

# Sen4CAP Hands-on Training

22-23 January 2020  
UCLouvain, Belgium

Welcome  
Pr. P. Defourny, UCLouvain – Belgium



**sen4cap**  
common agricultural policy

**UCL**  
Université  
catholique  
de Louvain



**e-geos**  
AN ASI / TELESPIAZIO COMPANY





## sen4cap

common agricultural policy



### Sen4CAP Objectives:

- **Provide evidence** how Sentinel derived information can support the modernization and simplification of the CAP **in the post 2020 timeframe**
- Provide **validated algorithms, products, workflows** and **best practices** for agriculture monitoring relevant for the management of the CAP

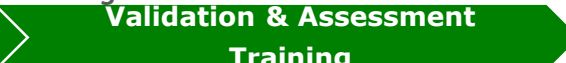
2017 ag. season – local sites



2018 ag. season – 6 national cases



2019 ag. season – 6 NRT national demo



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# A University rich of history through the centuries

## Foundation in 1425

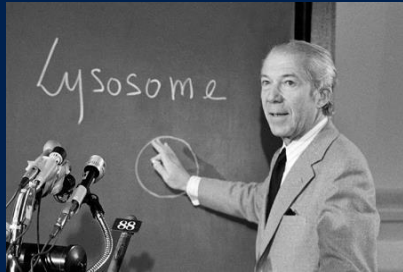
- » **1502: Erasme** taught in Louvain
- » **1595: Mercator** published his map projection
- » **1933: Georges Lemaître** proposed its « Big Bang » theory
- » **1974: Christian de Duve** – Nobel Price of Medecine

## Today an internationally attractive University

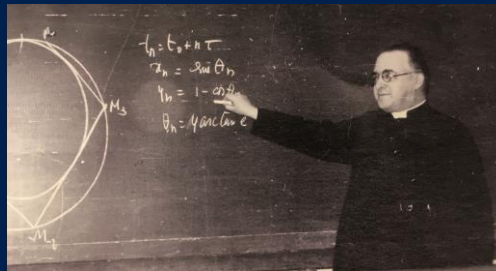
- +31 000 students, 6000 staff members
- 17 % international from 120 countries
- 7 locations in Belgium
- 2 univ. hospitals
- 2 experimental farms



## Tradition of Excellence



Christian de Duve



Georges Lemaître



Erasmus

- **128<sup>th</sup>** in the Times Higher Education Ranking
- **152** in the Shanghai Ranking
- **4<sup>th</sup>** Worldwide amongst comprehensive French-speaking universities
- **1<sup>st</sup>** French-Speaking university in Belgium

## Tradition of Excellence



Mercator



## International Outlook

- **17%** International Undergraduate and Master students
- **44%** International PhD students
- **30%** International teaching/research staff
- **>50** Joint degree programs with an international university





Louvain4  
Nutrition



Louvain4  
Ageing



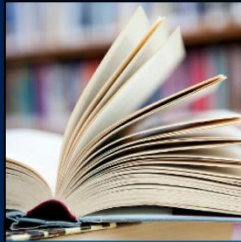
Louvain4  
Cities



Louvain4  
Space



Louvain4  
Migration



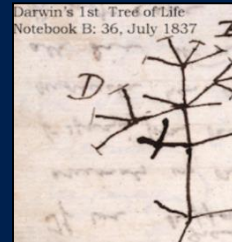
Louvain4  
Education



Louvain4  
Energy



Louvain4  
Water



Louvain4  
Evolution

# Louvain4Space

## Louvain4Space

- to **develop new projects** from a multidisciplinary approach;
- to **sustain our contribution to adress major challenges** for our societies;



Platform at University level  
More than 80 faculty members  
Spatial at UCLouvain across many disciplines

SST					SSS		SSH		
ELI	ICTM	IMCN	IMMC	IRMP	IONS	IREC	ESPO	ISP	ISPOLE
Recherche Spatiale									

