AI4COPERNICUS DAY - ARTIFICIAL INTELLIGENCE & EARTH OBSERVATION

Sentinels time series exploitation to support a more sustainable agriculture and biodiversity

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UCLouvain

EARTH & LIFE INSTITUTE

AGRO LOUVAIN

Namur – 17 Septembre 2019

AI from the perspective of our EO fields of application

Three successes

1. Most striking AI contribution to operational large scale application
2. Most local application soon operational till now
3. Leveraging ML capacities and mitigating RF sensitivity to unbalanced training for full scale NRT operational application

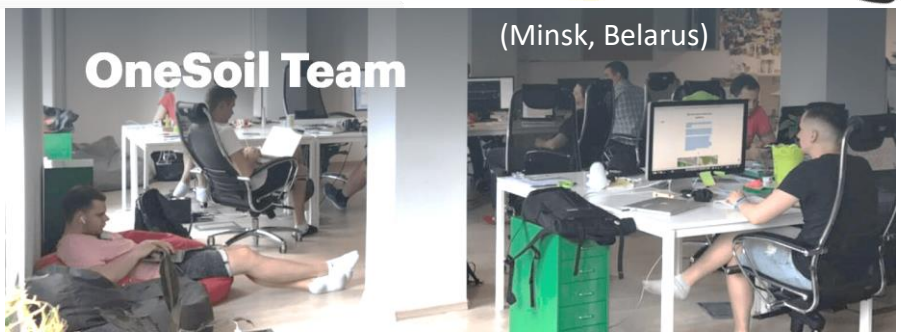
Three questions

Success 1

Quite spectacular scaling up of parcel delineation using CNN algo. at continental scale for whole US and whole of Europe !

Make reliable agricultural decisions with AI

Get to know the field in seconds and take informed actions with the OneSoil platform. To make farming simple, we analyze satellite images with machine learning technologies. For free.



OneSoil β How it works

Data for the year 2018, 2017 or 2016
in USA and Europe

Total size of fields, ha	Total number of fields
393.8M	**62.2M**

Countries ranking

#	Country	Fields S, ha	Number
1	USA	182.9M	17M
2	Ukraine	38M	2M
3	France	27.7M	7M
4	Germany	18.3M	4M
5	Poland	15M	4M
6	Spain	14.9M	5M

