EARTH & LIFE INSTITUTE

Sentinel-2 for agriculture and land surface monitoring from field level to national scale

The on-going BELCAM, Sen2-Agri and LifeWatch experiences

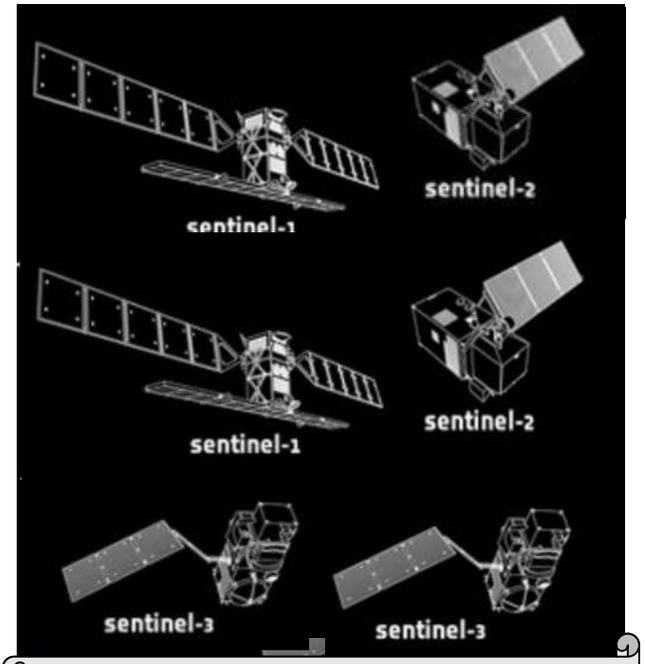
C. Delloye, S. Bontemps, N. Bellemans, J. Radoux, F. Hawotte, P. Defourny

"The Bright Side of Remote Sensing" workshop – 25th of October

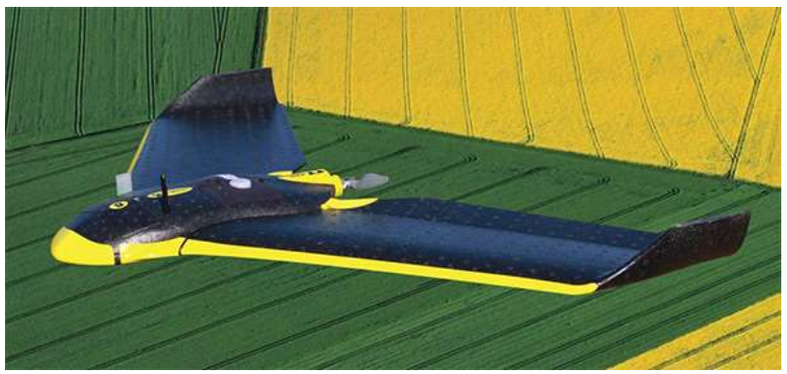
UNIVERSITÉ CATHOLIQUE DE LOUVAIN

EO and IT (r)evolution change the game

Copernicus



Free, open and long term data policy (EU)



Change much needed for agriculture and food supply chain for :

- market price volatility reduction
- improved use of land, soil and water
- reduction of environmental impacts e.g. fertilizers and pesticides reduction
- crop management innovations
- climate change adaptation …