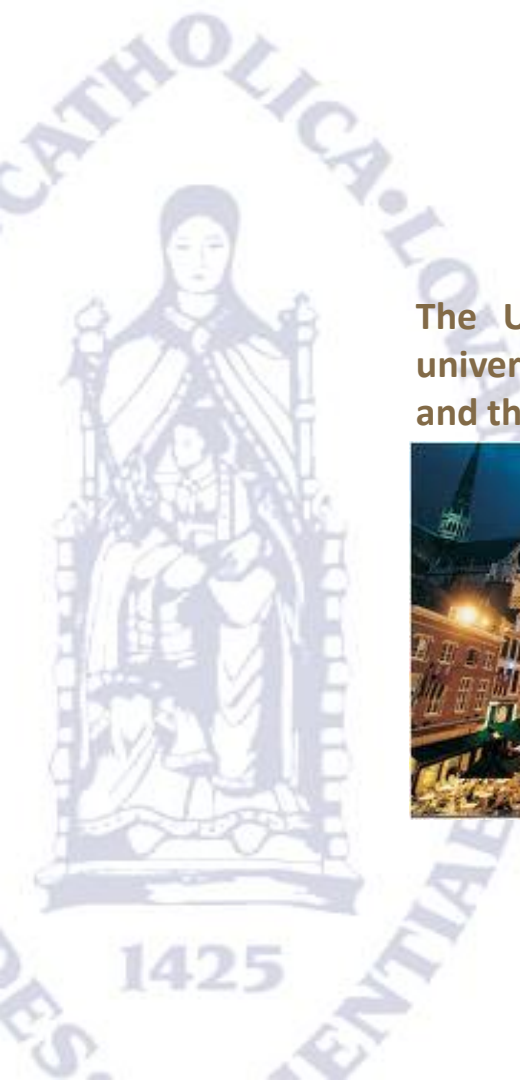


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# UCLouvain

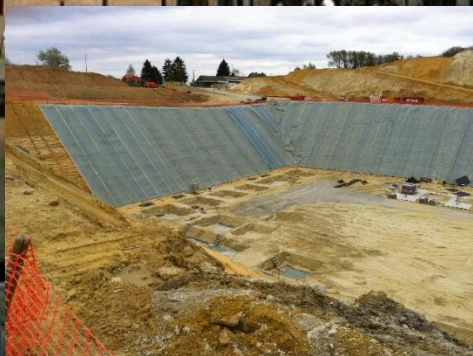


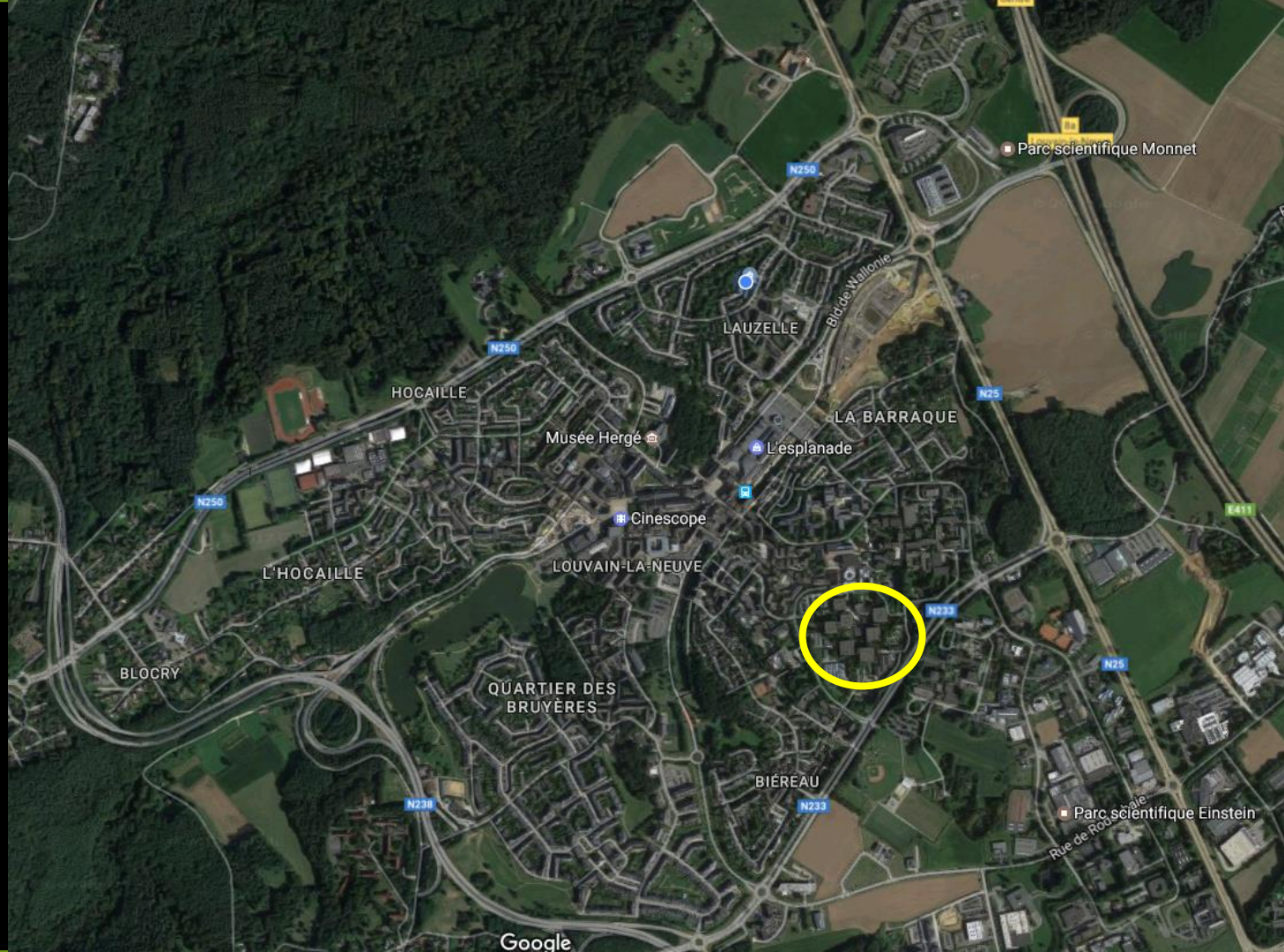
The Université catholique de Louvain, founded in 1425, split into two universities : the French-speaking UCLouvain in the town of Louvain-la-Neuve and the the Dutch-speaking KULeuven located in the Flemish city of Leuven.



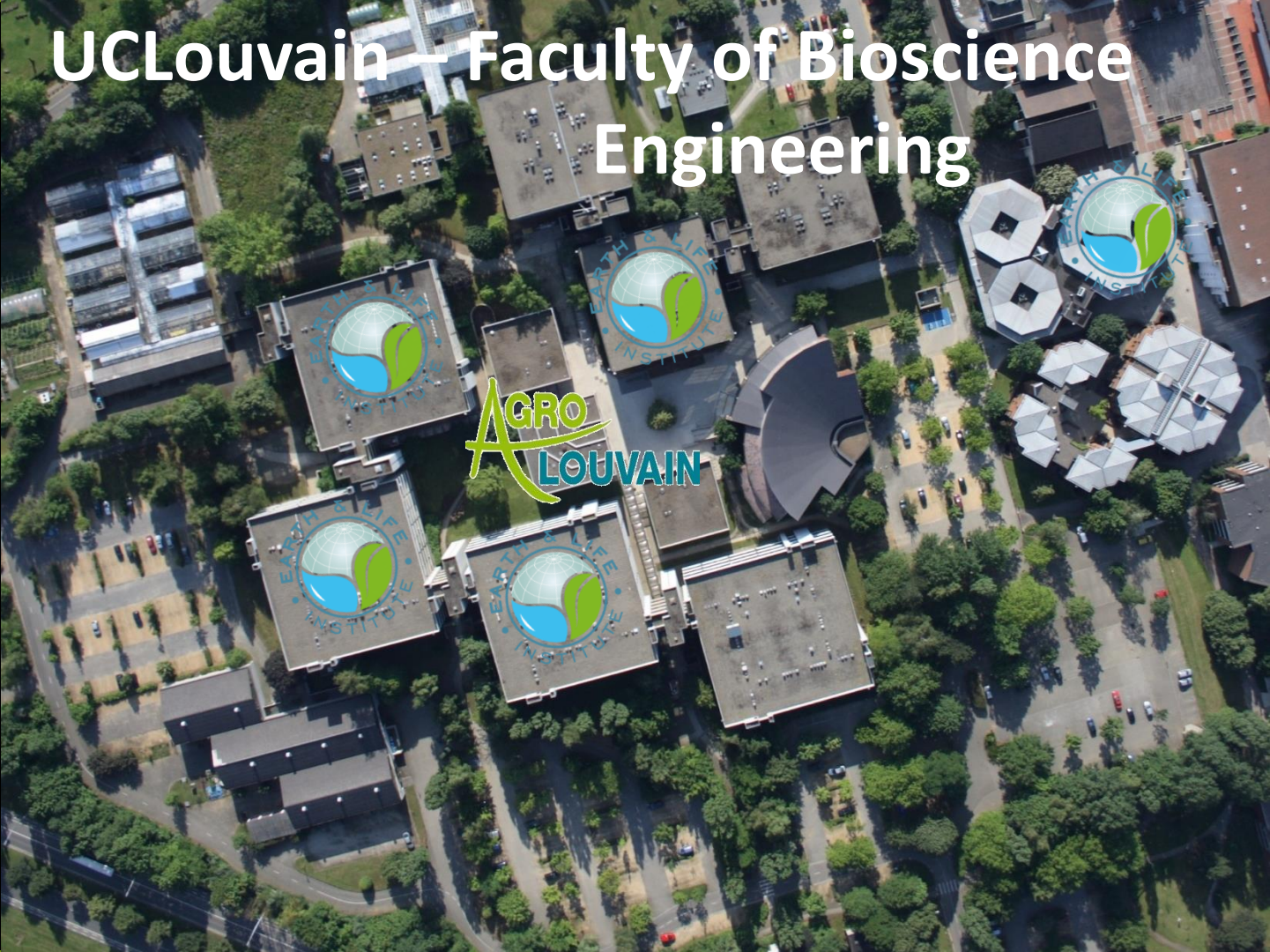
Louvain-la-Neuve - *a pioneer urban project designed 45 years ago as an ecofriendly town and built from scratch in the farm fields*