Show all 44 countries ↓

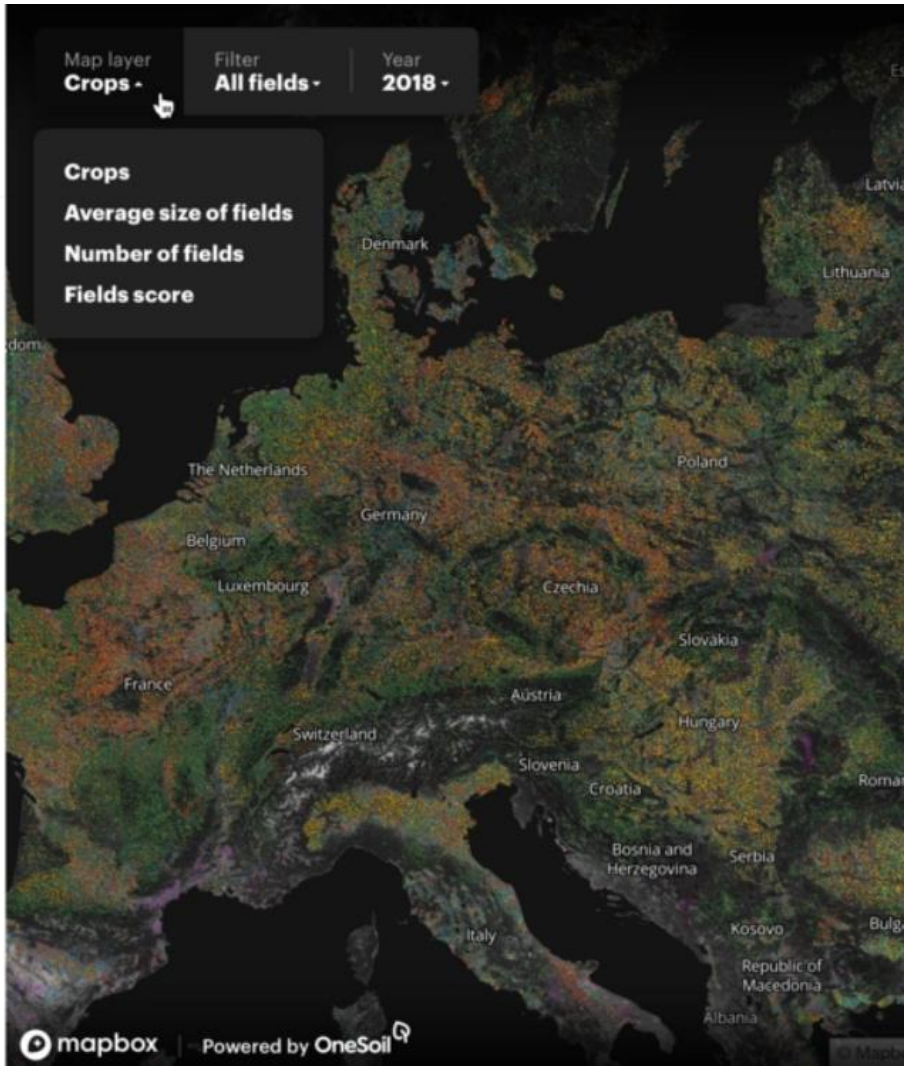
Crops ranking

#	Crop	Fields S, ha	Leader in S
1	Maize	88.9M	USA
2	Grass	80.5M	USA
3	Wheat	65.4M	USA
4	Soybeans	52.5M	USA
5	Alfalfa	15.9M	USA
6	Barley	12.1M	USA

Show all 27 crops ↓

Popular crops in largest countries

#	Country	Crop distribution
1	USA	



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Earth and Life Institute - *Geomatics*

A quite impressive AI solution to a simple but critical availability problem …

possibly enabling better SAR exploitation !

OneSoil β

About Platform Devices Technology Team Blog

Allocating field boundaries

We manually marked tens of thousands of fields, and then trained an algorithm to allocate boundaries automatically. We show what happens with fields at any scale, from a whole region to a particular piece. As a result, any farmer can receive information about the state of his fields in our platform.

IoU 0.85

The accuracy of the automatic markup model

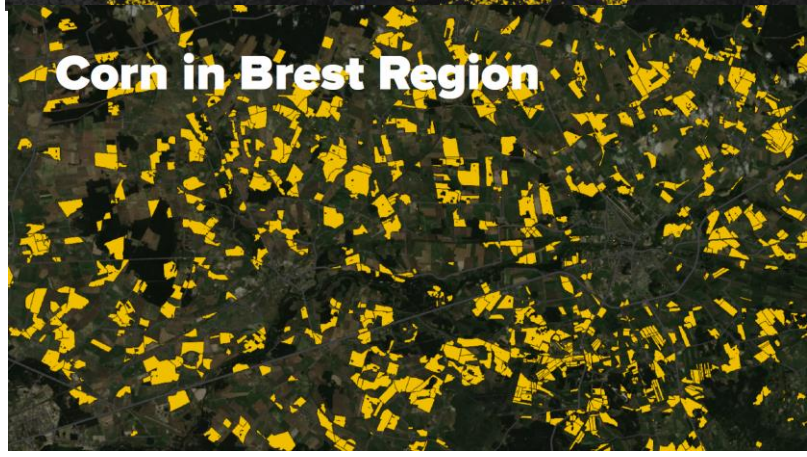
49 years — the time one person would spend to manually mark these fields

21,603,849
Fields marked in the USA

35,923,503
Fields marked in Europe

Our algorithms allocate field boundaries with a 5-meter accuracy

First interactive map with AI detected fields and crops

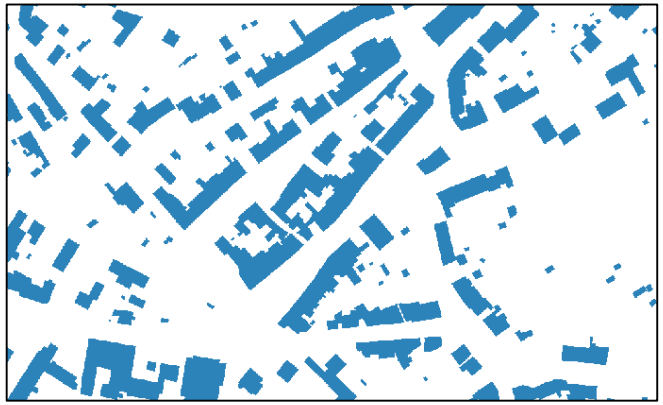


The real challenge where most needed : parcel boundaries in the African agricultural landscapes !