BELCAM

Belgian

Product at the belgian scale

Collaborative
IT platform

Pilot & Technical Centers

Pionneers farmers

Agriculture Monitoring
parcel level

3 crops: wheat, potato, maize

5 scientific partners led by UCL and 8 pilot/technical centers

http://maps.elie.ucl.ac.be/belcam/

Partnership and collaborative system

Farm sourcing

Researchers

Products based on data rich model

Feedback & Field data

NRT delivery

Users

Field zoning

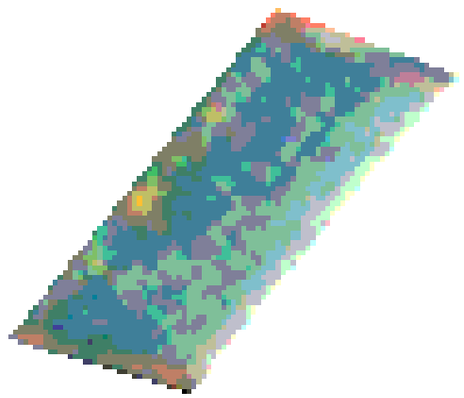
Mapping of intra-field heterogeneity

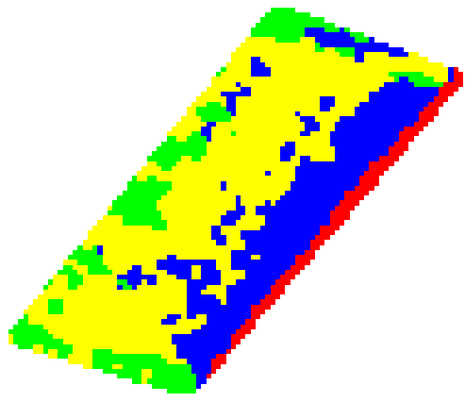
Benchmarking
RapidEye 2015, 5m

Visual representation
NIR, RedEdge, Red

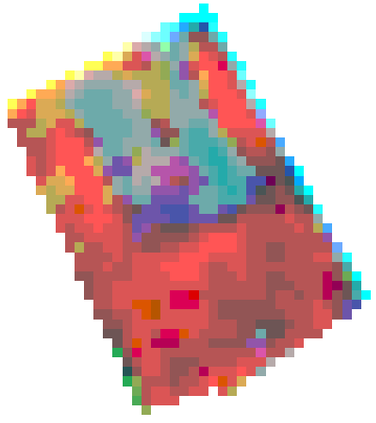
Segmentation result

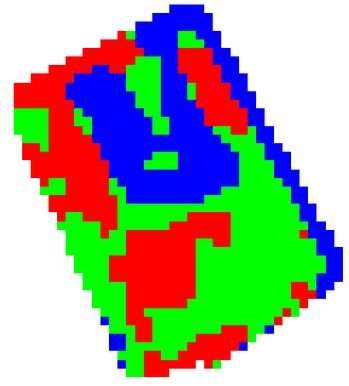
Winter wheat



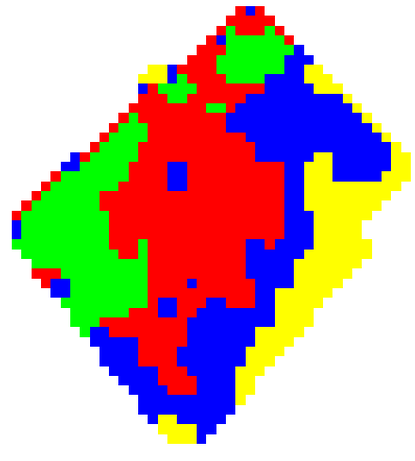


Maize





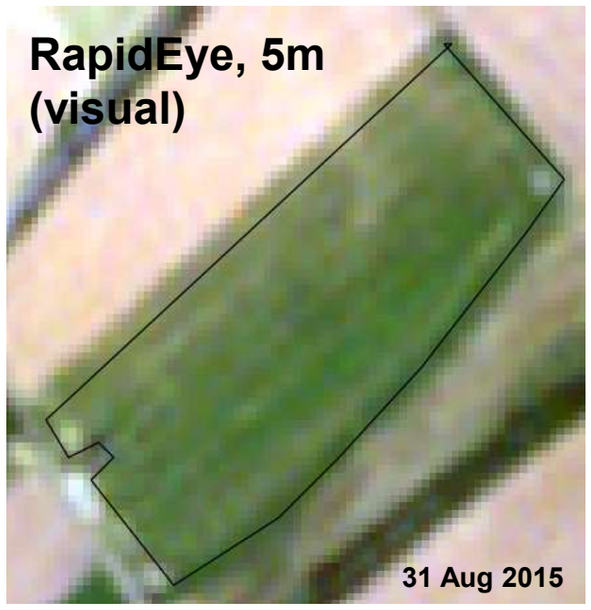
Potato

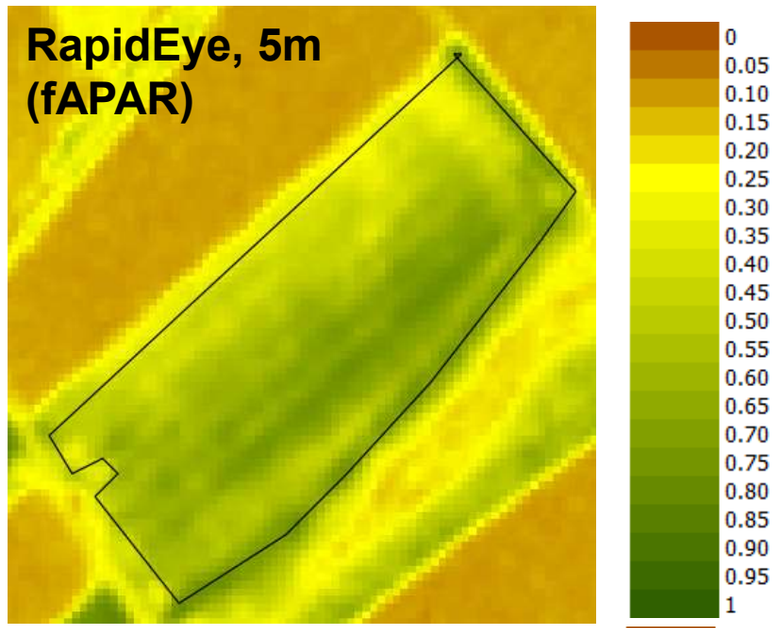


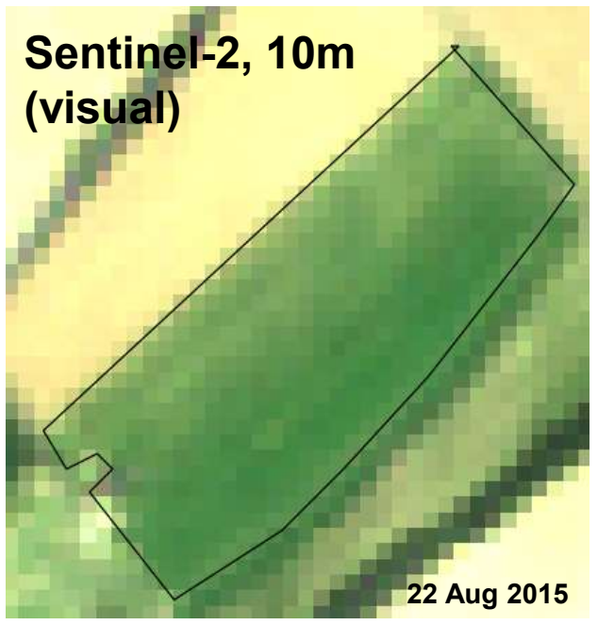
Field zoning

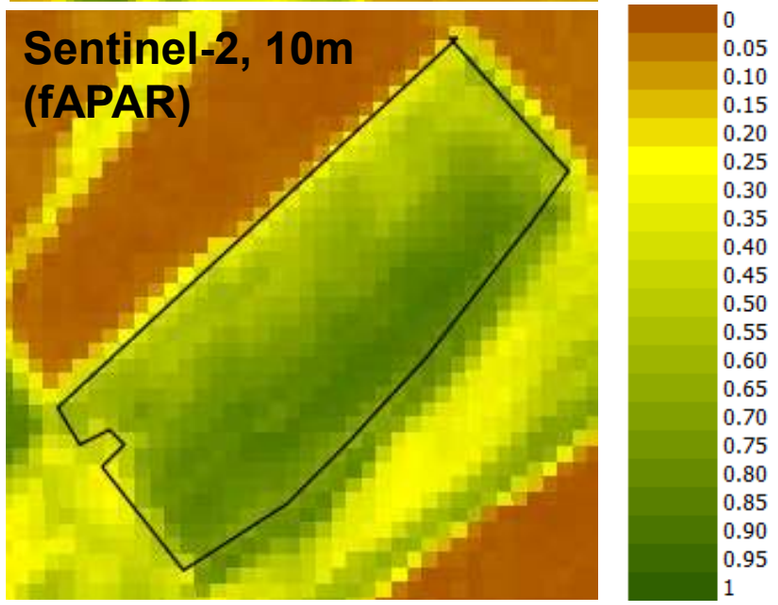
Mapping of intra-field heterogeneity

Comparison RapidEye & Sentinel-2A

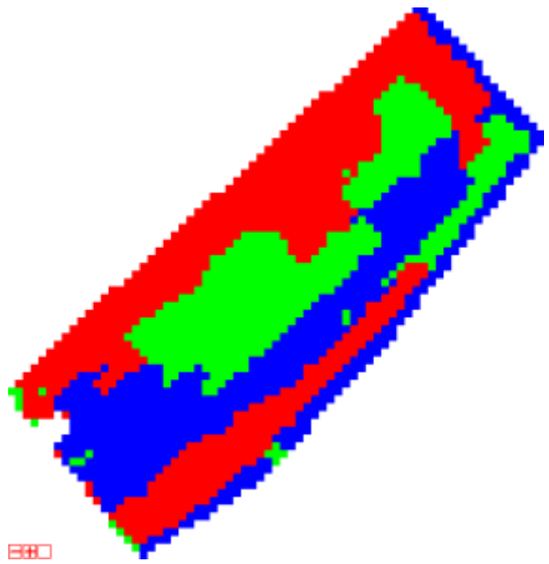


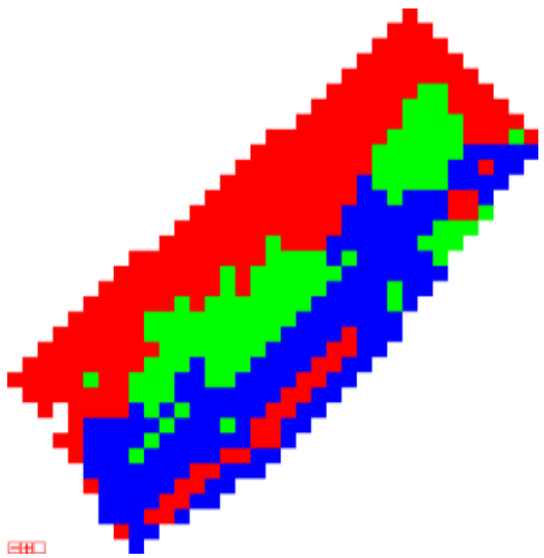






Segmentation results:

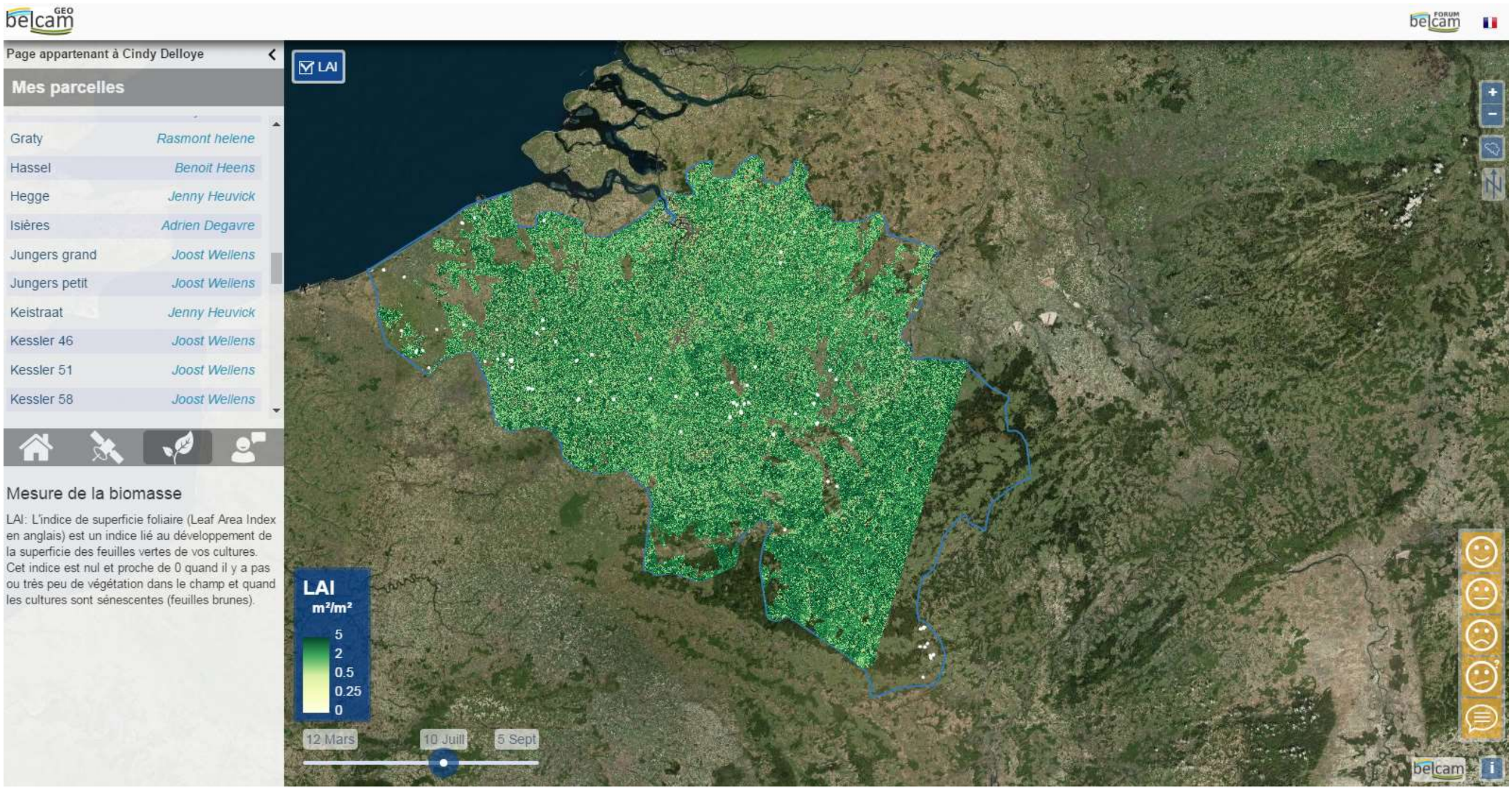




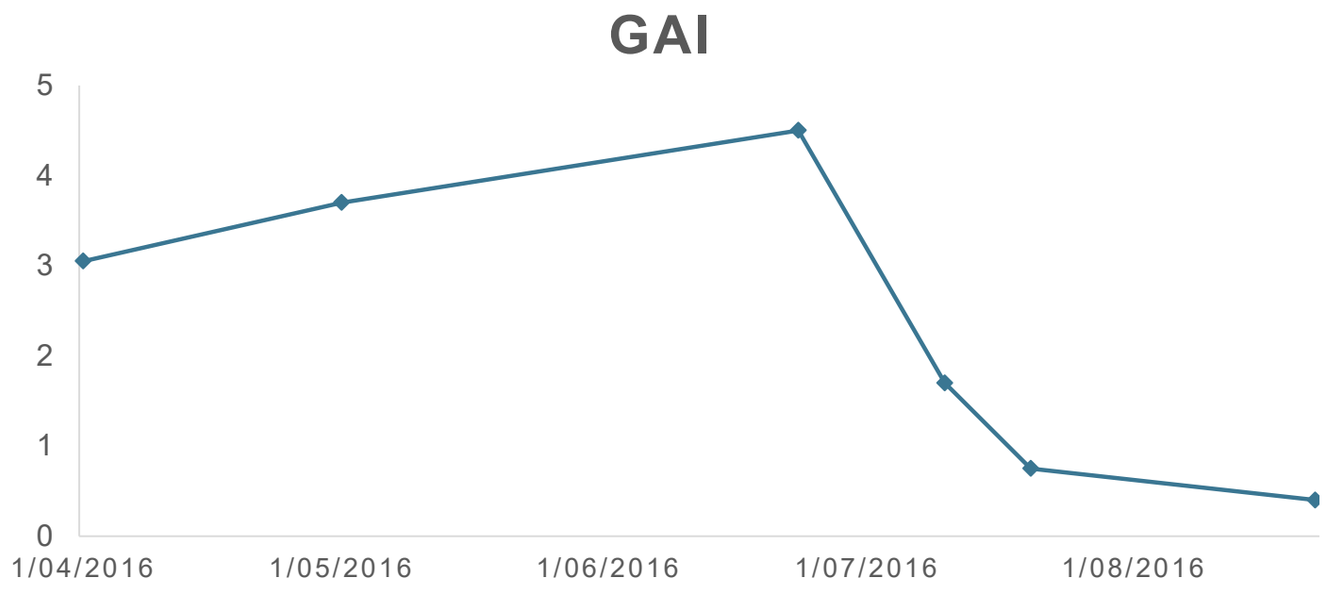
Example: potato field in Gembloux

Green area index

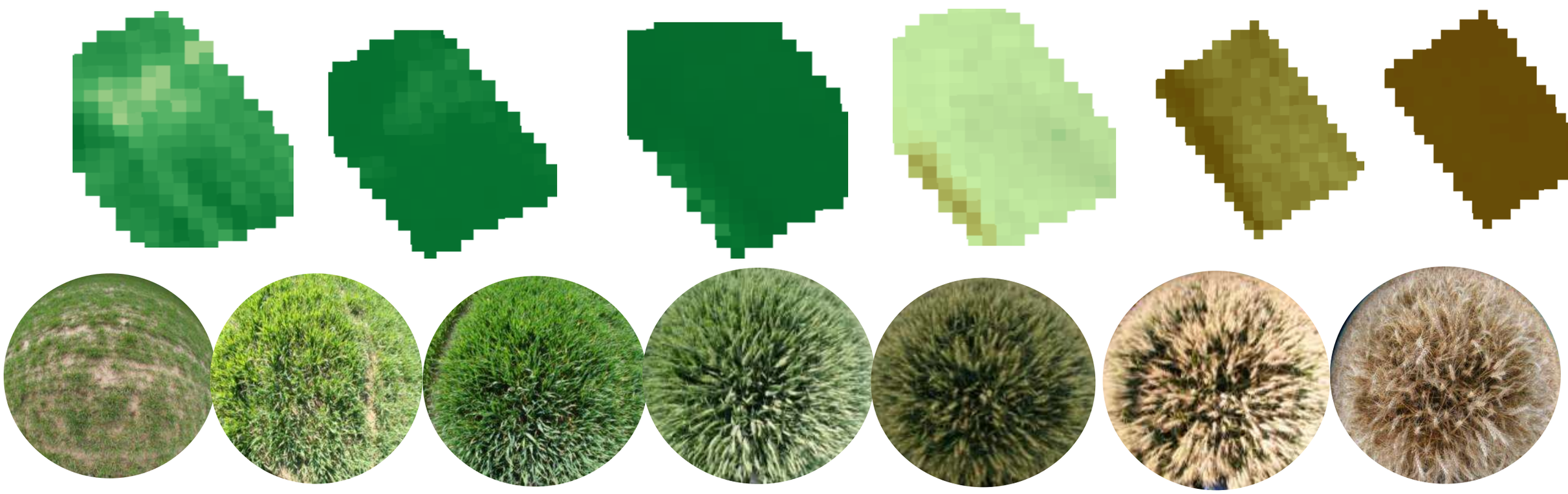
At the Belgian level available for farmers