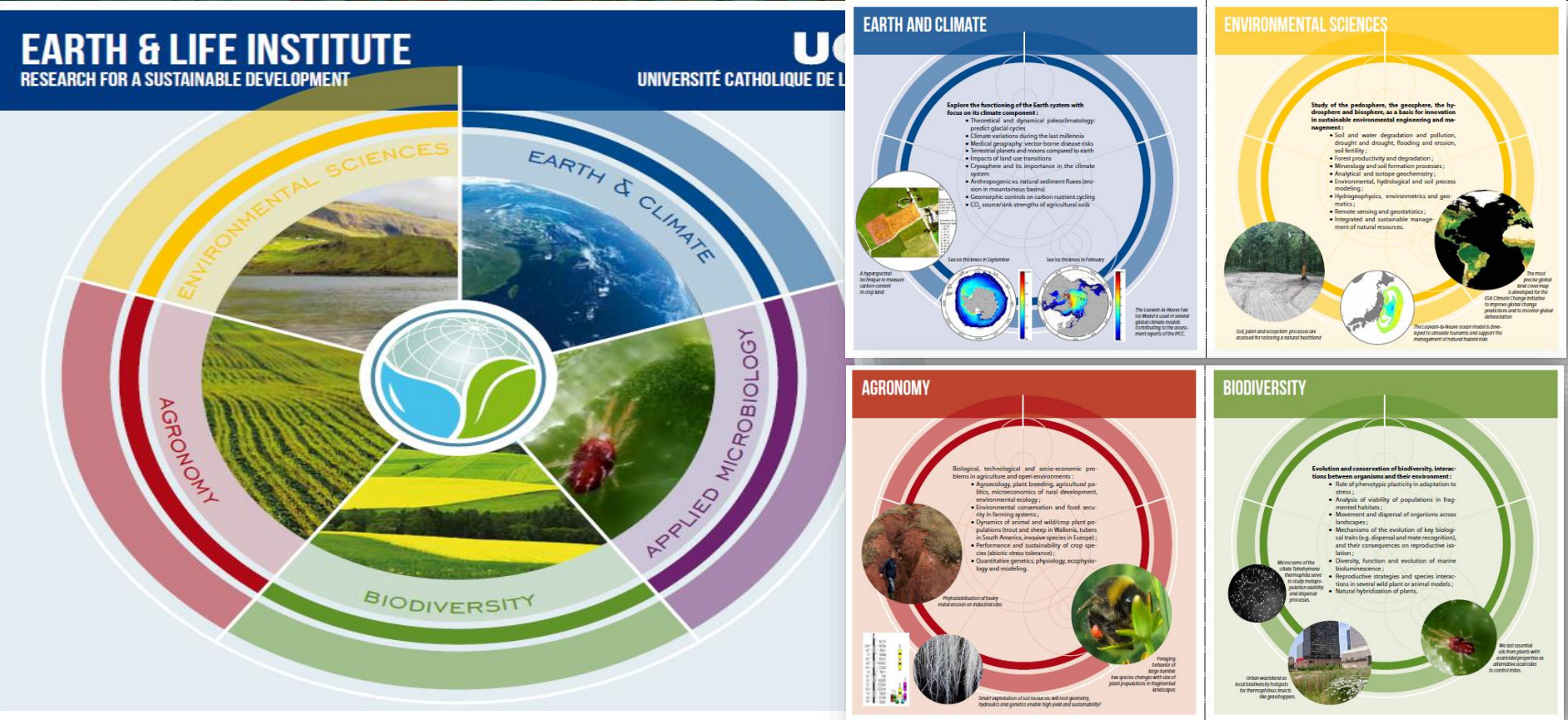


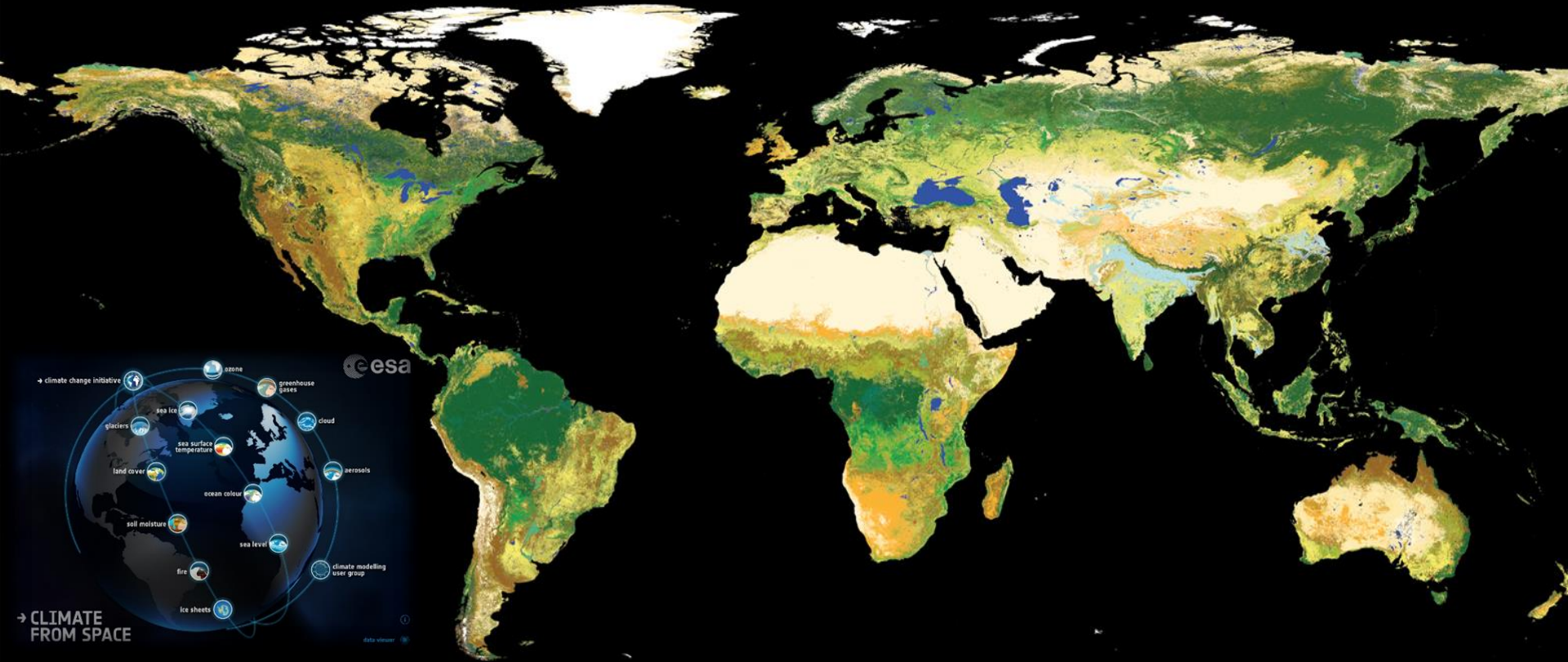


# UCLouvain – Faculty of Bioscience Engineering



# UCLouvain Earth Observation mainly in the Earth and Life Institute





**GlobCover 2005 & 2009 introduced automated global LC mapping using the full 300 m MERIS time series**



Climate  
Change

# EU Copernicus service (C3S): 1992 - 2018

## Consistent 300 m annual global LC time series

UCLouvain  
Earth and Life Institute • Geomatics

MÉRIS full archive  
(2003-2012)

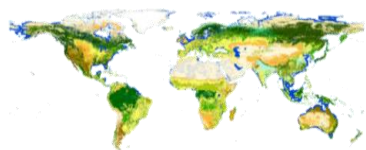
AVHRR  
(1992-1999)

SPOT-VGT full archive  
(1999-2014)

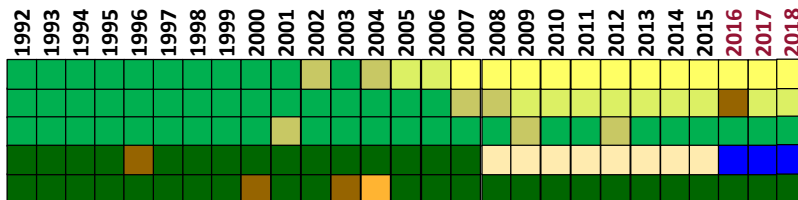
PROBA-V  
(2014-2015, 2016-2019)

CCI time series classification chain

Baseline  
(2003-2012)



Annual per-pixel temporal trajectories



Back- and up-dating applied to all classes

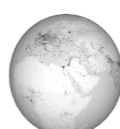
+ Blending of existing of single class layers



no annual change



including annual change



Global  
Urban Footprint

1992

1993

1994

...

