation frequency
- **Multi-temporal analysis** of seasonal image composites to address (i) permanent and (ii) temporary water/wetness
- **First high-resolution retrieval of surface wetness** on continental scale
- Extensive **in-situ reference knowledge base** for calibration and validation

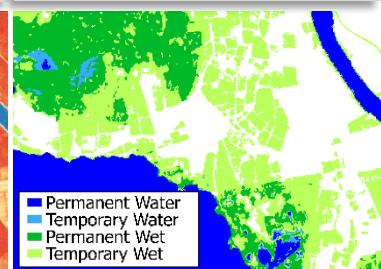
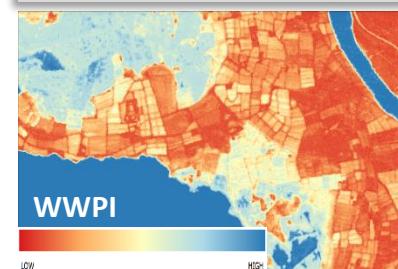
First Results:



S-1 Soil Saturation Degree



S-2 (mNDWI)





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Small Woody Features (SWF)

Products (1):

- SWF 2015 including :
 - Linear hedgerows and scrubs
 - Tree rows
 - Isolated patches of trees

Input Data:

- VHR IMAGE 2015 (Pleiades 1A/1B, WorldView-2/3, GeoEye-1, Deimos-2 and Dubaisat-2)
- Riparian Zones GLE & In-situ data

Highlights:

High quality information on small woody linear & patchy structures at continental level.

Detailed detection of small landscape elements.

Big data: Computation of very high volume (> 100 TB).





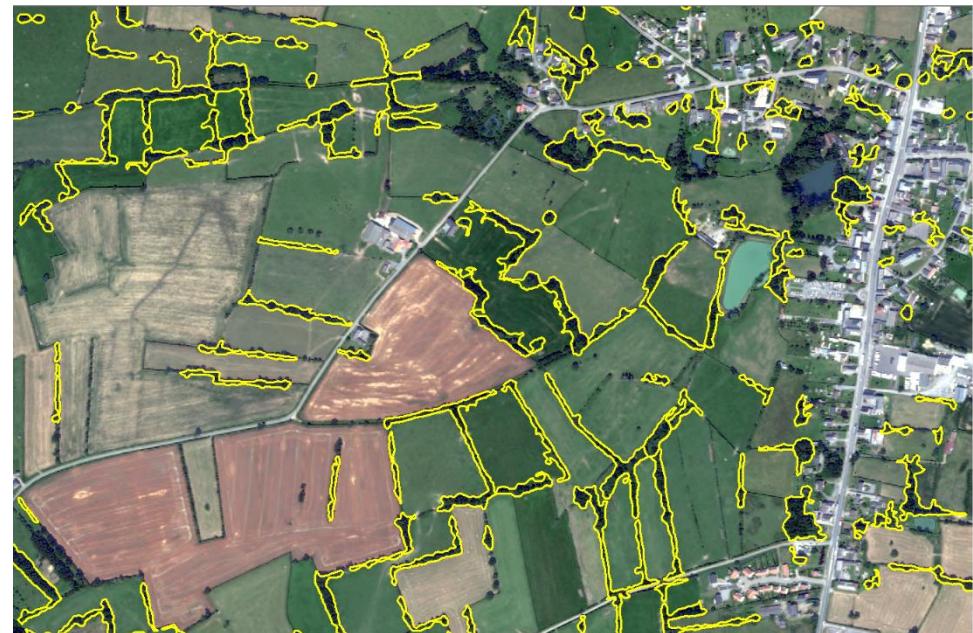
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Small Woody Features (SWF)

Advanced methods/Techniques:

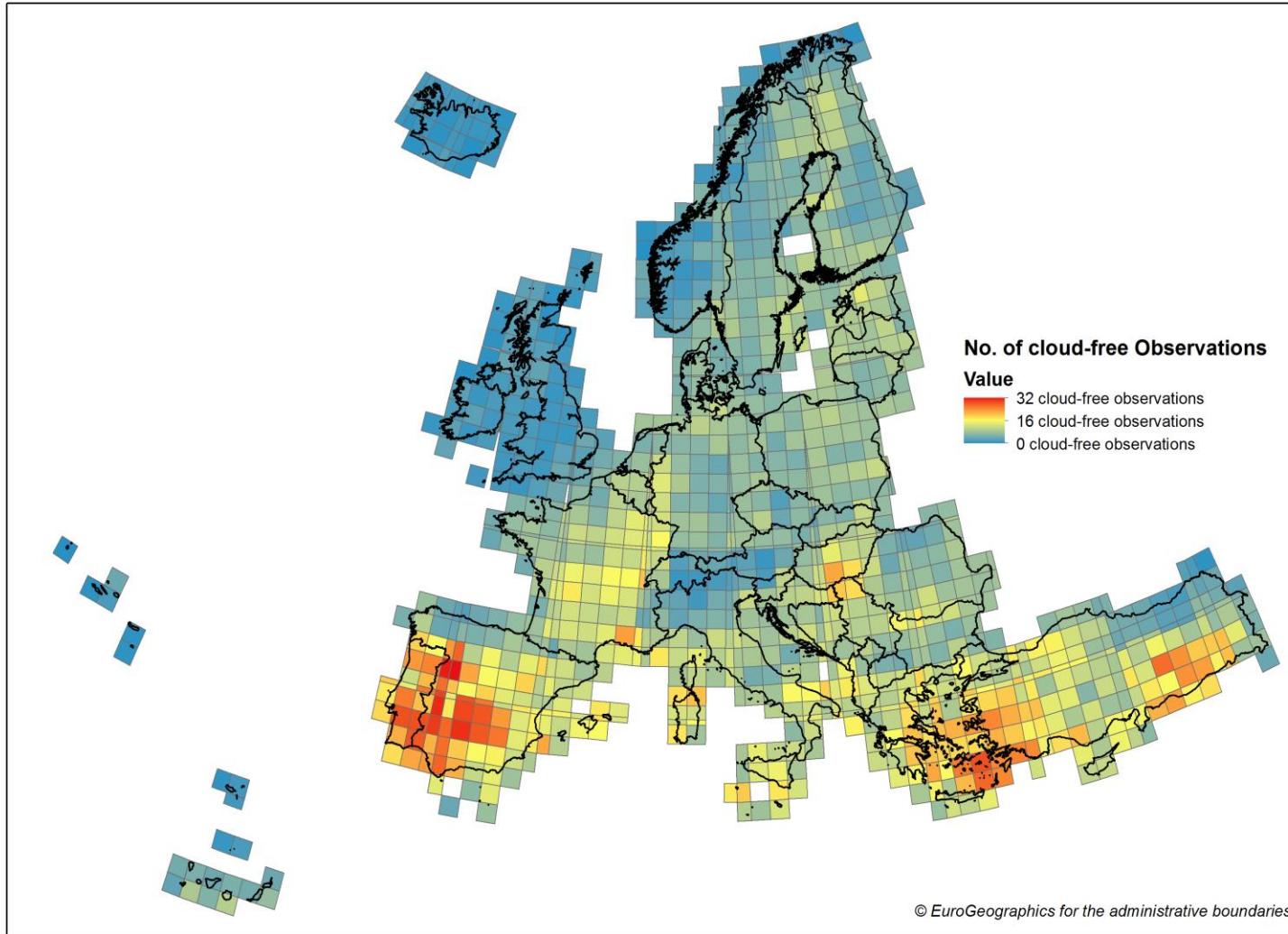
- First **pan-European** Layer derived from **VHR** dataset (multi-Sensor approach)
- Combination of **pixel/object-based** and **spectral/textural** techniques
- **Cloud computing** and automated processing

First Results:



Critical gaps in input EO data and in in-situ/reference data provision

★ Optical HR Cloud free observations



Number of cloud free observations for HRL2015 production per MGRS tile (incl. ResourceSat-2, SPOT-5, Landsat 8 and Sentinel-2) over the 2014-2017 period