Green area index
Crop growing follow up



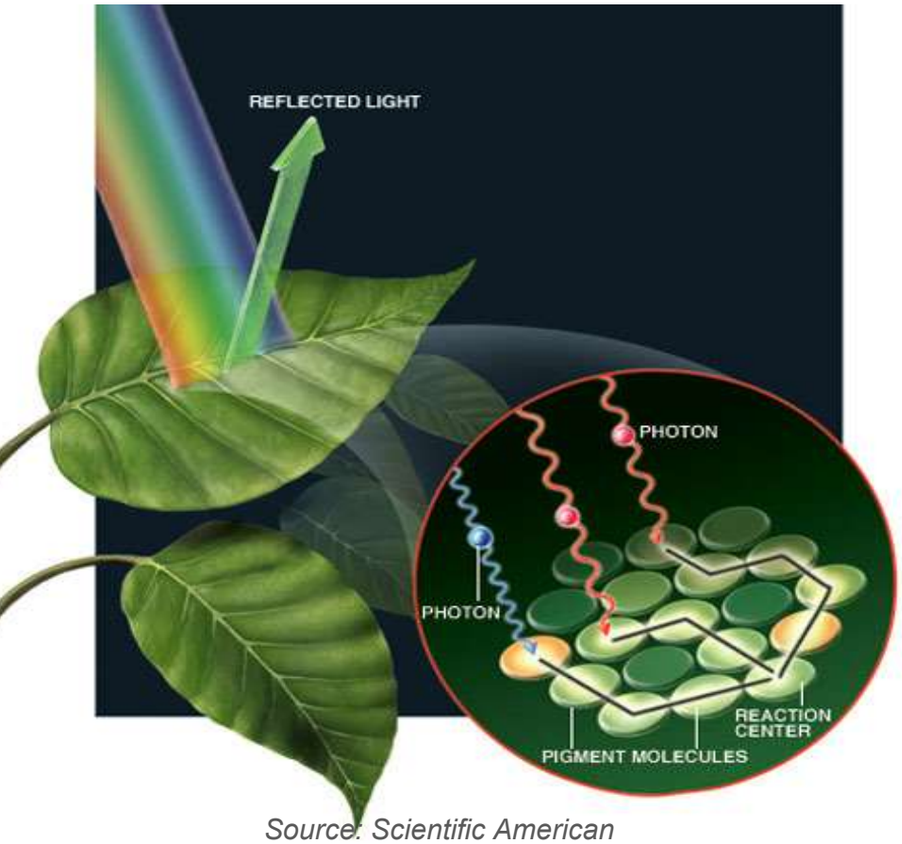
Evolution of the GAI from April to August – winter wheat



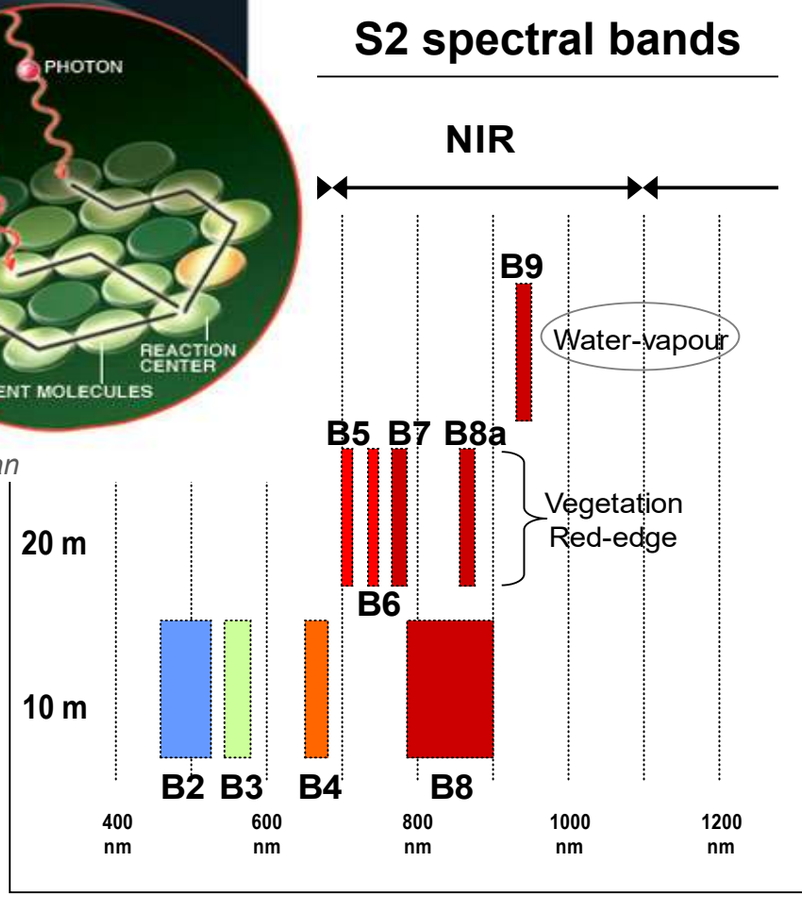
Nitrogen advice

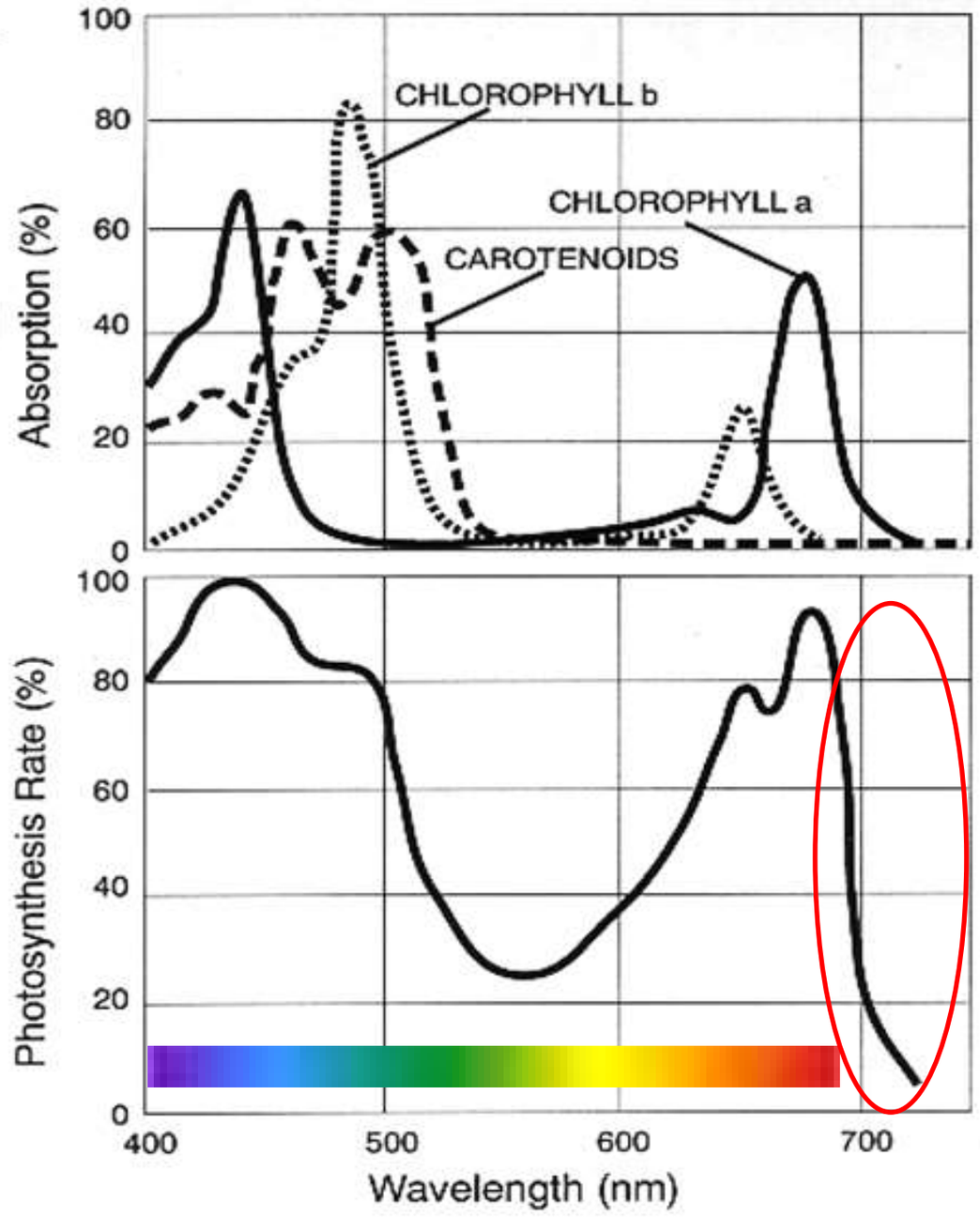
Red-edge to estimate Chl content

Link between Reflectance of S-2 & Plant pigments



Source: Scientific American





Source: http://www.life.uiuc.edu/govindjee/paper/gov.html, from "Concepts in Photobiology: Photosynthesis and Photomorphogenesis", Edited by GS Singhal, G Renger, SK Sopory, K-D Irrgang

Nitrogen advice

Sentinel data to improve the N recommendation

Split in fraction

	Total nitrogen dosis	Complementary dosis
Maize	Requaferti	June-July
Potato		
Winter wheat		3rd dosis in May based on LB

- Focus on the 3rd dosis
- RS data used to decide if the complementary dosis is applied or not.
- If yes, adjustement according to the actual Crop Nitrogen Status

Input data

- Crop type & variety
- Soil characteristics
- Crop residues use
- Manure application frequency
- Previous crop (type, yield)
- Cover crop type
- Cover crop biomass
- Cover crop ploughed/ not ploughed
- …

Sentinel-2

Sentinel-1

Wheat example: nitrogen application in 3 fractions

Nitrogen advice

Link between Chl & Nitrogen at the canopy level

$$C_{ab,leaf} \times GAI = C_{ab,canopy} \leftrightarrow N_{canopy}$$

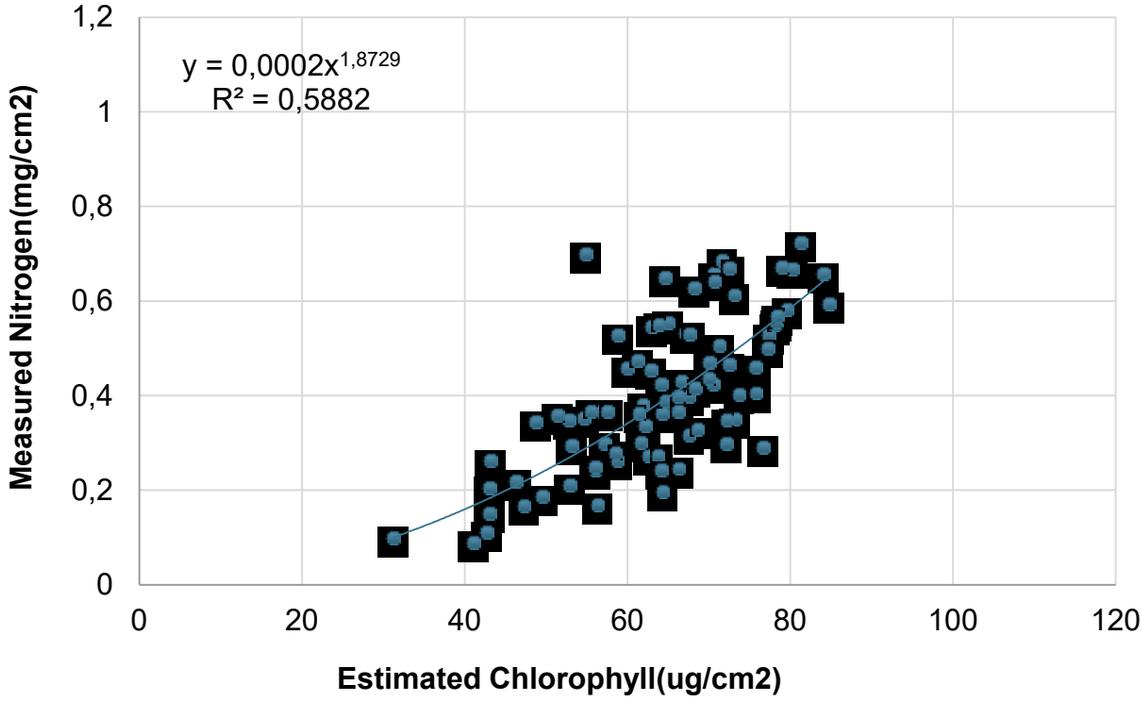
Prospect model (Jacquemoud et Baret, 1990)