2014

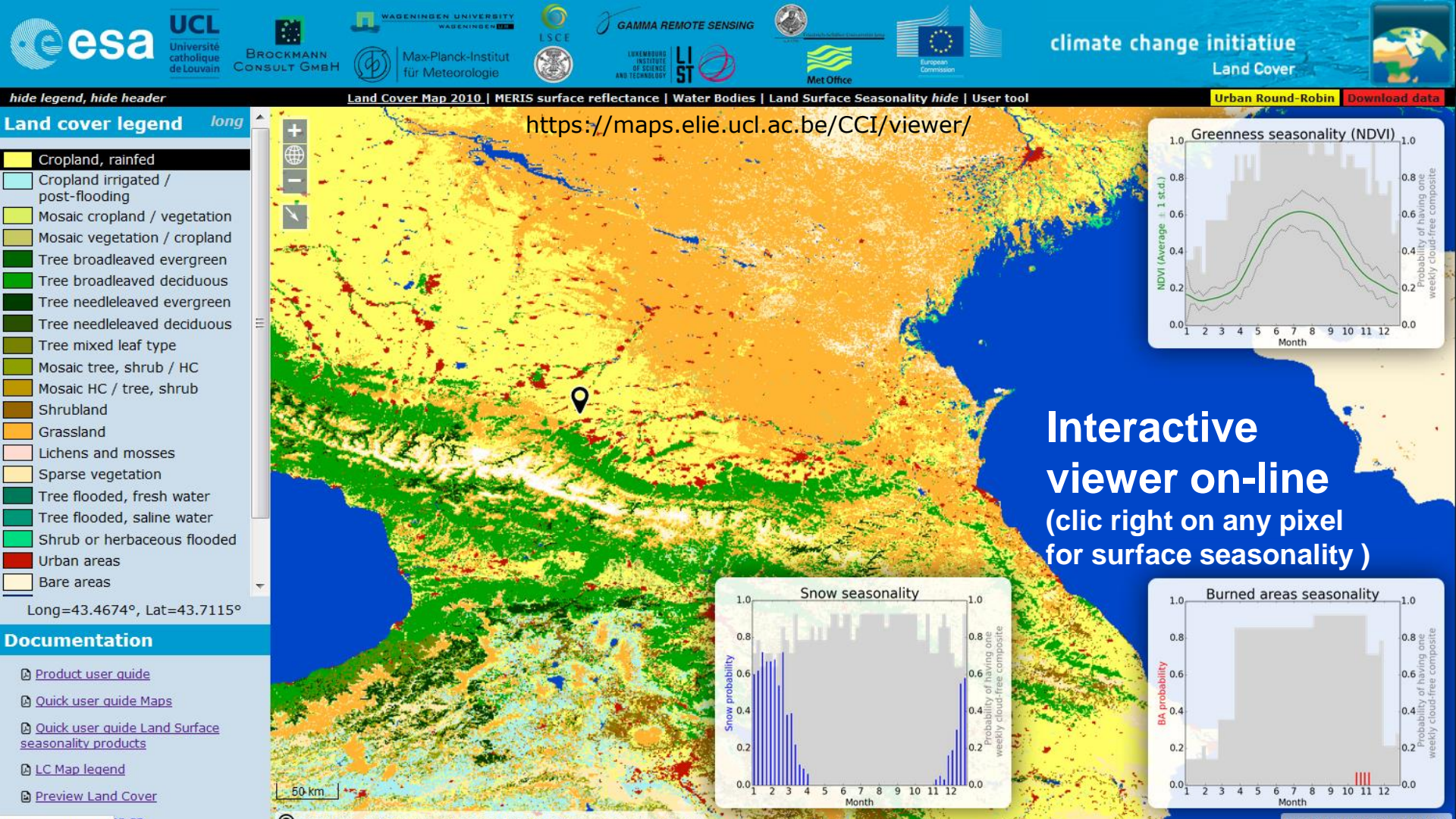
2015

2016

2017

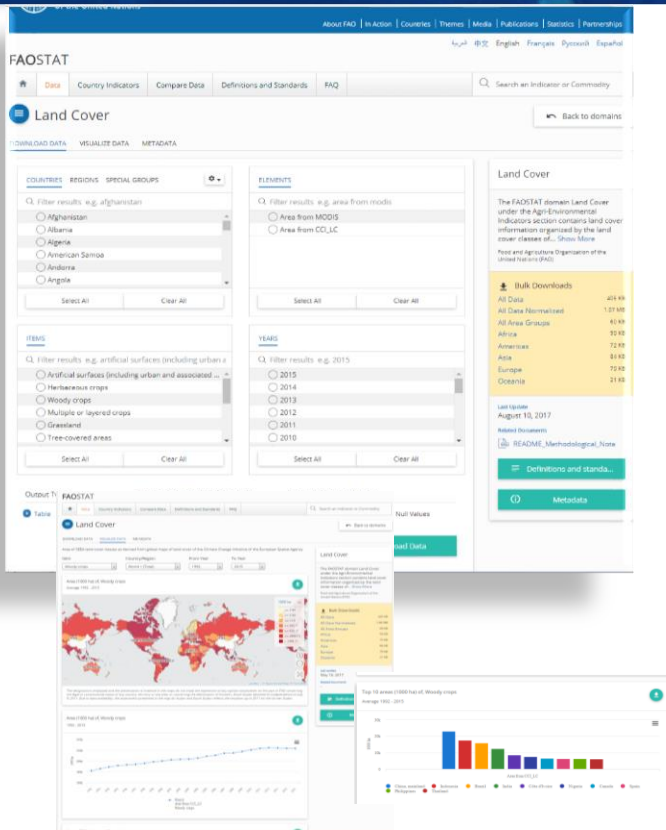
2018

27 consistent annual LC maps



# FAO-Stat uptake for its Environ. Accounting System

## OECD USES ESA DATA TO MEASURE GREEN GROWTH



### An OECD Green Growth headline indicator

Changes in the biophysical characteristics of natural habitats are the best proxy available to monitor pressures on ecosystems and biodiversity.

The OECD headline indicator seeks to measure changes from more natural to more anthropogenic land cover types. This is because at the global scale, natural vegetated areas are critical for the conservation of biodiversity and the provision of ecosystem services.

The headline indicator measures changes in natural and semi-natural vegetated land which is used to identify the less anthropogenic and less intensively used vegetated

land. This broad definition has the advantage of being flexible enough to apply usefully across the Earth's biomes in all their extraordinary diversity. In its current edition, the headline indicator distinguishes nine broad land cover classes: tree cover, grassland, wetland, shrubland, sparse vegetation – classified as (semi-) natural land – as well as cropland, bare land, inland water and artificial surfaces.

### Monitoring progress towards Green Growth

Our ability to sustain economic and social progress in the long run will depend on our capacity to reduce dependence on natural capital as a source of growth, abate pollution, enhance the quality of physical and human capital and reinforce our institutions. An indicator on changes in land use and land cover has been included in the set of Green Growth headline indicators. They are to be used in the country reports prepared out by the OECD, in policy analyses at national and sub-national level, and in communication by the OECD.

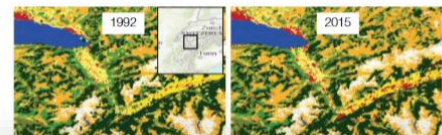
Report and browse data on <http://oe.cd/ggi>.

### Monitoring Land cover change

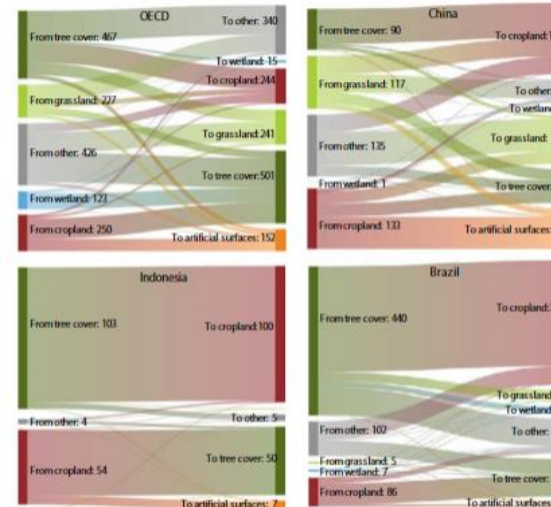


### Urbanisation in the Alpine valleys

Land cover changes in Haute-Savoie (left), Lake Geneva and Valais (upper left, centre and right) and Aosta (lower-right) regions of France, Switzerland and Italy. Urbanisation (red) of cropland and grassland (yellow and orange) is widespread.