Detection of new build up areas in Wallonia thanks to convolutional network and a dataset with most of the existing build up areas

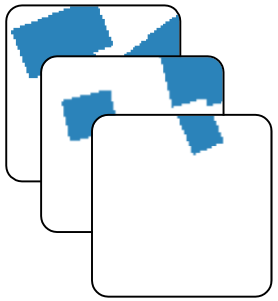
=WalOUS Development of an operational and reproductible land-cover and land-use mapping method in Wallonia

Reference data:
buildings from the PICC database
= MASK



High resolution data:
Orthophotos at 25cm
(4 bands : R,G,B,NIR)
= IMAGES

Prepararation of training and validation dataset:
- Slippy map
- Pairs of (images,mask)
- Image size = 256x256



Success 2

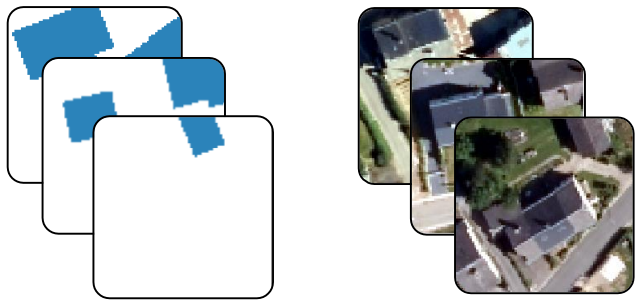
Detection of new build up areas in Wallonia thanks to convolutional network and a dataset with most of the existing build up areas

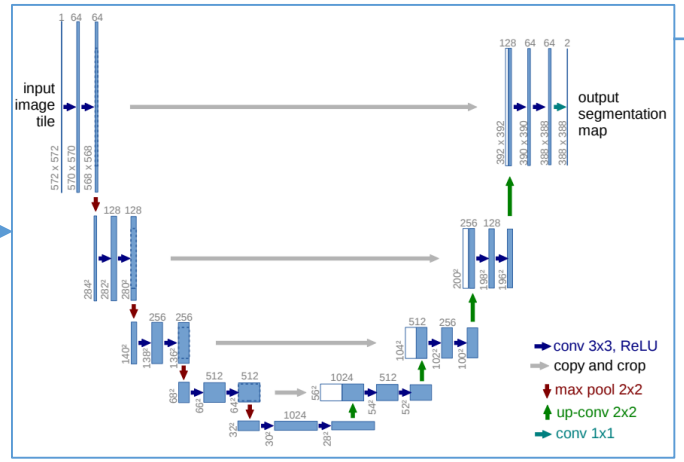
=WalOUS

Loss function

CNN U-Net
(RoboSat pipeline)

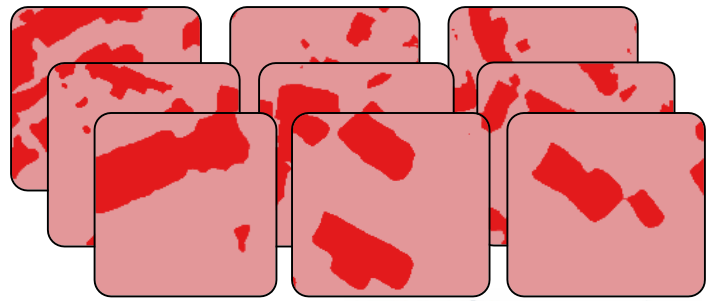
Training & model performance assessment datasets





Trained model

Prediction
(Robosat pipeline)



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Detection of new build up areas in Wallonia thanks to CNNs

Quite promising results for four different landscapes

AI detection

PICC reference dataset

PICC + AI detection


0 days 00 hours 00 minutes
Sentinel-2 constellation:
summer solstice

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
  => ***governemental willingness to master the information process***

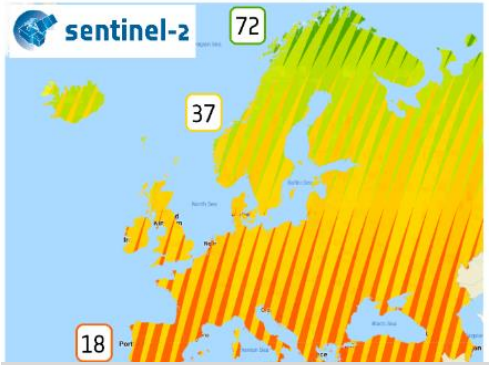
- Crop-specific monitoring can have major impacts on the international markets
  => ***timeliness makes the information value***