$$NNI = \frac{current\ N\%}{critical\ N\%}$$

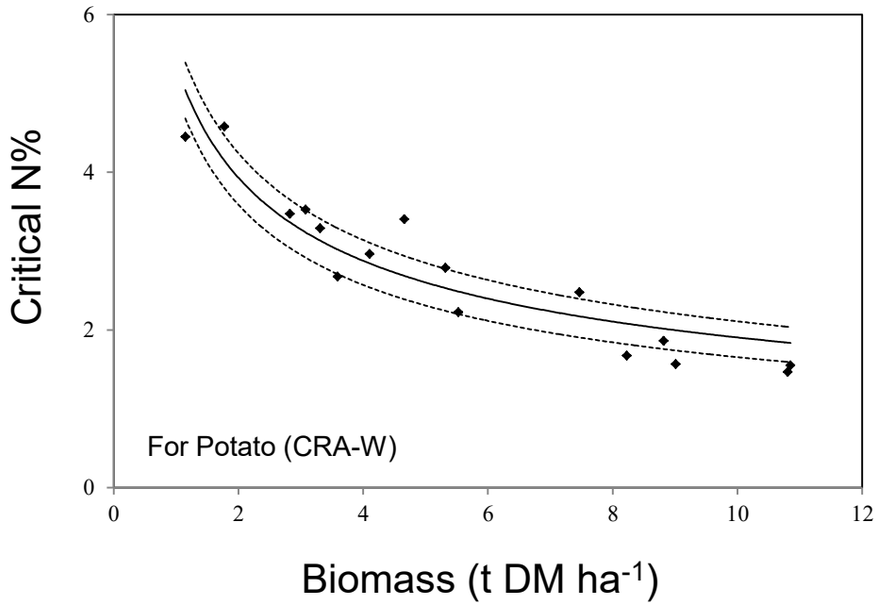
NNI = 1 optimal N nutrition
NNI > 1 N excess
NNI < 1 N deficiency

Application of the 3rd dosis

Relation N vs Chl, leaf level



Critical N dilution curve



Sentinel-2 for Agriculture

onsortium

upport & data provider

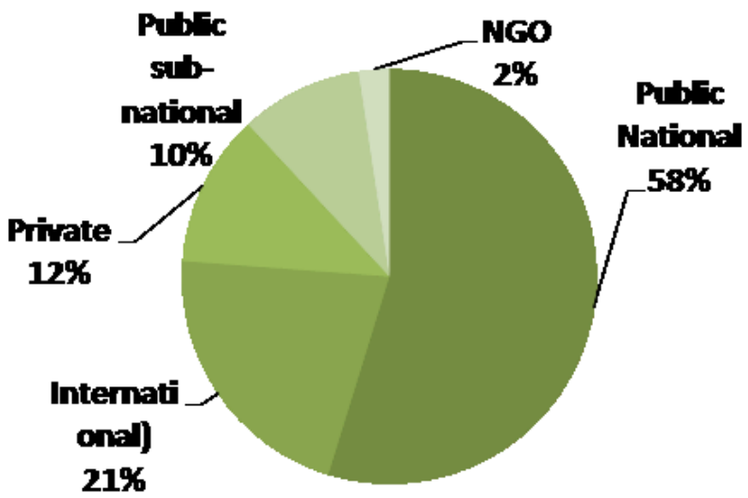
esa

hampion sers + sites managers

1st User Consultation organized by ESA in 2012

2nd User Consultation through surveys in 2014

Survey filed up by 42 institutions



1st Sen2-Agri Users Workshop – FAO May 2014

2nd Sen2-Agri Users Workshop – EU Nov. 2015

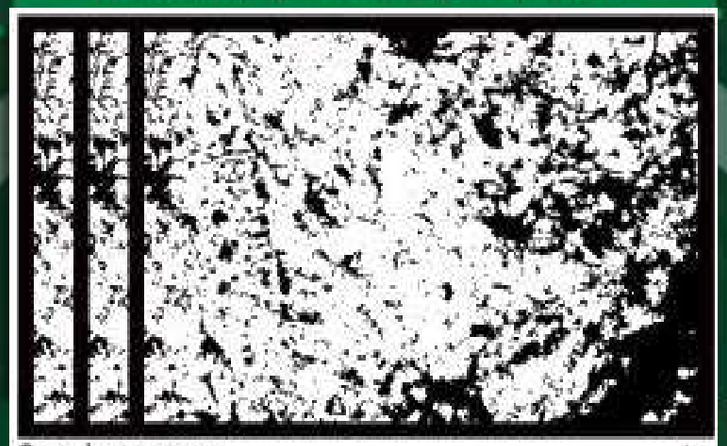
Sen2-Agri = System to deliver automatically 4 products

In line with the GEOGLAM core products

Monthly cloud free surface reflectance composite at 10 & 20 m

CLOUD FREE SURFACE REFLECTANCE COMPOSITES

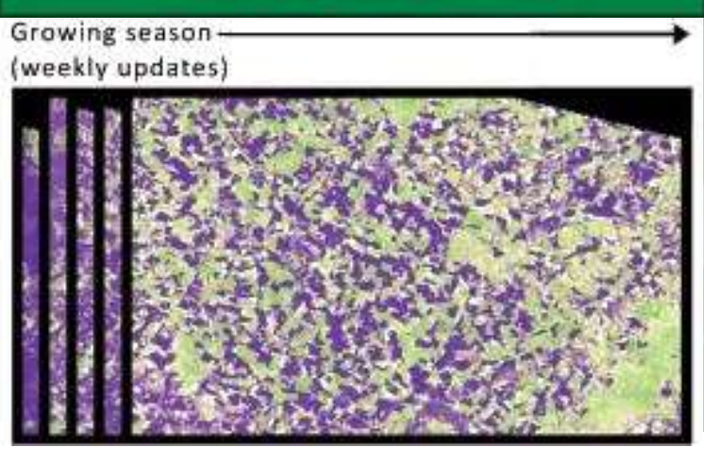
DYNAMIC CROPLAND MASK



Binary map identifying annually cultivated land at 10m updated every month

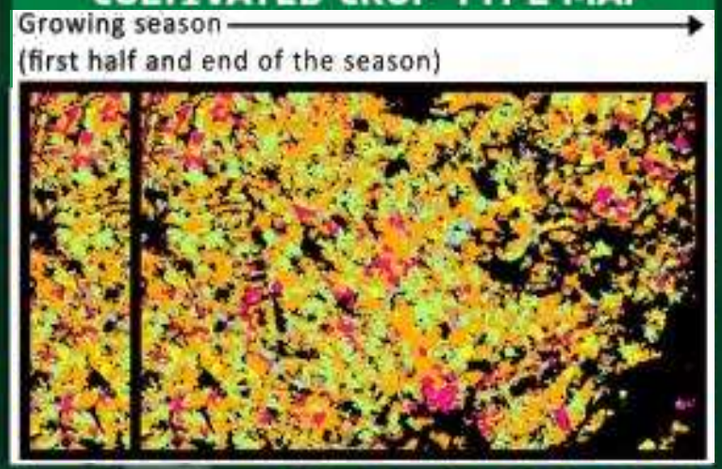
Open source toolbox
Capacity building and training

VEGETATION STATUS



Vegetation status map at 20 m delivered every week (NDVI, GAI, pheno index)

CULTIVATED CROP TYPE MAP



Crop type map at 10 m for the main regional crops including irrigated/rainfed discrimination

System operation for crop type

Before the start of the monitoring period

System initialization

Monitoring period

Automatic EO data download
Manual in situ data upload

SoS — 6M — EoS

EO data providers

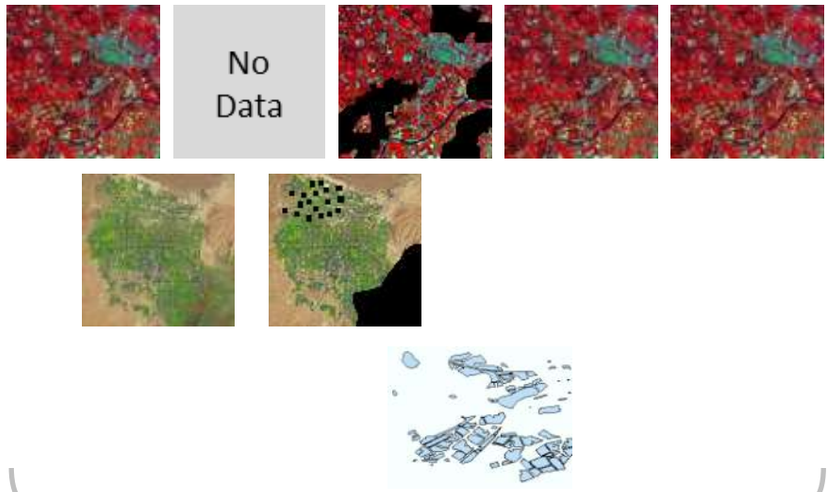
Operators

System operation for crop type

Before the start of the monitoring period

System initialization

Monitoring period

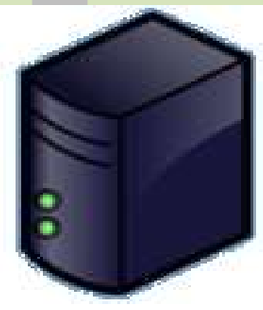


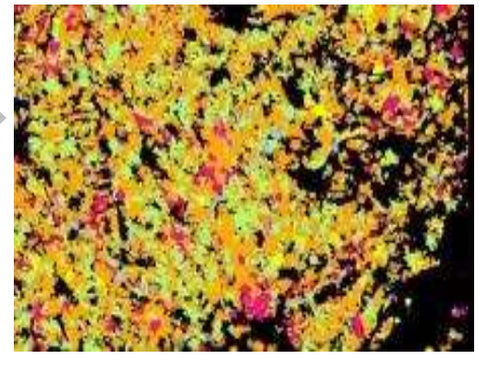
Automatic EO data download
Manual in situ data upload