### Patterns of land cover change 1992-2015, thousand km²



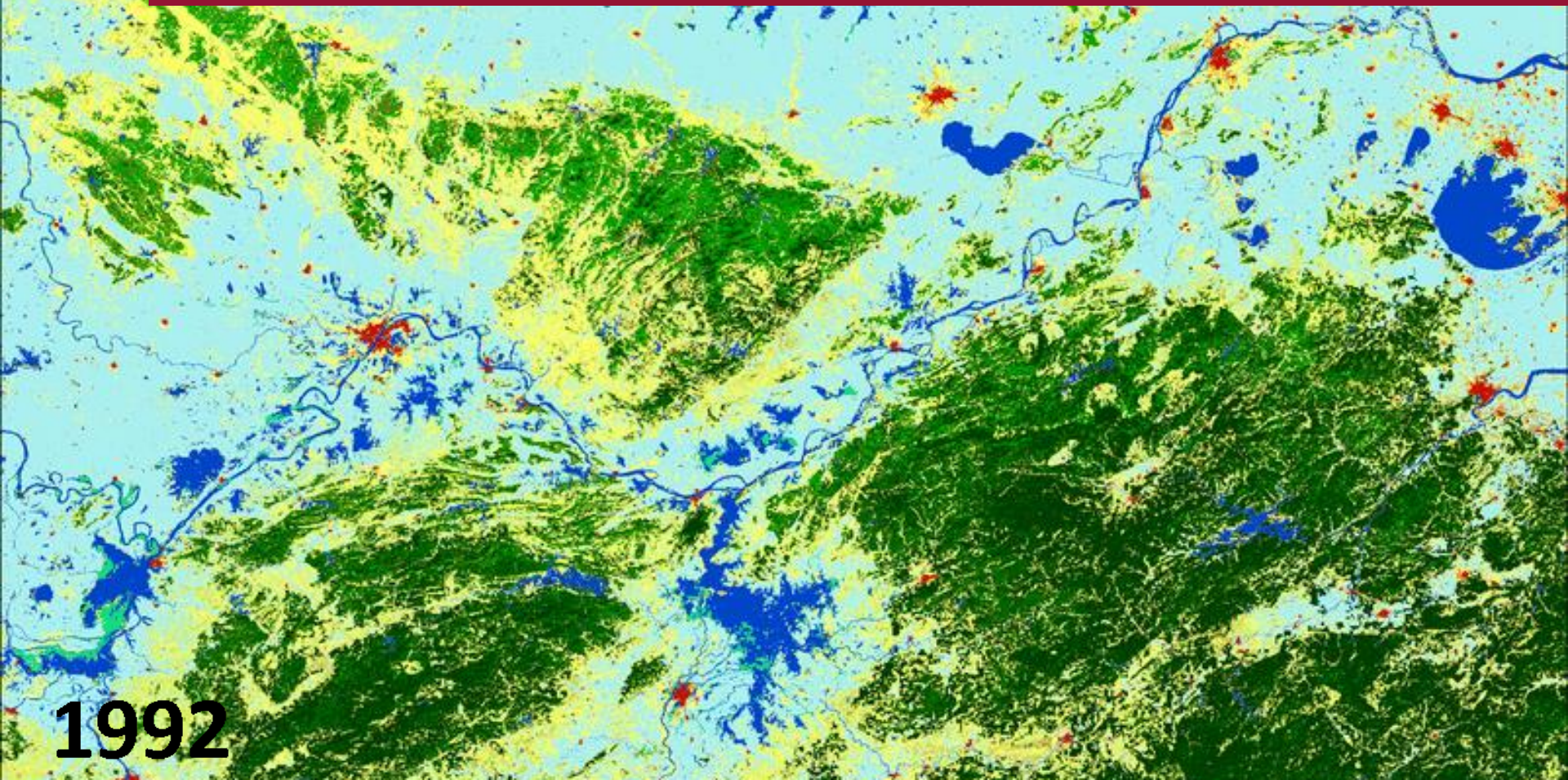
<http://www.oecd.org/env/indicators-modelling-outlooks/monitoring-land-cover-change.htm>

Consistent deforestation patterns captured from  
1992 to 2017 in Paraguay

1992

A satellite map of Paraguay in 1992. The map shows a dense green forest covering most of the land. A prominent blue line, representing a river, runs vertically along the right side of the image. There are several small, irregular yellow and brown patches scattered across the green forest, indicating early stages of deforestation. The overall texture of the map is grainy, typical of satellite imagery from that era.

Land cover change captured from 1992 to 2017 in  
China



1992

# First regional LC map at 10m - Meso America LC 2017



# First continental map at 20 m available for feedback and download from ESA since Sept. 2018



ESA CCI LC 2016 Web Viewer

Home

Viewer

Download

Feedback

Users Feedback Compendium



## → CCI LAND COVER - S2 PROTOTYPE LAND COVER 20M MAP OF AFRICA 2016



48112 views



3667 downloads



### → Info

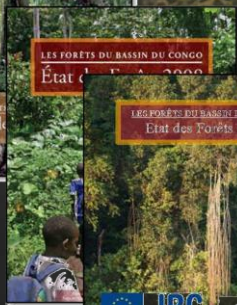
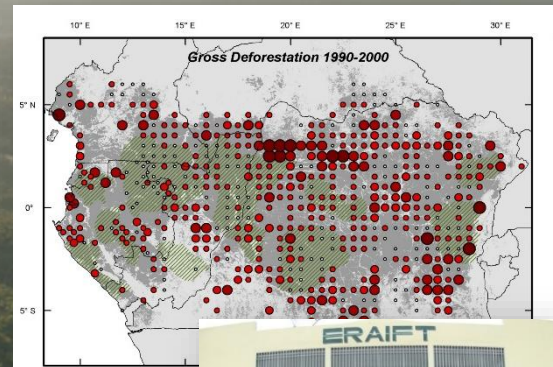
The CCI Land Cover (LC) team is proud to announce the successful development of a prototype high resolution LC map at 20m over Africa based on 1 year of Sentinel-2A observations from December 2015 to December 2016. The main objective of the 'S2 prototype LC map at 20m of Africa 2016' release is to collect users feedback for further improvements.