- **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



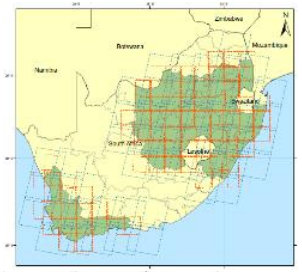
S-2A & -2B (July-Sept 2018)

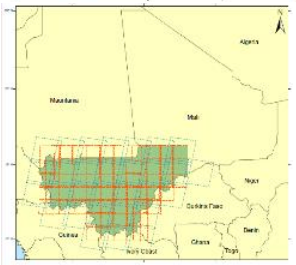
⇒ How to streamline data flow from observation to information ?

Sen2-Agri open source system to deliver in season 10-m basic products : national cropland/crop type maps

sentinel-2

→ AGRICULTURE





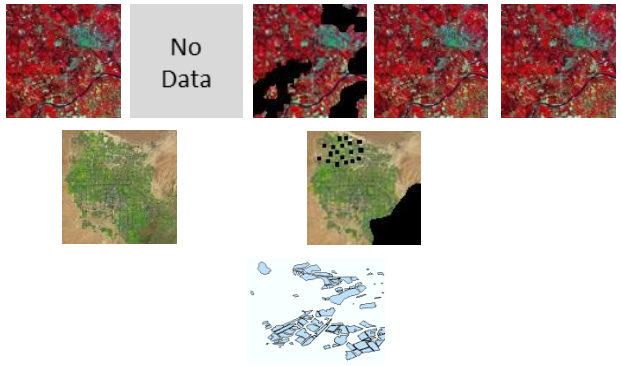
GEOGLAM
Global Agricultural Monitoring

(Defourny et al., RSE2019)

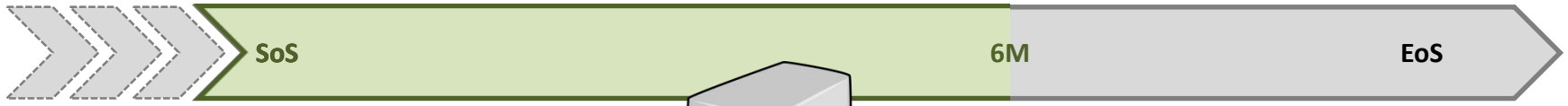
Before the start of the monitoring period

System initialization

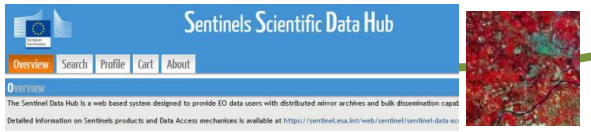
Monitoring period



Automatic EO data download
Manual in situ data upload



EO data providers



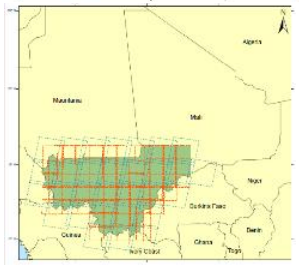
Operators

Success 3

Sen2-Agri open source system to deliver in season 10-m basic products : national cropland/crop type maps

sentinel-2

→ AGRICULTURE



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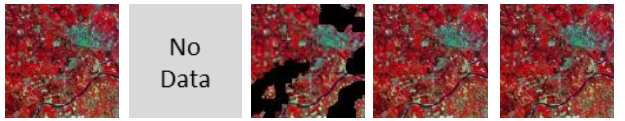
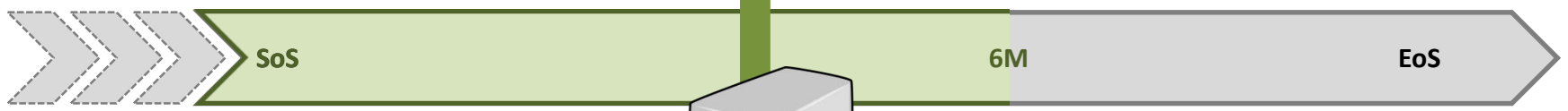
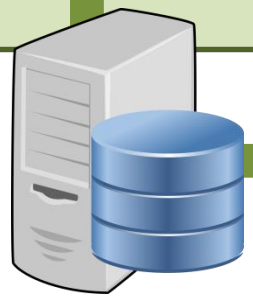