SoS

6M

EoS





EO data providers

Operators

System operation for crop type

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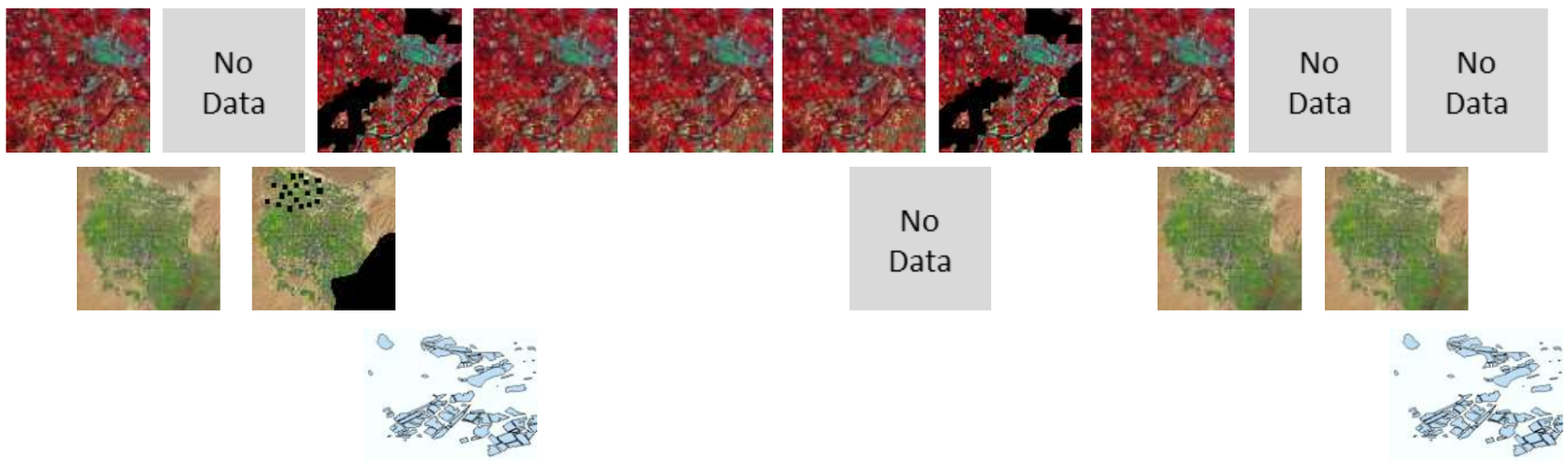
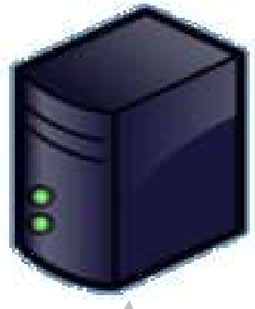


SoS — 6M — EoS

EO data providers



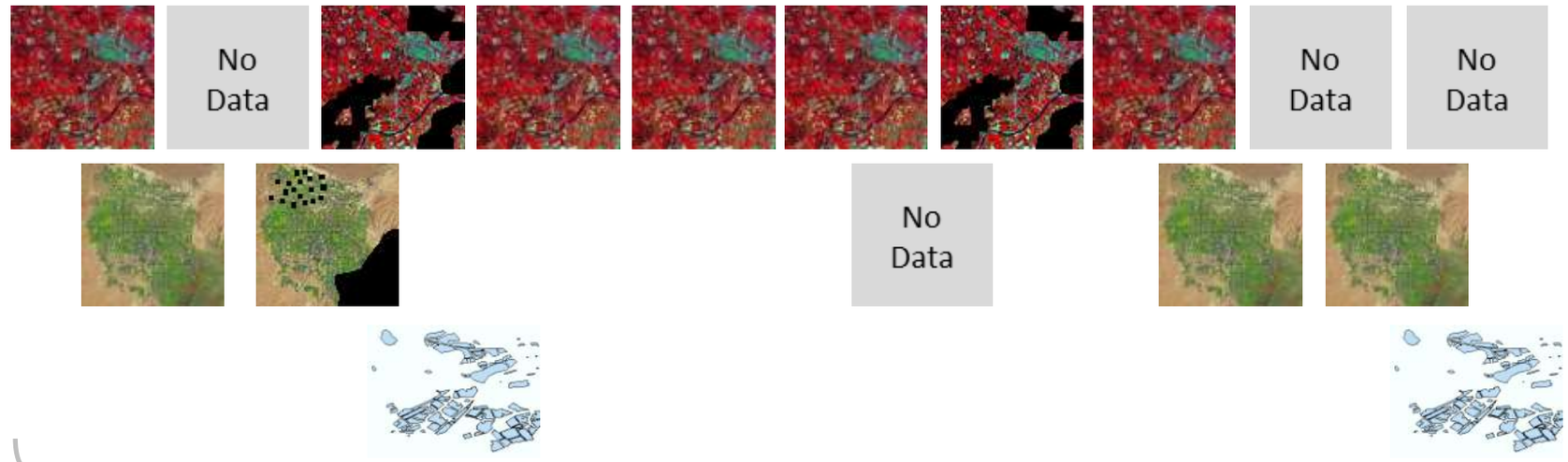
Operators

System operation for crop type

Automatic EO data download
Manual in situ data upload

Before the start of the monitoring period

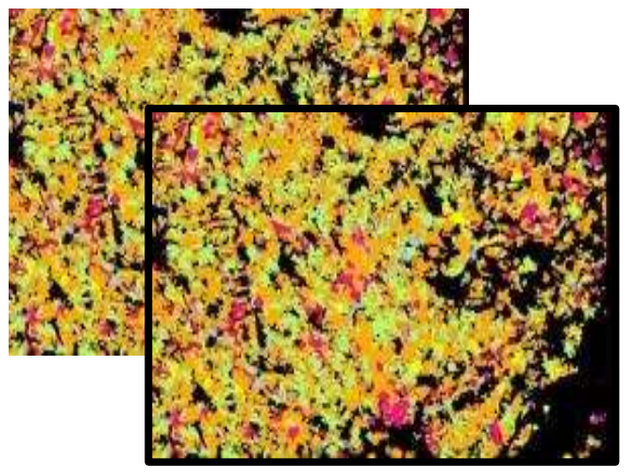
Monitoring period



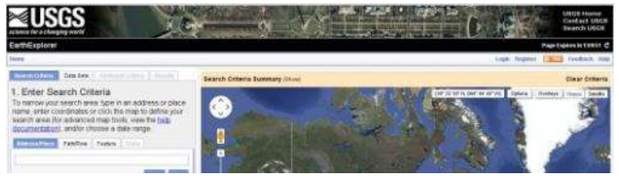
System initialization

SoS

EoS



EO data providers



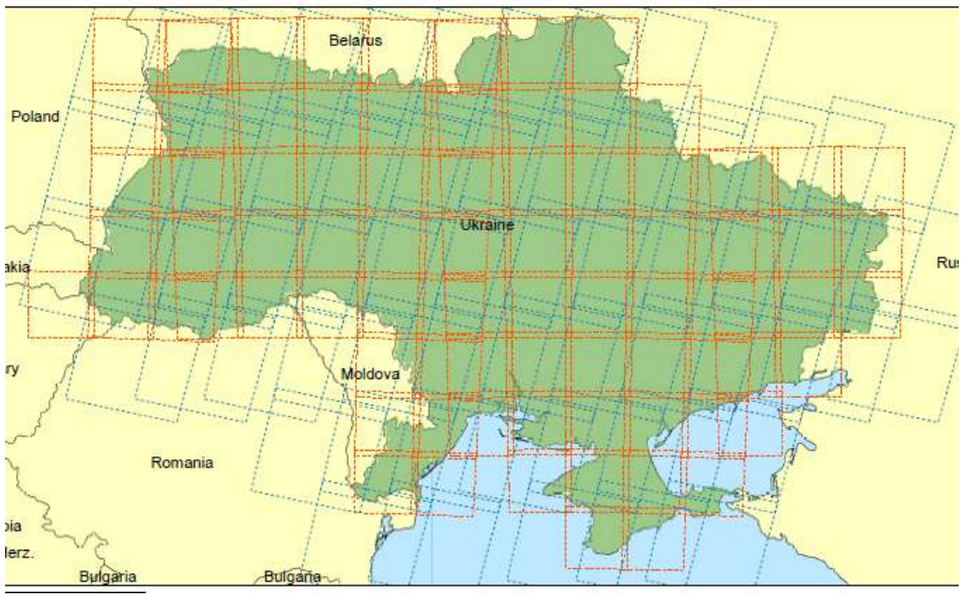
Operators

Last project phase

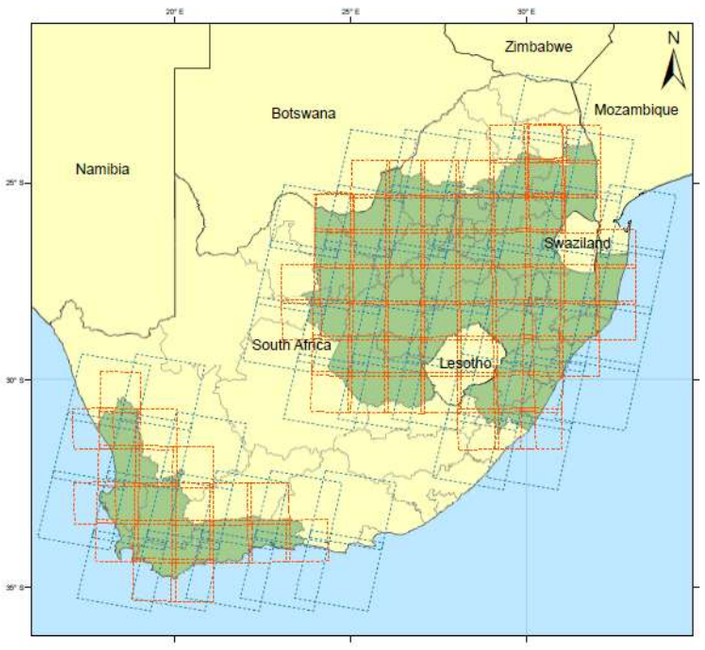
Demonstration phase : 3 national sites

Operational test Sen2-Agri system: production in NRT of the 4 products using S-2a & Landsat 8 at national scale with ***in situ*** system implementation,

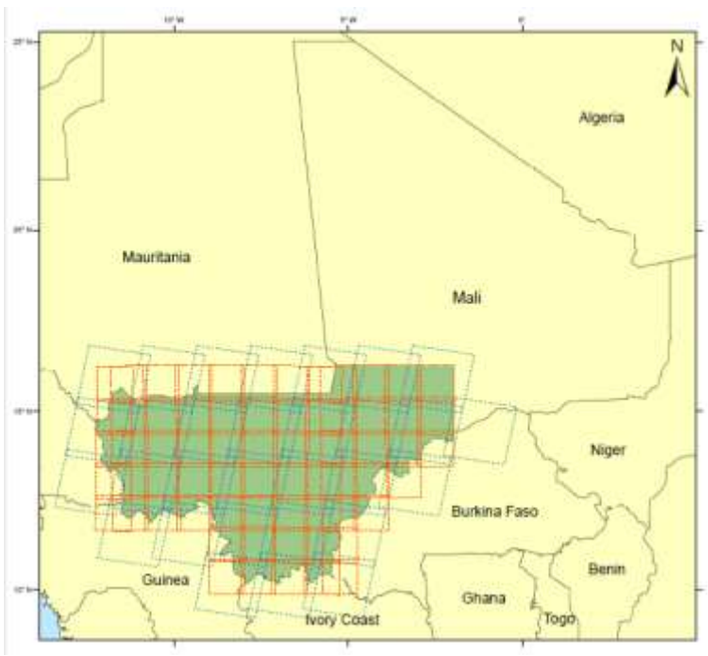
Ukraine (SRI)



South Africa (ARC)

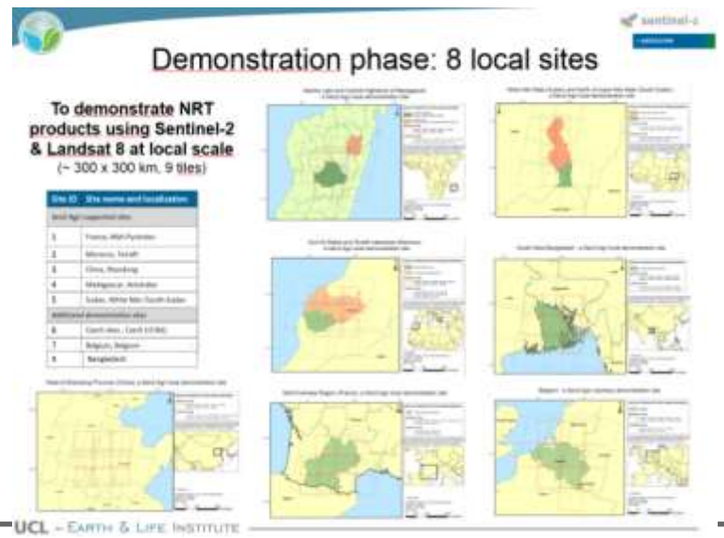


Mali (ICRISAT & IER)