<http://2016africalandcover20m.esrin.esa.int/>

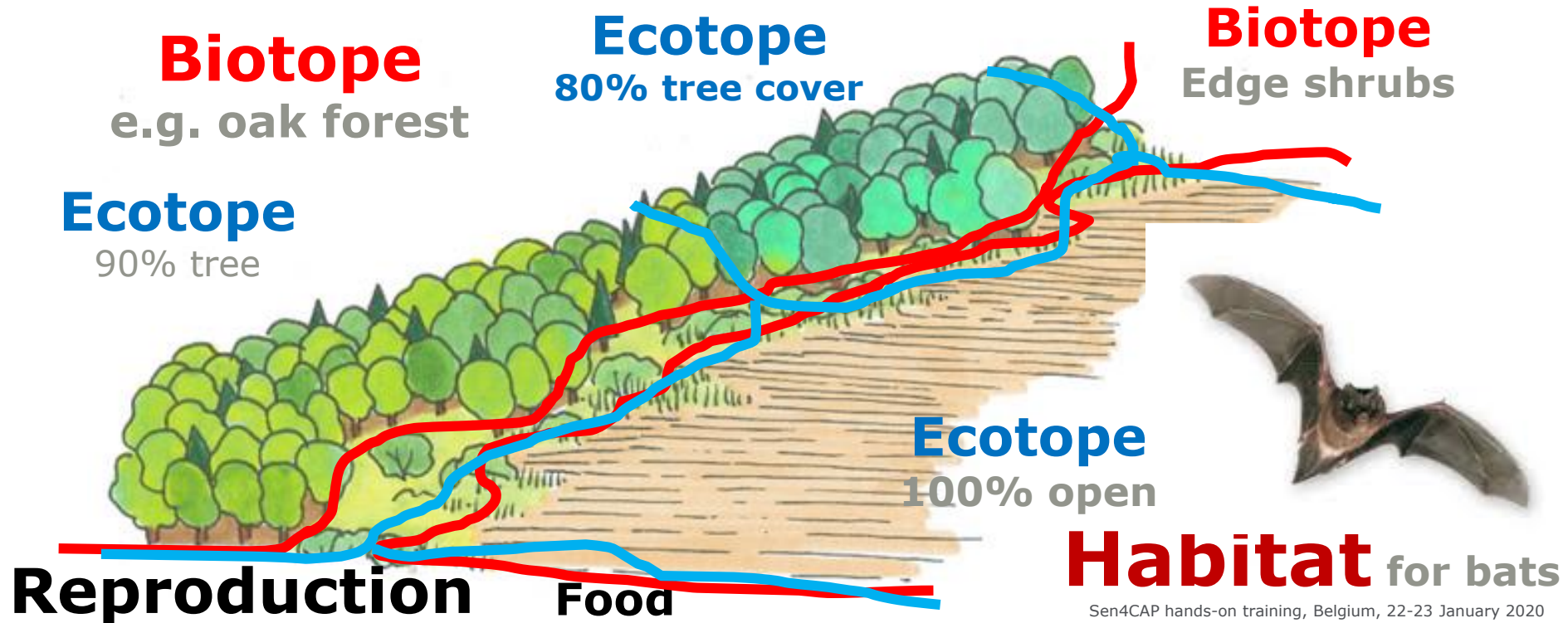
Des connaissances aux services de tous

# Observatoire des forêts d'Afrique Centrale

Découvrez l'Observatoire

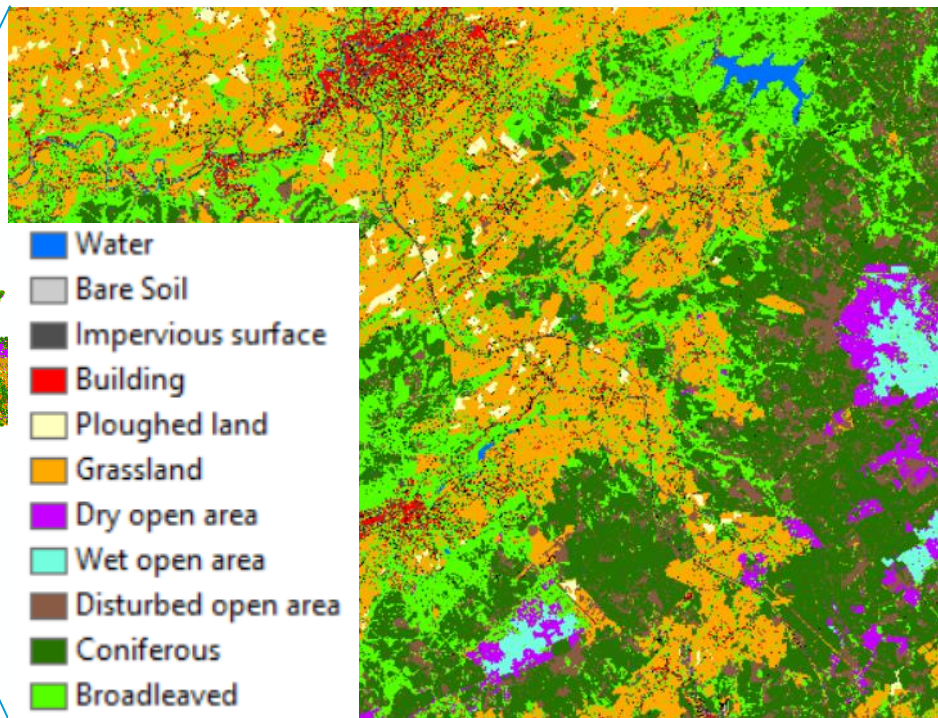
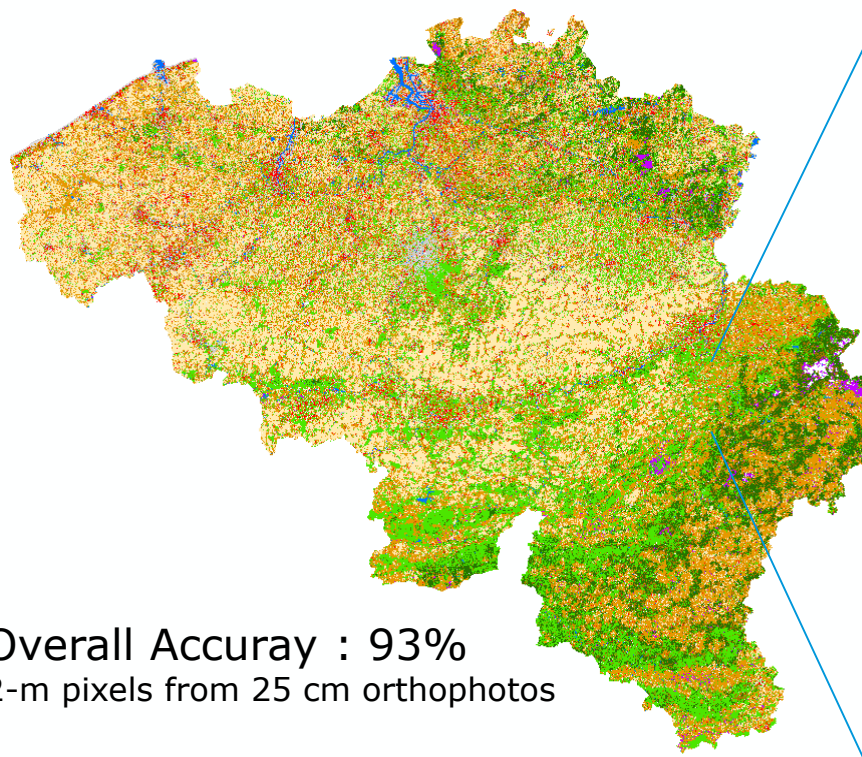


*UCLouvain in charge of terrestrial habitat characterisation*



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# VHR Land cover not enough for ecological habitat




Overall Accuracy : 93%  
2-m pixels from 25 cm orthophotos

(Radoux et al., 2019)

2006

2015

## Land cover variables

 Tree cover, broadleaved, deciduous, closed to open (>15%)

## detail in the ecotope:

73%

9

17%

## 250m around the ecotope:

41%

14%

18%

26%

## 500m around the ecotope:

23%

15%

7

46%

10

## Soil variables

## Ecosystem dynamics

## Ecotopes

Ecotope content

Thematic legend

Variables alone

Mix variables

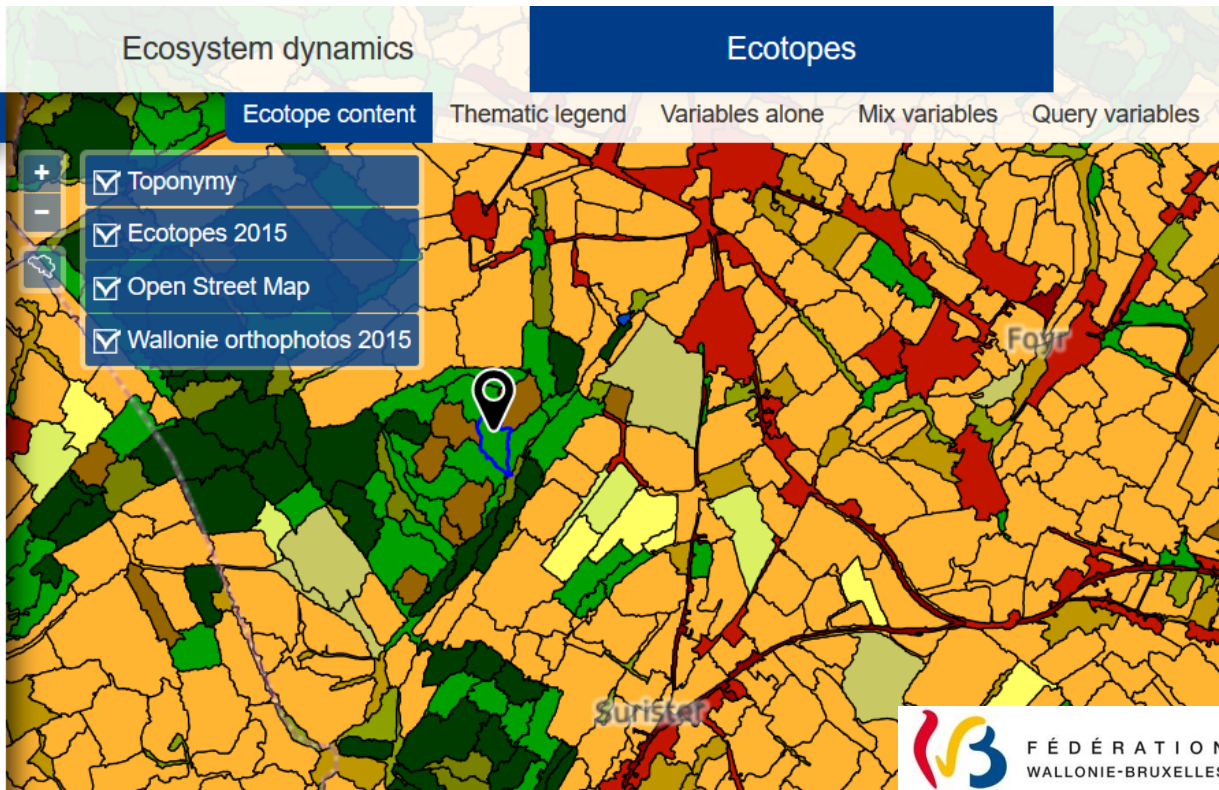
Query variables

☒ Toponymy

☒ Ecotopes 2015

☒ Open Street Map

☒ Wallonie orthophotos 2015



[uclouvain.be/lifewatch](http://uclouvain.be/lifewatch)

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## Sentinel-2 and Landsat-8 enabling

- crop specific monitoring at parcel level
- crop type area indicator at national scale

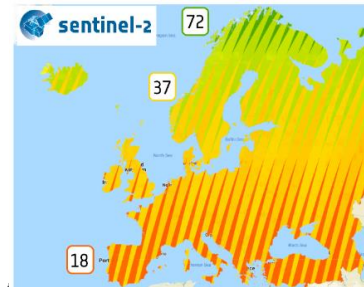
# How to handle such a huge amount of EO data in NRT for agriculture ?