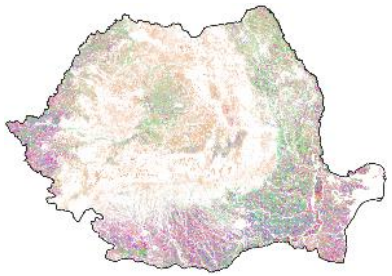




Automatic EO data download
Manual in situ data upload

EO data providers

Mid-season crop type



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sentinel-2

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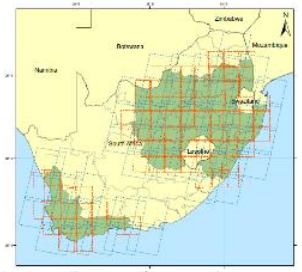

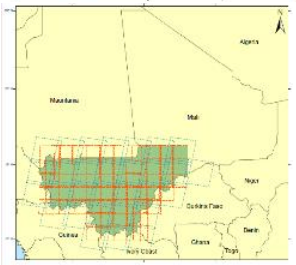

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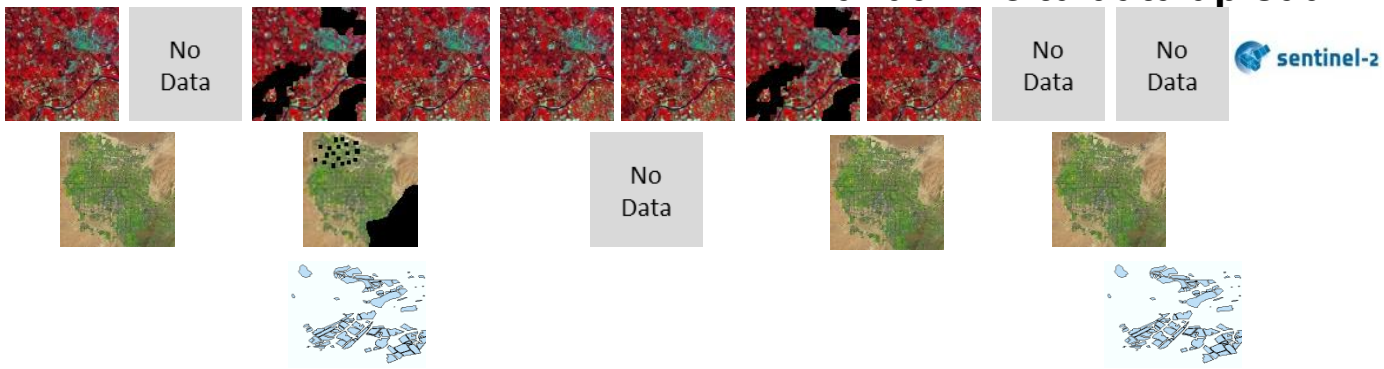
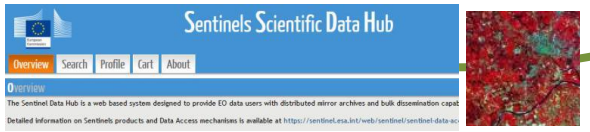
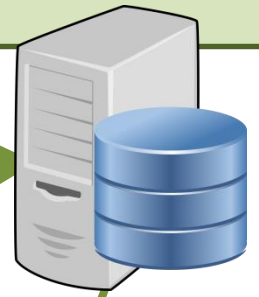


SoS — 6M — EoS

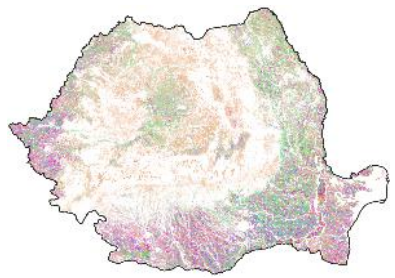
EO data providers





Operators

Mid-season crop type



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sentinel-2

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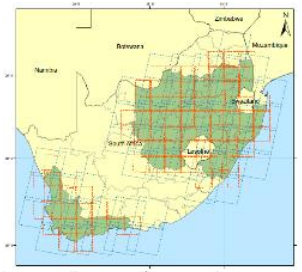