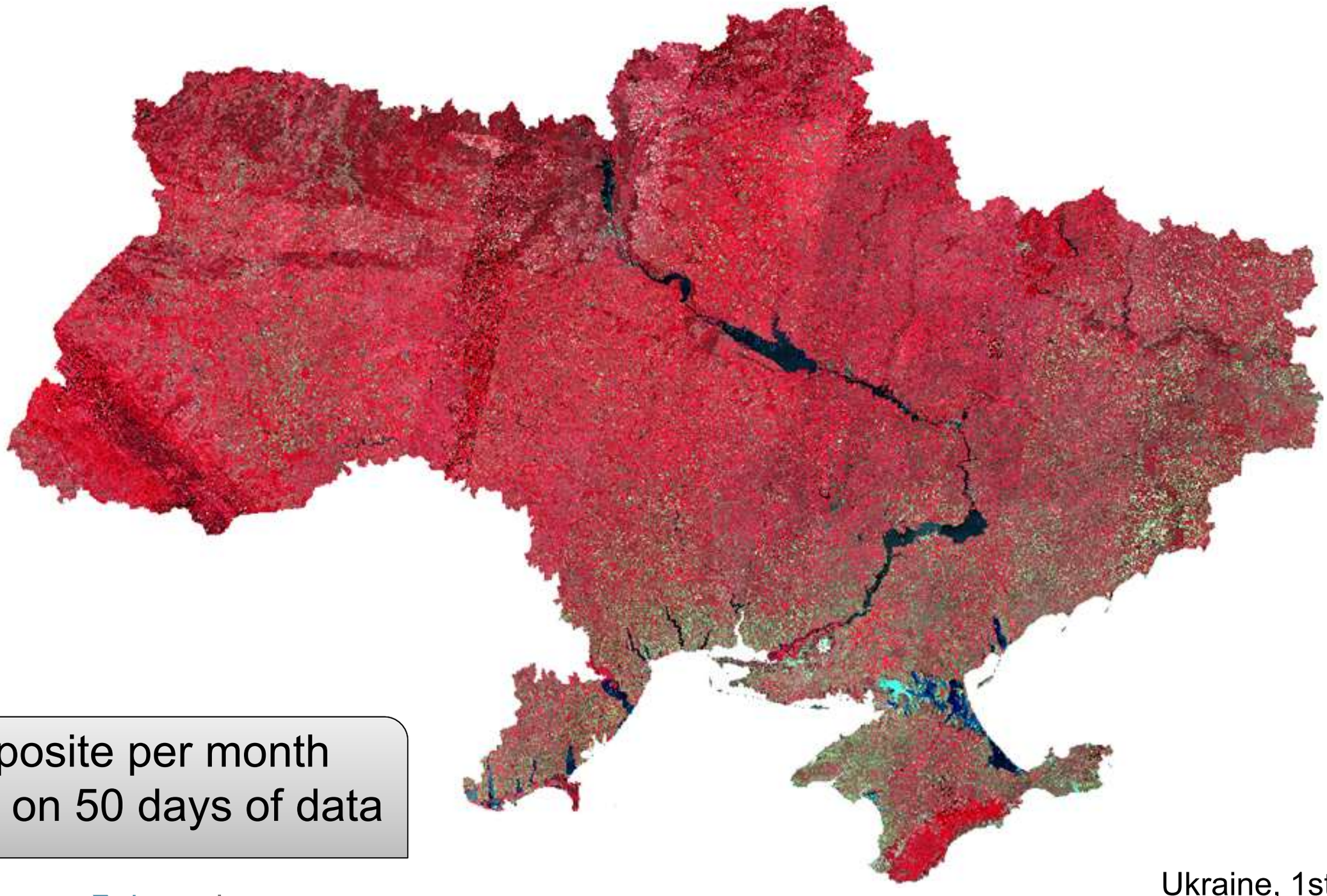


Area covered ~ 500 000 km²

// System developed and tested on 8 local sites



First nationwide cloud free composite at 10m resolution from Sentinel-2

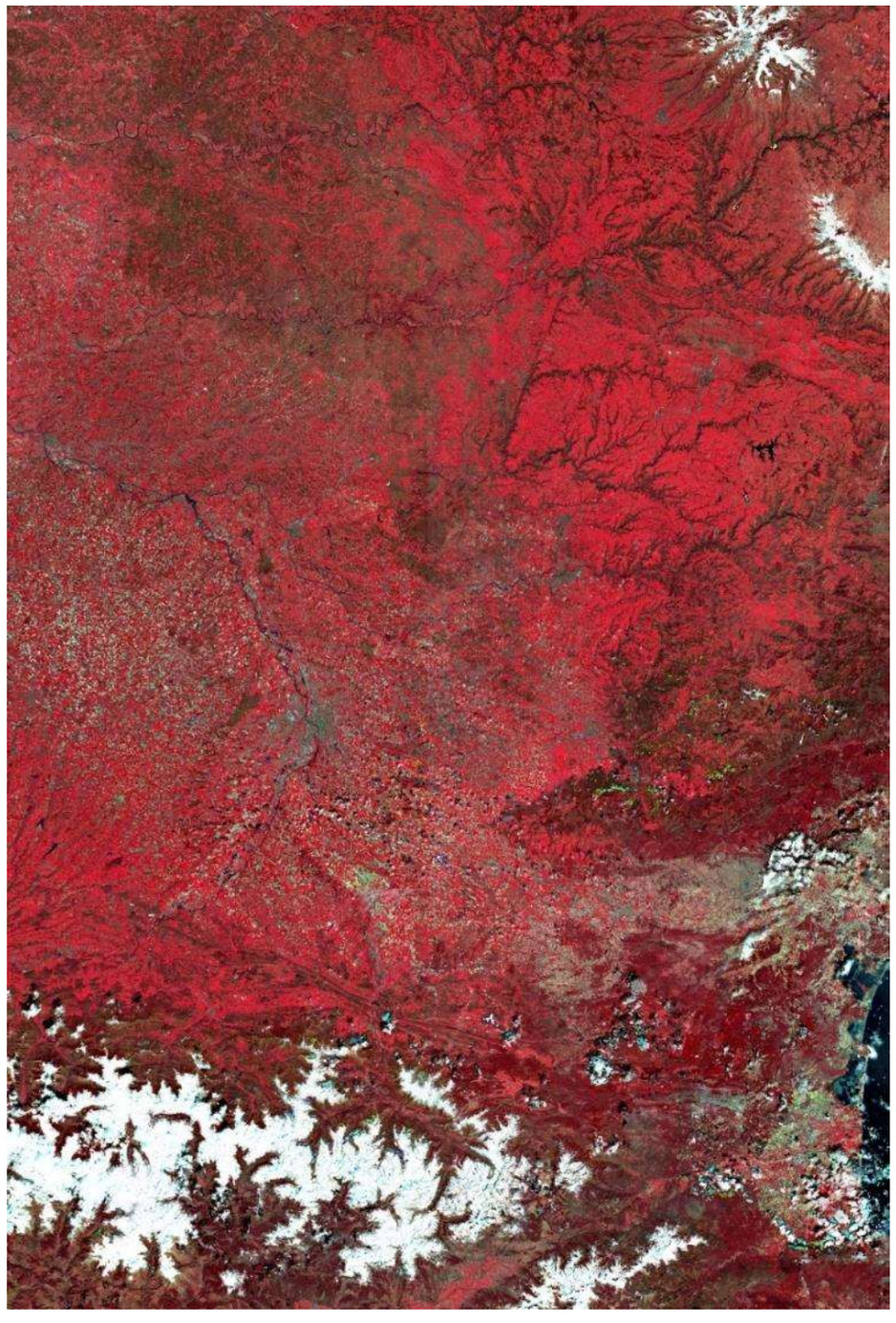


1 composite per month
Based on 50 days of data

Ukraine, 1st of July

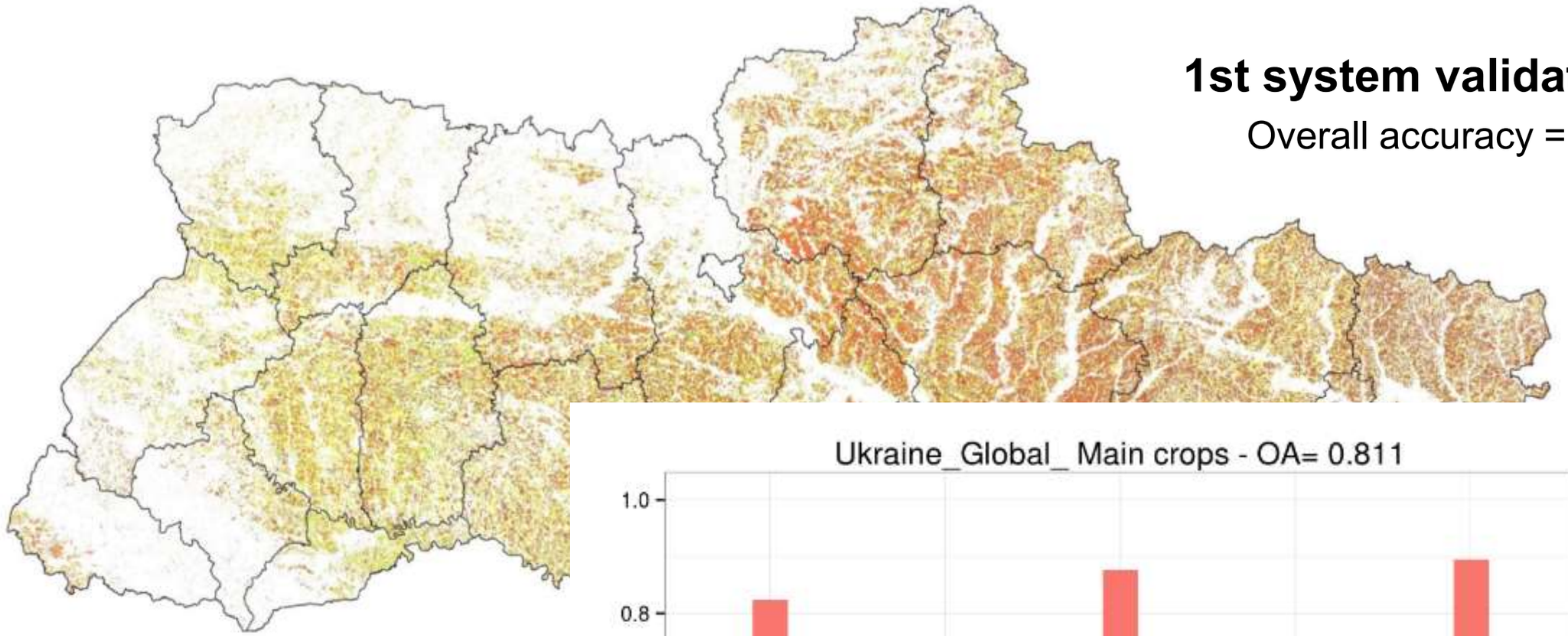
France & Sudan cloud free composite

France – Midi-Pyrénées



Sudan – White Nile / South Sudan

First nationwide croptype map at 10m resolution from Sentinel-2



UKRAINE CROP TYPE MAP 2016

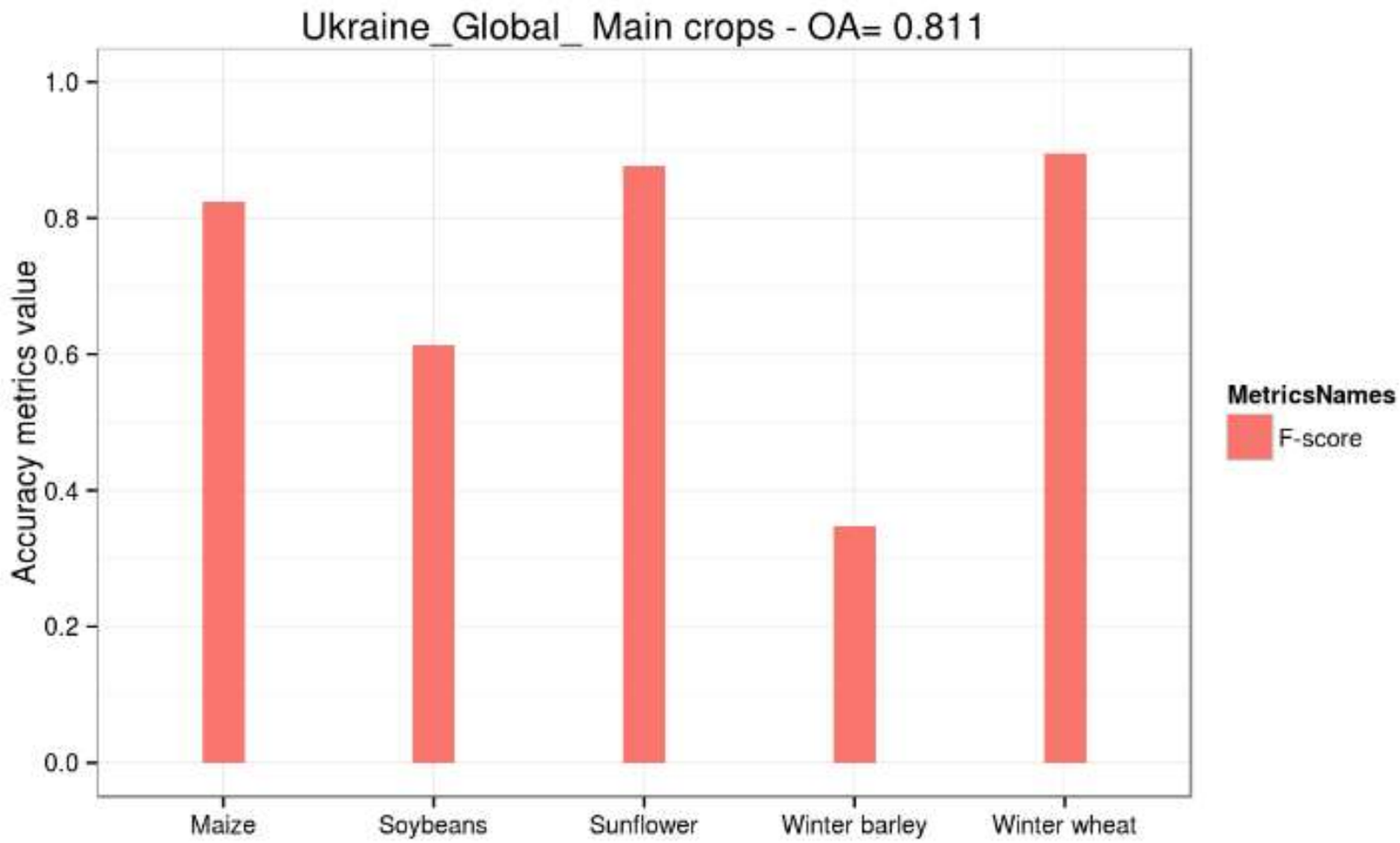
- Non-Cropland
- Maize
- Soybean
- Winter Wheat