- ❑ Food monitoring is a very sensitive issue for national security / sovereignty  
=> ***governmental willingness to master the information process***
- ❑ Crop-specific monitoring can have major impacts on the international markets  
=> ***timeliness makes the information value***
- ❑ **Big volume of EO imagery** need to be processed continuously to an appropriate level (Level 4) still to be turned into relevant information:

Country (in TB)	S1 SLC	S2 L1C	L8 L1T	S1 L2A	S2 L2A	L8 L2A
Italy	25,43	1,78	1,43	17,57	5,12	0,93

28 TB                      23 TB

⇒ **How to streamline data flow from observation to information ?**



Sen4CAP hands-on

S-2A & -2B (July-Sept 2018)

# Sen2-Agri: from an ESA project to an open source system

Algorithm  
Development  
2014

Prototypes of  
EO products  
2015

Demonstration &  
Validation  
2016-2018

Uptake &  
Operations  
2017...

Users Products spec.  
Benchmarked  
Methods

System Development  
Products prototype  
SPOT5-T5

National use cases  
Local use cases

Capacity building  
Training activities

Fitness-to-use  
assessment

System qualification

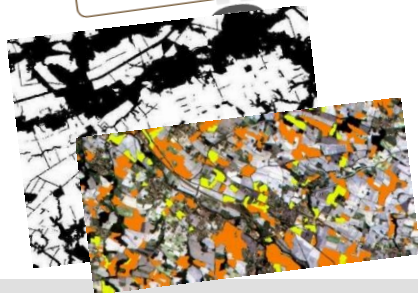
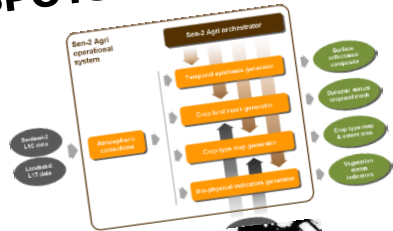
1300+ downloads

20+ large scale  
Implementation

System support

Bi-monthly  
webinars

Capacity  
building



Hands-on training Belgium, 22-23 January 2020

European Space Agency



# Sen2Agri system : an open source system demonstrated at full scale in NRT or off-line, running locally or in the cloud



Sen-2 Agri  
operational  
system

Sen-2 Agri orchestrator

**Version 2.0 release !**

Temporal synthesis generator

Crop land mask generator

Crop type map generator

Bio-physical indicators generator

In situ  
information

L1 time  
series

Atmospheric  
corrections

L2A time  
series



sentinel-2

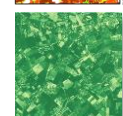
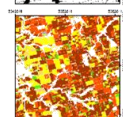
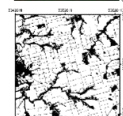
→ AGRICULTURE

Surface  
reflectance  
composite

Dynamic annual  
cropland mask

Crop type map  
& extent area

Vegetation  
status indicators



Monthly cloud free  
surface reflectance  
composite at 10-20 m

Cropland mask at 10m  
updated every month

Crop type map at 10 m  
for the main regional  
crops

Vegetation status map  
at 10 m delivered every  
week (NDVI, LAI, fCover, fAPAR)



Documented and downloadable at  
[www.esa-sen2agri.org/resources/software/](http://www.esa-sen2agri.org/resources/software/)

UCLouvain



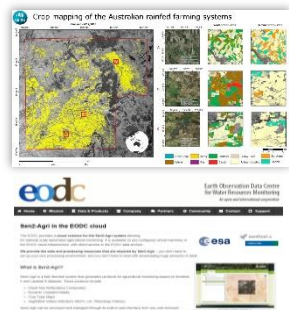
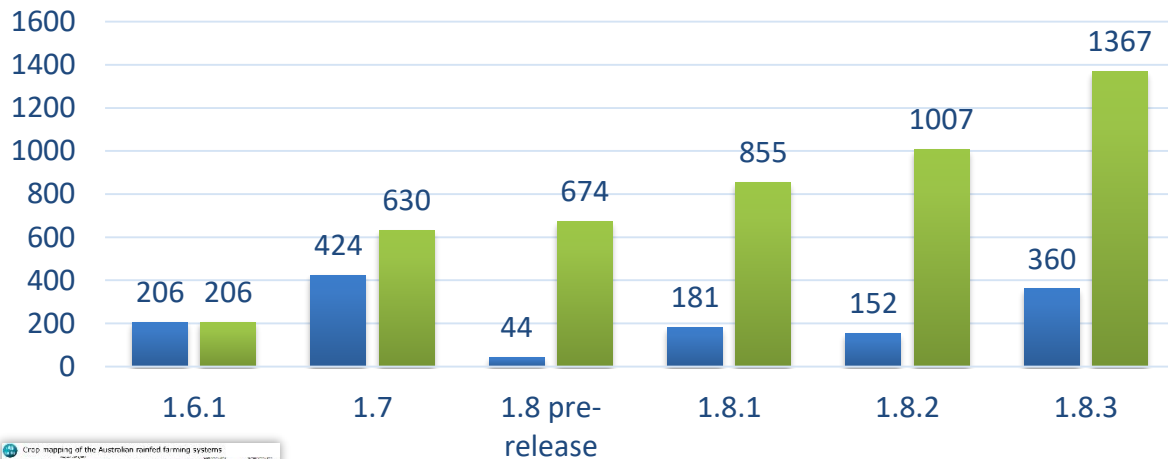
CS

CS

European Space Agency

# Sen2-Agri system download

## Downloads since July 2017

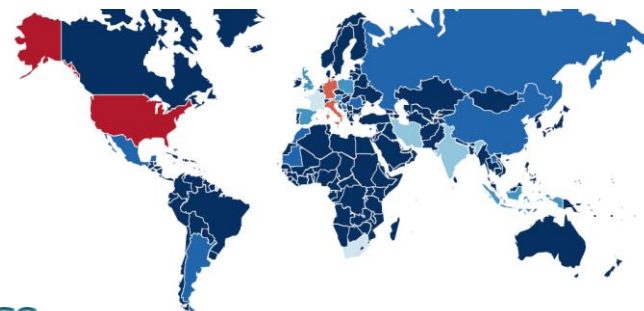


■ Downloads ■ Cumulative Downloads



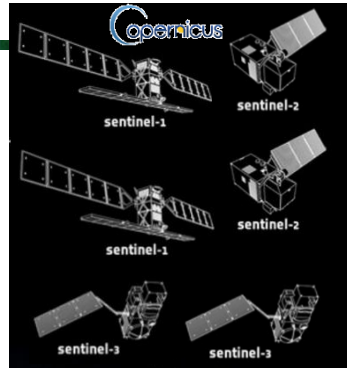
## TOP 10 DOWNLOADS

UNITED STATES:	50
GERMANY:	49
ITALY:	46
FRANCE:	31
SOUTH AFRICA	25
INDIA:	20
IRAN:	19
SPAIN:	18
UK:	18
INDONESIA:	16




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# Sen2-Agri put some pieces of the EO and IT (r)evolutions together



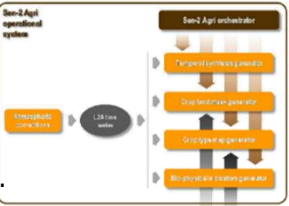
Free, open and long term data policy (US, EU,...)



Landsat-8  
Landsat-9  
Radarsat CM




Open source processing tools using ML and AI algo.




Sen2-Agri operational system


- Band 2 Agri webserver
- Temporal context generator
- Cloud masking generator
- Biophysical modeling module
- Active sensors for the state
- Other external inputs from
- Experiences & networks
- Temporal data selection




VAM food security analysis  
WFP surveys




Mobile internet for many




Mobile internet for many






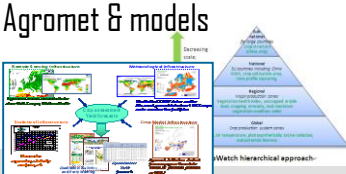
CEOS  
Coordination for EO systems redundancy & harmonization



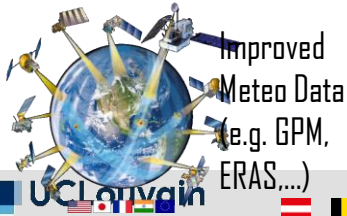
JECAM  
Joint Experiment for Crop Assessment and Monitoring  
Global network with cross site experim.  
Best practices & standards



GEOGLAM  
Global Agricultural Monitoring



Agromet & models



UCLouvain  
Improved Meteo Data (e.g. GPM, ERAS,...)