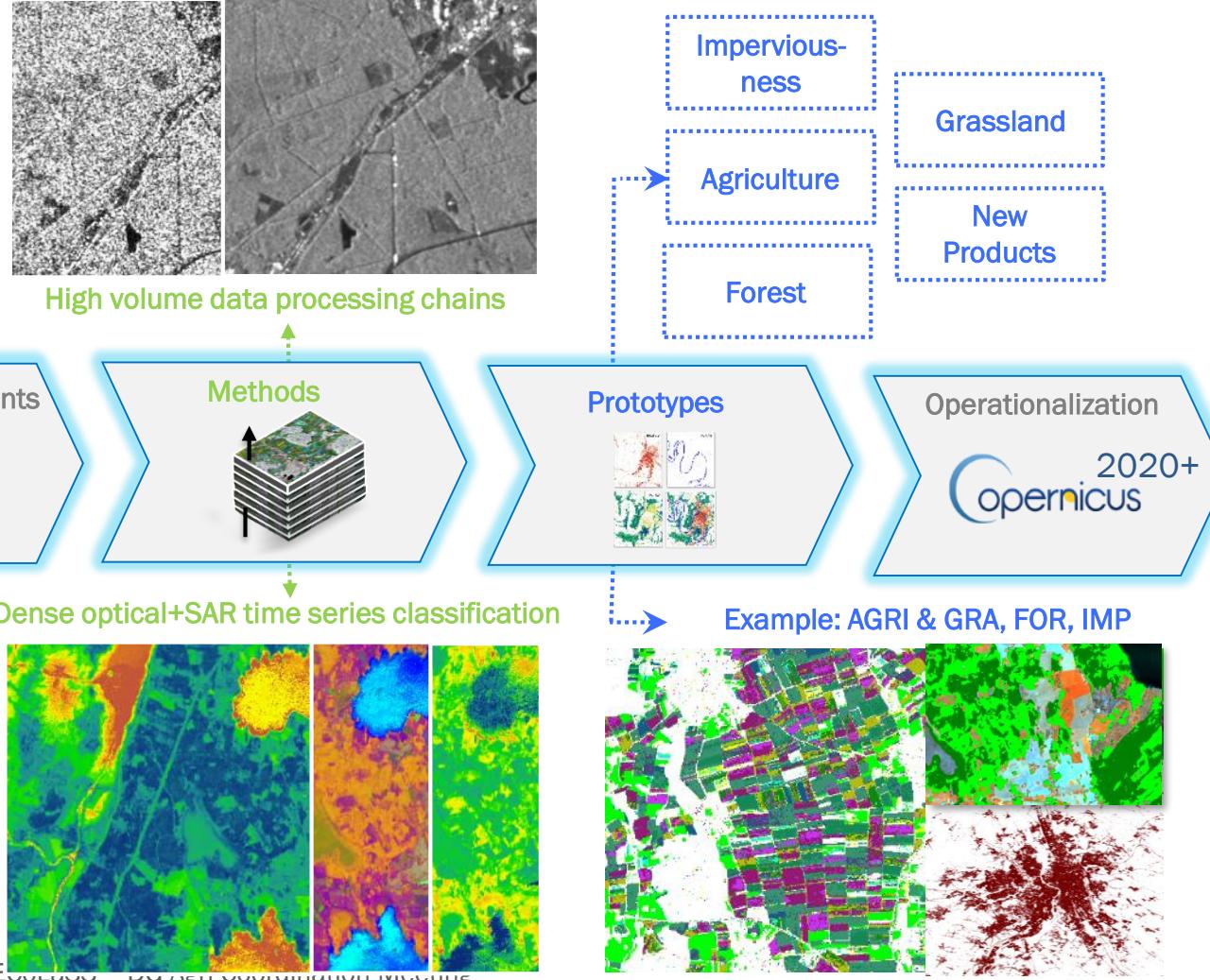
Perspectives

- ★ HRL IMD et FOR seront finalisés pour fin Mars/ début Avril
- ★ HRL GRA et WaW le seront quelques semaines plus tard
- ★ HRL SWF prendra plus de temps à cause de la disponibilité des images et de contraintes méthodologiques
- ★ Temps de production raccourci par rapport au millésime 2012
- ★ Potentiel pour des améliorations supplémentaires pour 2018 maintenant que les constellations S1 & S2 sont complètement opérationnelles
- ★ Couverture nuageuse reste problématique pour certaines régions
- ★ Synergie S1 et S2 nécessaire



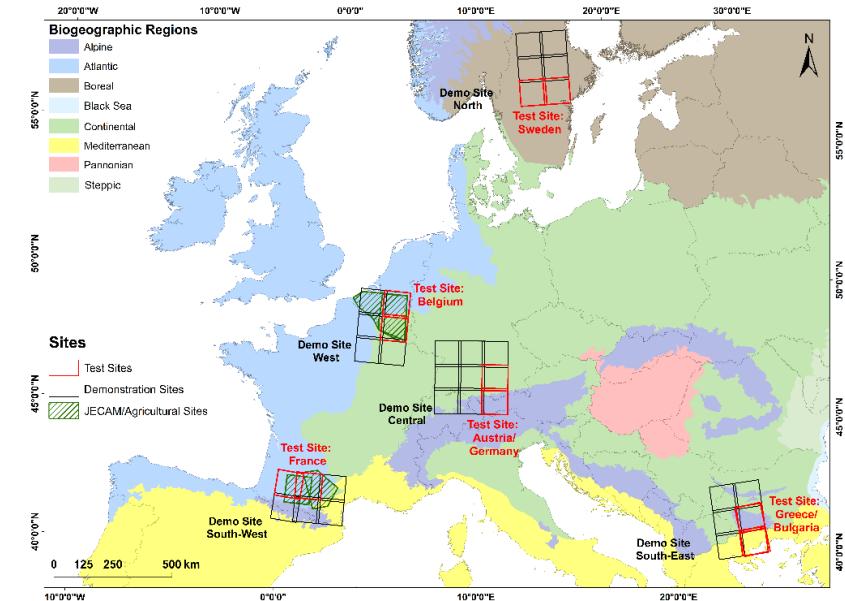
ECoLaSS: “Evolution of Copernicus Land Services based on Sentinel data”

Key Objective = **improve** existing & develop **novel** products/services for future operational pan-European & Global Components of the CLMS for 2020+

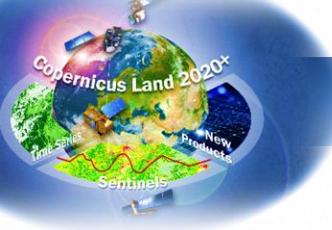


ECoLaSS
(H2020 Grant Agreement no. 730008)

www.ecolass.eu
 @ECoLaSS2020



Test- and Demonstration sites in various biogeographic regions.



Thank you on behalf of the ECoLaSS team !!

GAFAG L. Moser, M. Probeck, G. Ramminger, D. Herrmann & Development Team



C. Sannier, S. Villerot, B. Desclée & Development Team



H. Gallaun, M. Schardt, J. Deutscher, K. Granica



P. Delfourmy, X. Blaes, I. Moreau, J. Wolter

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