- Spring barley
- Sunflower
- Other Crops

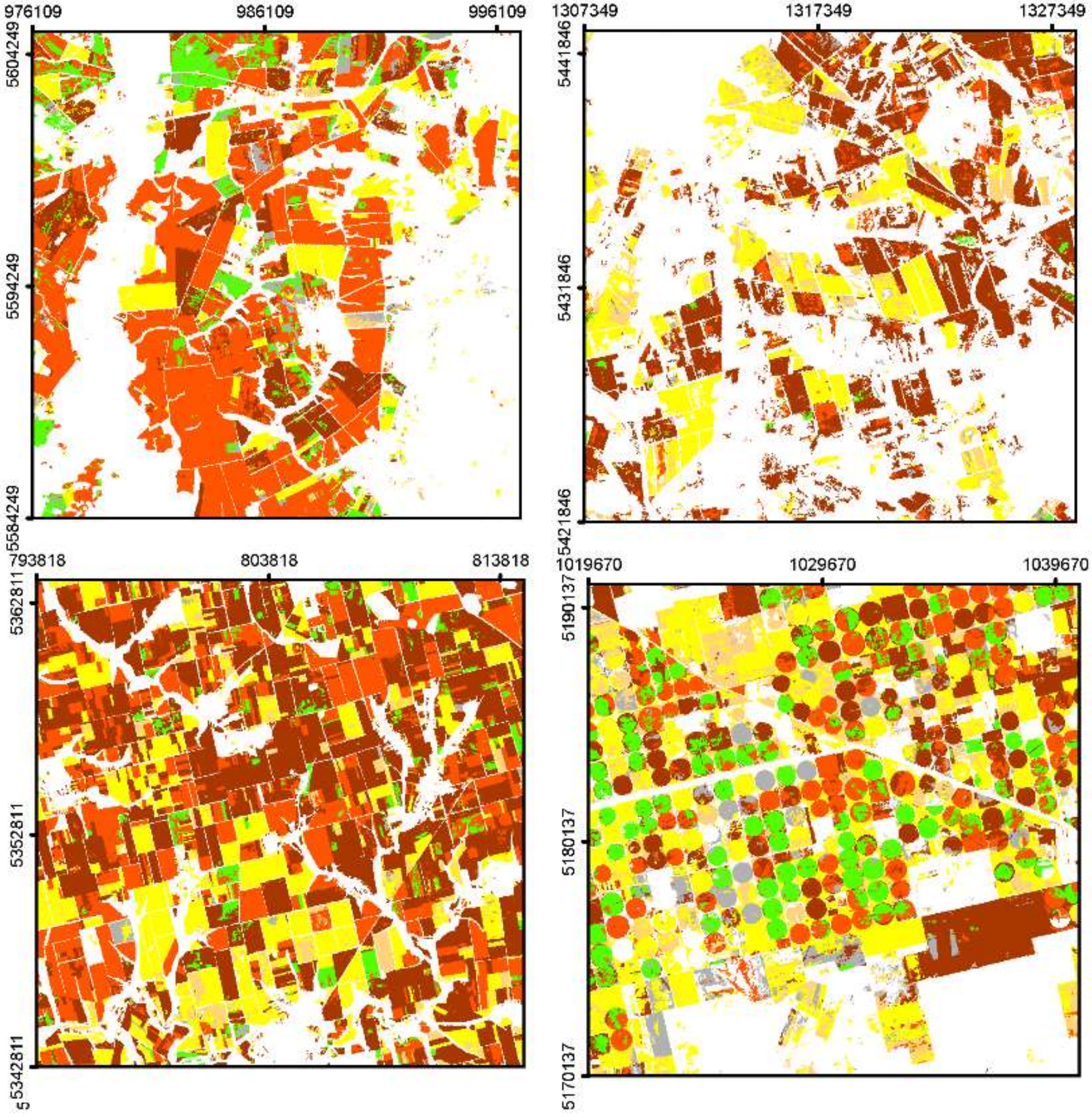
Crop mask

Overall accuracy: 0,9

1st system validation:

Overall accuracy = 0,81

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793818
803818
813818
5362811
5352811
5342811
1019670
1029670
1039670
5190137
5180137
5170137

Vegetation status map

GAI series over cropland

18/02/2016

18/04/2016

28/04/2016

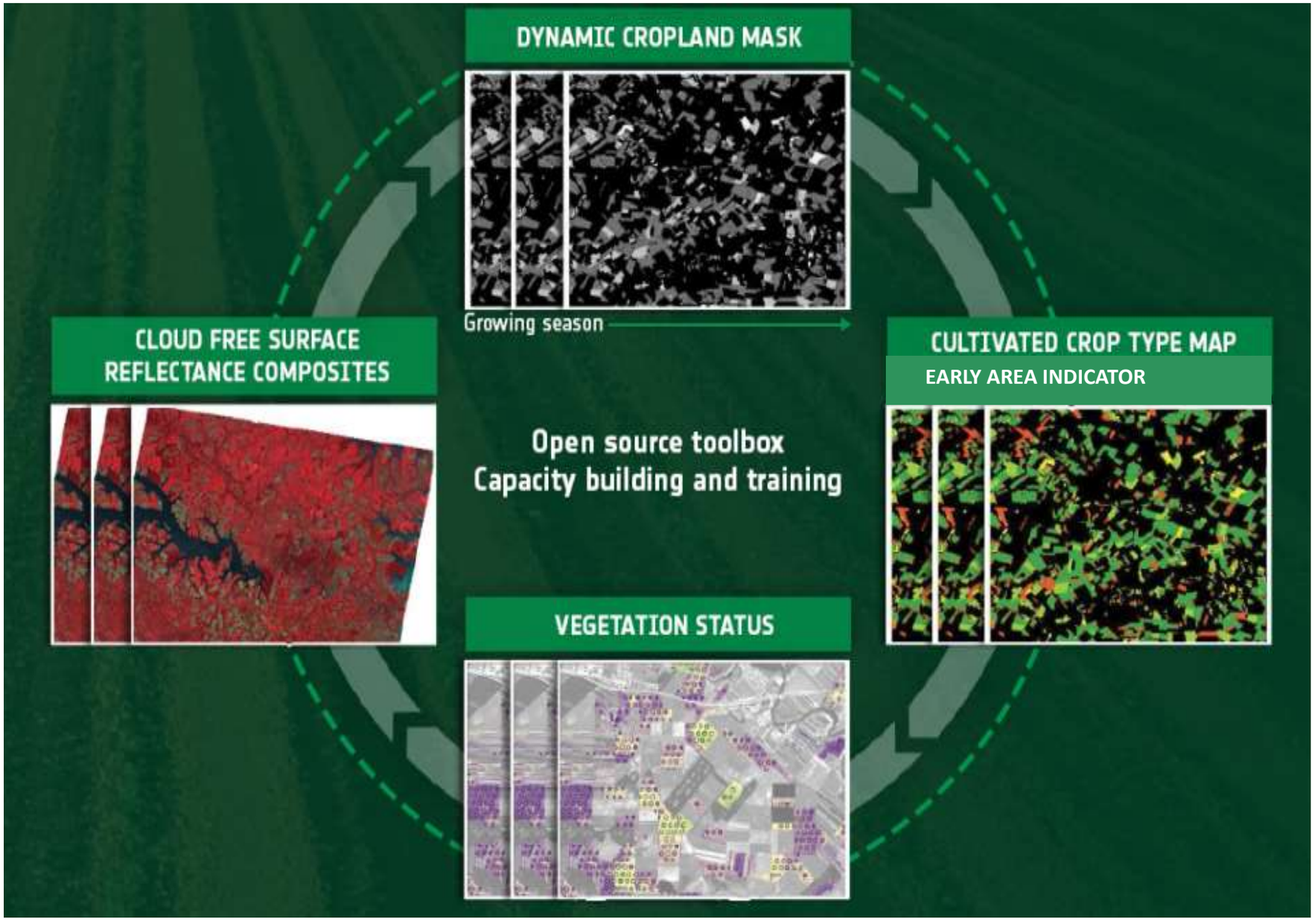
17/06/2016

17/07/2016

09/08/2016

Availability of the system

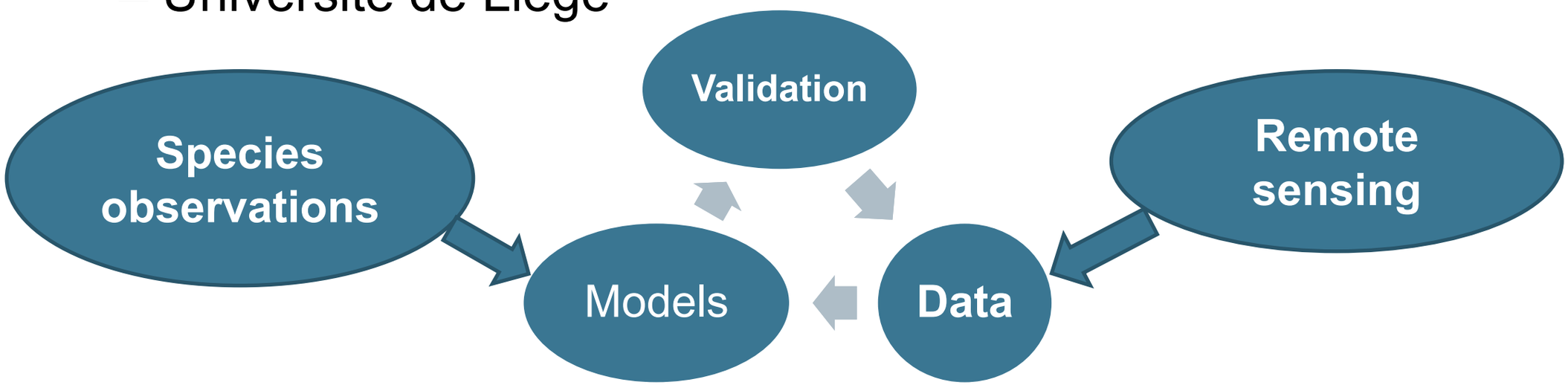
Free, open access and fully documented from May 2017
http://www.esa-sen2agri.org/