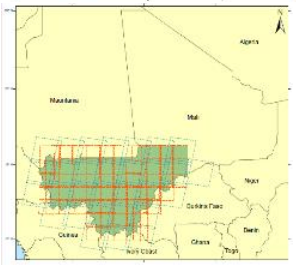

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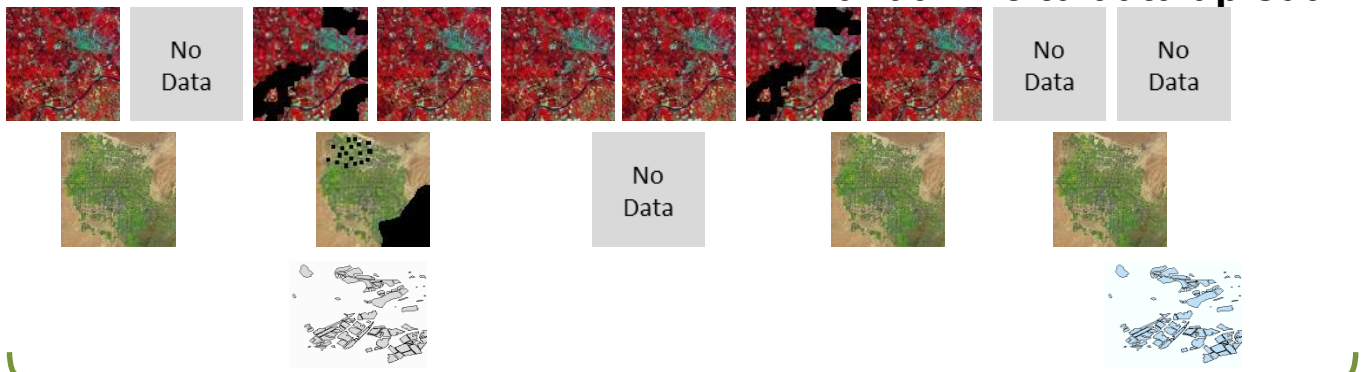
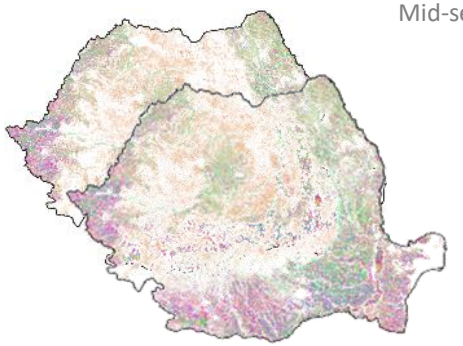