EO ag. basic products => field level

1. Cropland mapping
2. Crop type mapping
3. Biophys. var. (fCover, LAI, fAPAR)
4. Crop condition monitoring


Meteo-EO-stat model => regional

5. Regional yield estimate/forecast
6. Nat./reg. production estimate


Internet of things & AI

7. Ag. practices monitoring
8. Early yield estimate
9. Crop production stat.
10. Nitrogen use efficiency
11. Emergence date

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European Space Agency



## Global network of 34 voluntary JECAM sites



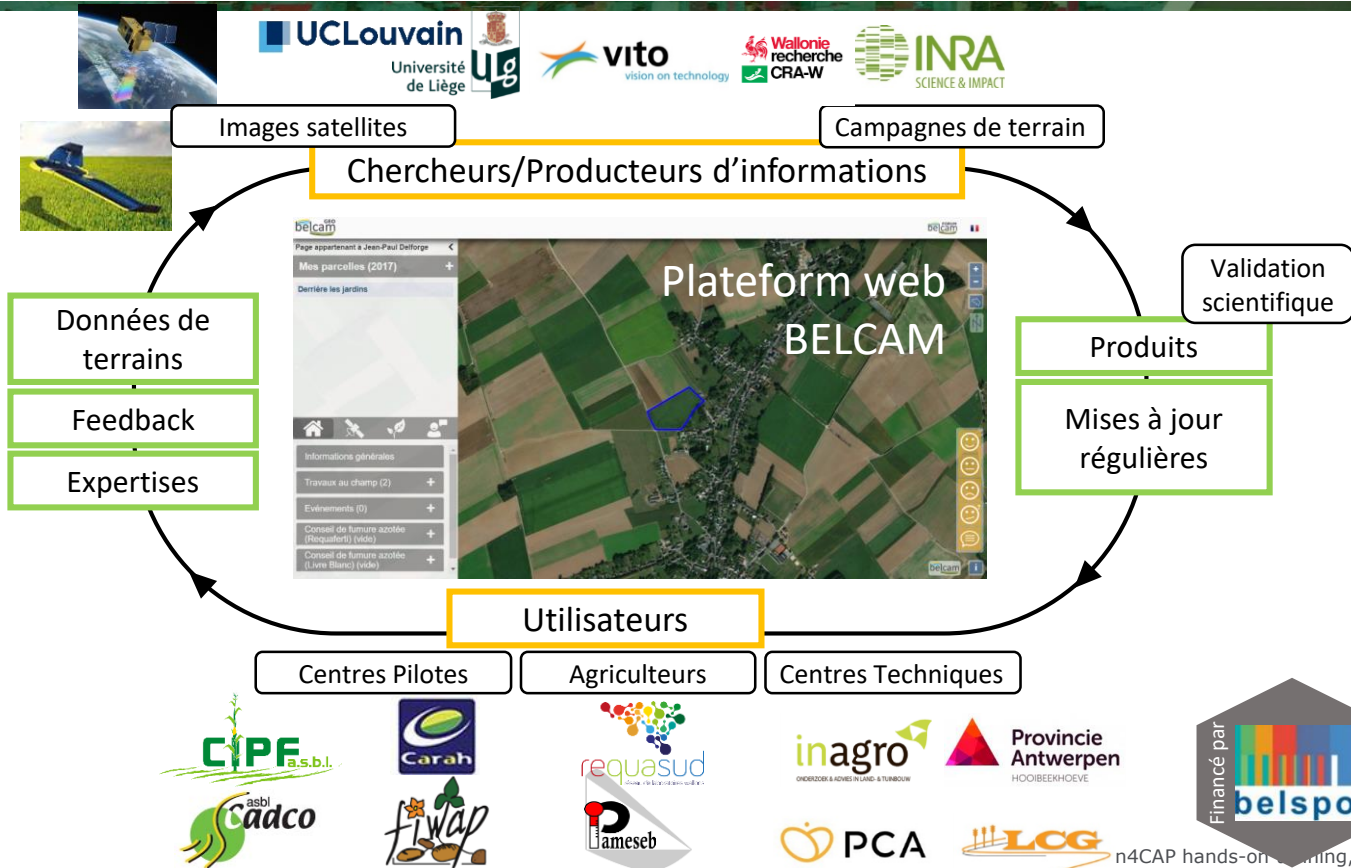
long-term network of widely distributed sites **collecting each year different EO time series and corresponding in situ data on a voluntary basis** to embrace the global diversity of croppings systems  
=> building guidelines and best practices

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# BELCAM - Belgian Collaborative Agriculture Monitoring

Belgian Collaborative Agriculture Monitoring



### Mes parcelles

Filtres: monnet 4 Tout le monde

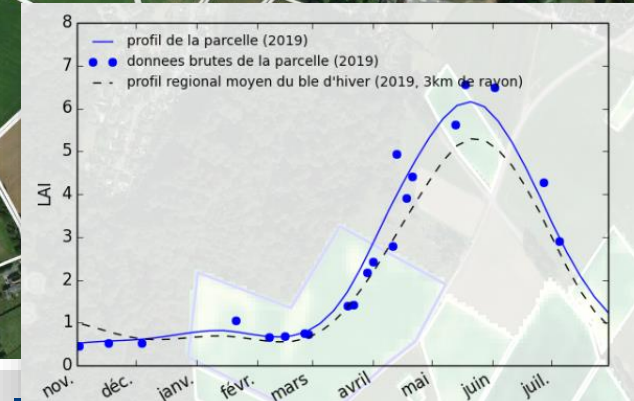
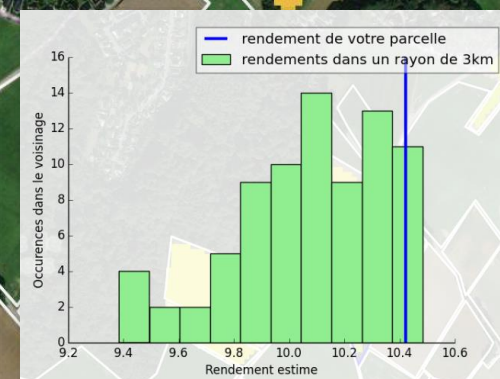
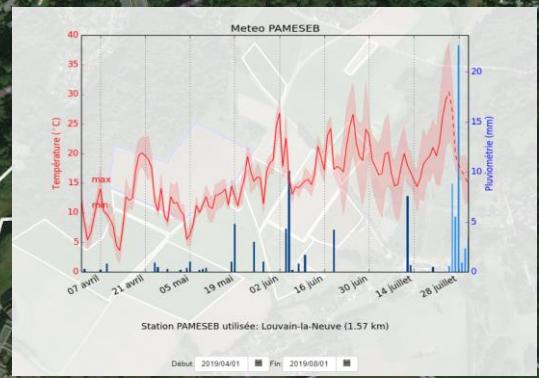
- my new parcel
- test10
- test11
- test12
- test14
- test7
- test8
- test88
- test9
- Vieuxsart 19 DEMO
- Vieuxsart 24 DEMO
- Villers 3 DEMO
- Villers 4 DEMO

### Indicateurs

- ☐ LAI
- ☐ LAI (Belgique)
- ☐ Azote absorbé
- ☐ Biomasse aérienne
- ☒ Estimation du rendement

Date: 15/07/2019

# Yield estimate at parcel level for 3 crops over Belgium





**GEOGLAM**  
Global Agricultural Monitoring



**sentinel-2**

→ AGRICULTURE



**sen4cap**

common agricultural policy

**sen4stat**



→ climate change initiative



App for Android / iPad



→ CLIMATE  
FROM SPACE

data viewer



climate  
from space

Click image to open expanded view

[http://cci.esa.int/  
content/tablet-app](http://cci.esa.int/content/tablet-app)

### Land Water Storage

contribution to sea level rise

3.3mm

per decade

10%

2003-2013

cci Land Cover  
Open Water Bodies