Lifewatch

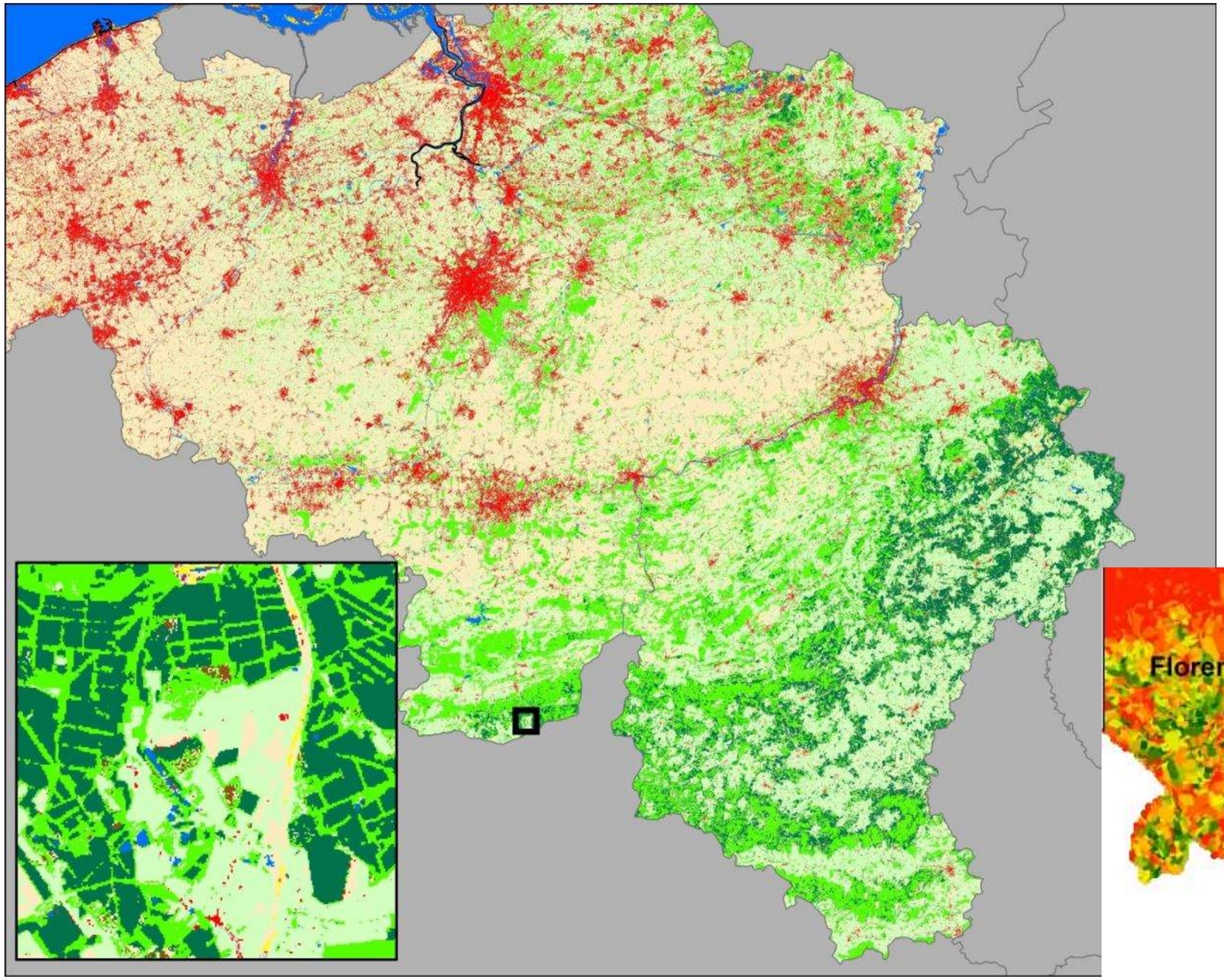
European Research Infrastructure Consortium for biodiversity research

- Partnership between two Universities
  - Université catholique de Louvain
  - Université de Liège

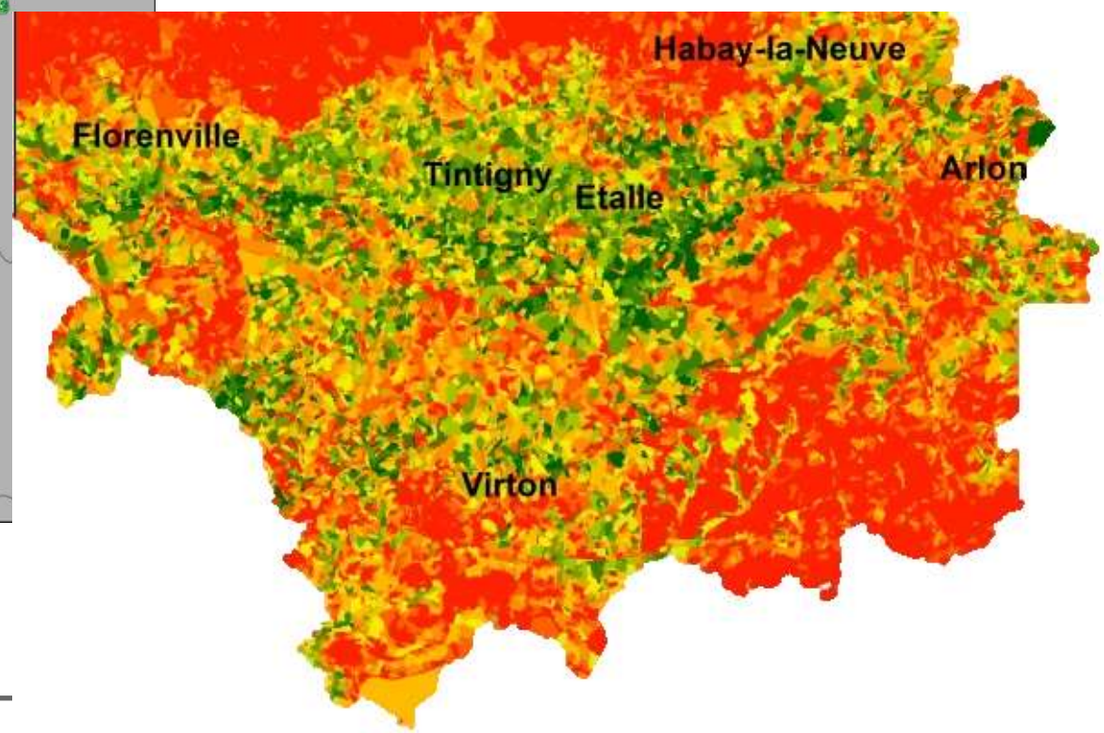


- Coarse resolution data for phenology
- High resolution data for land cover description

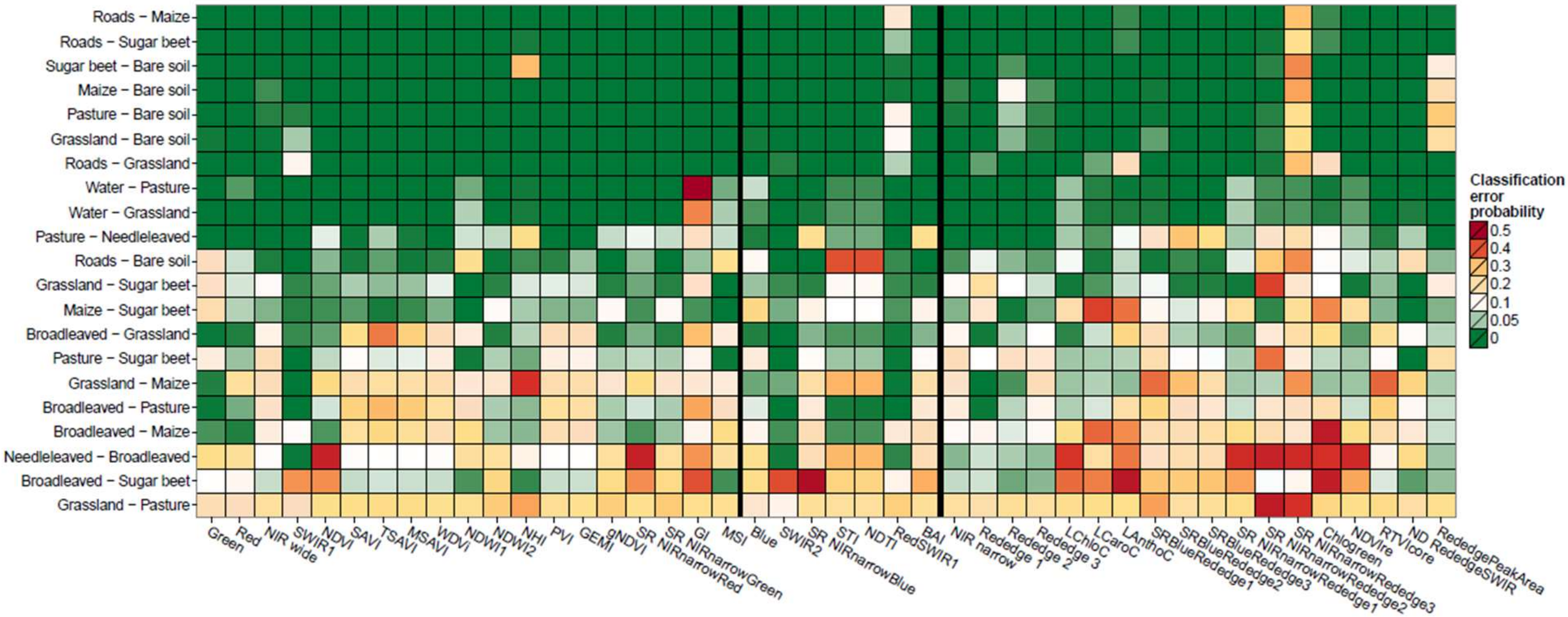
S2 classification (2016) contributes to land cover description used for habitat models



Lycaena dispar
habitat suitability map



Investigation of Sentinel-2 potential for small object detection



Minimal size for accurate detection :

- rivers → 5 m ,
- water bodies → 14 m ,
- roads surrounded by vegetation → 5-7 m

Radoux et al, 2016, Remote Sensing

From October 2014 to March 2019

From March 2014 to March 2017

www.lifewatch.be

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