EO data providers

Operators

Mid-season crop type

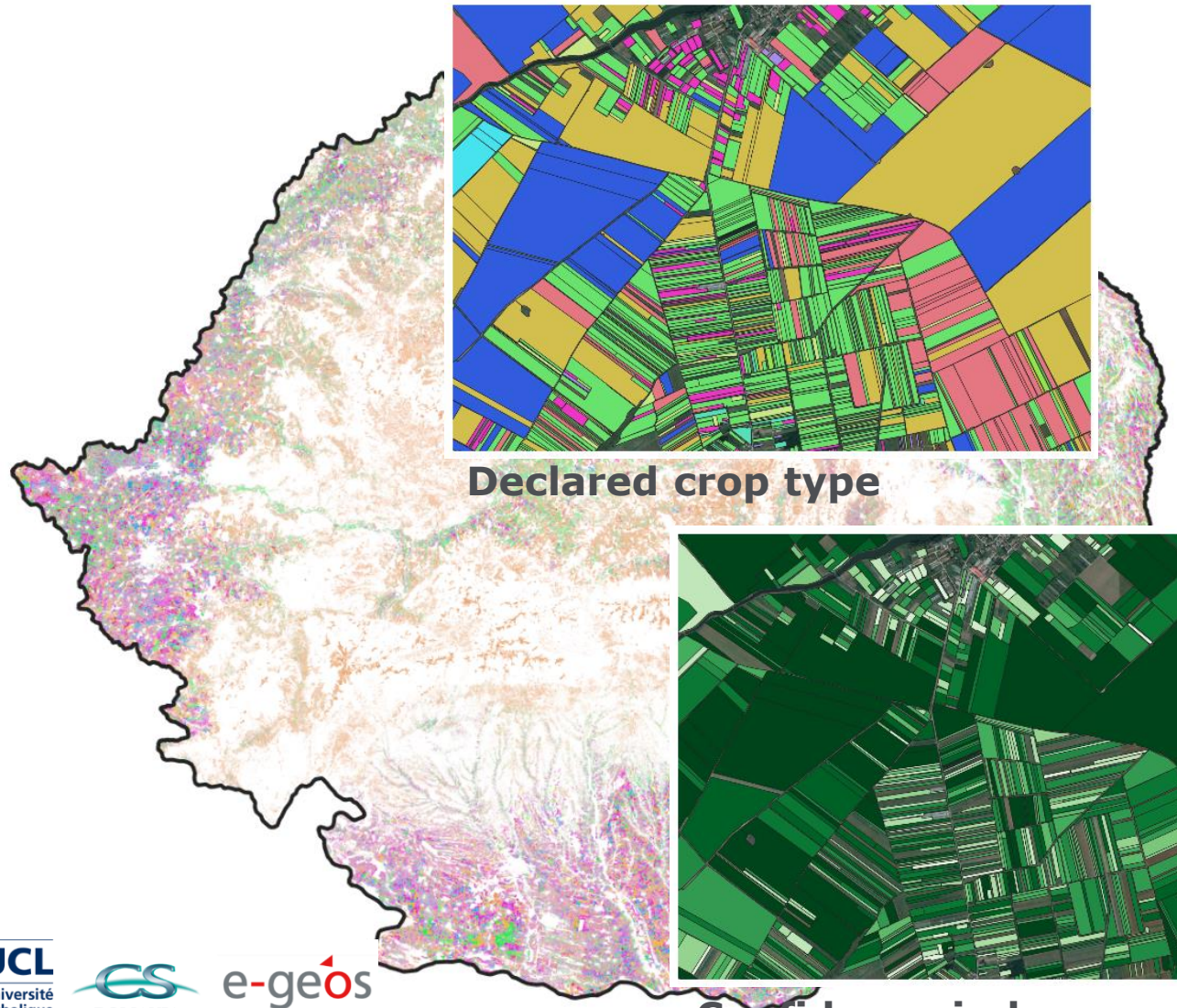


End of season crop type

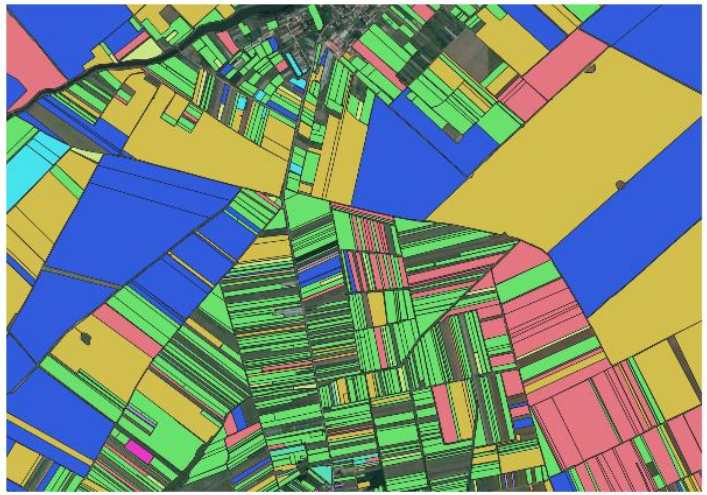
Success 3

2018 National crop maps + 2019 NRT demo for 6 EU countries

Example of Romania (100+ crop types)

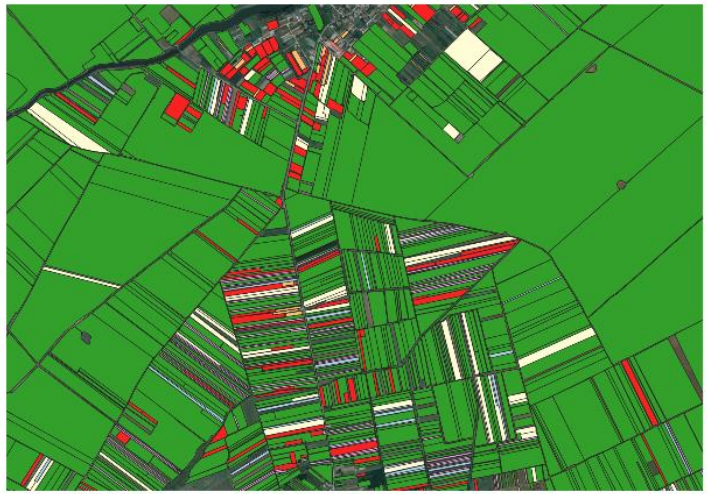


Declared crop type



Predicted crop type

Confidence index



Conformity assessment

Crop type
- Alfa-alfa
- Autumn barley
- Autumn common wheat
- Autumn rape
- Bean peas
- Corn
- Fresh vegetables
- Sunflower
- Permanent crop
- Grassland

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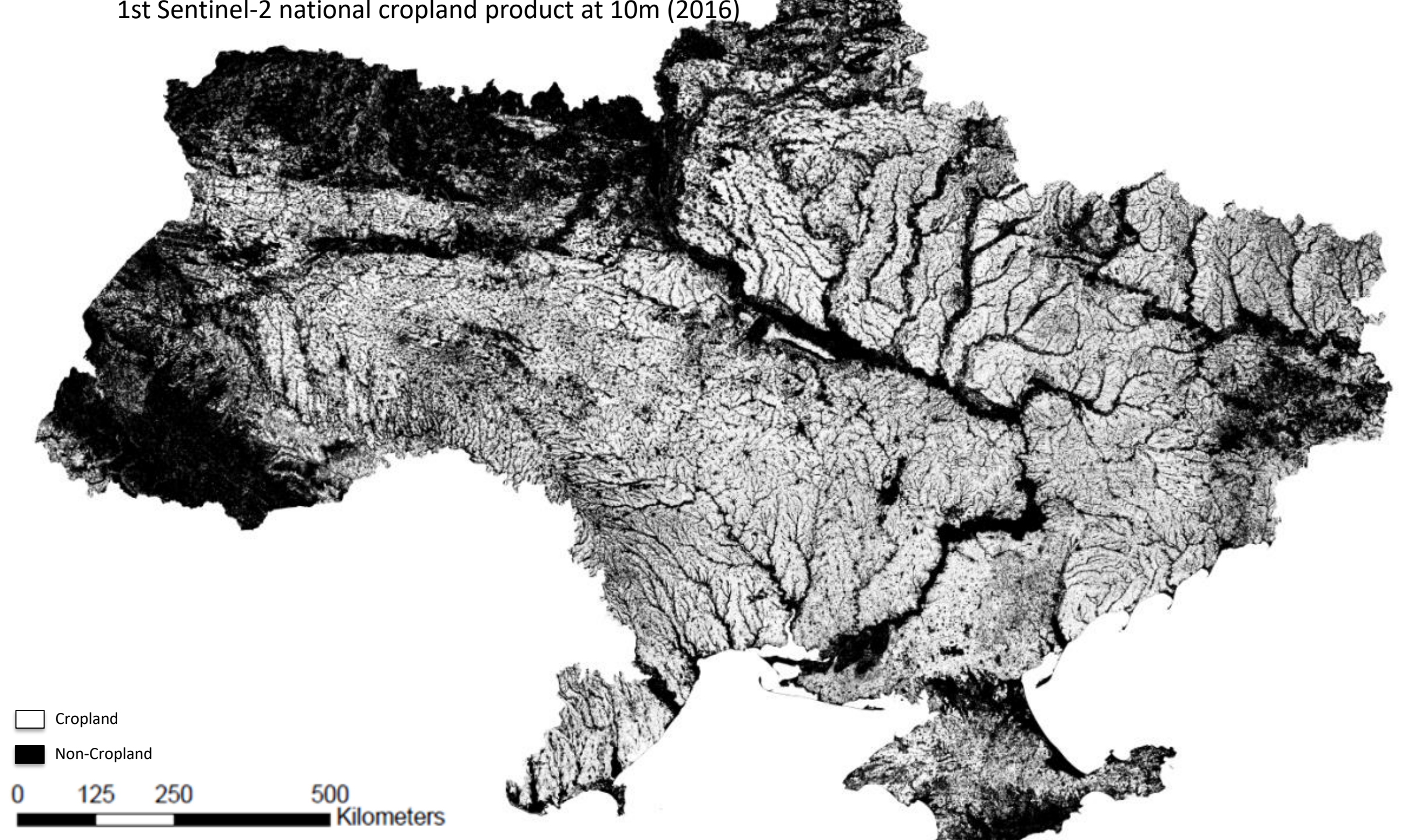
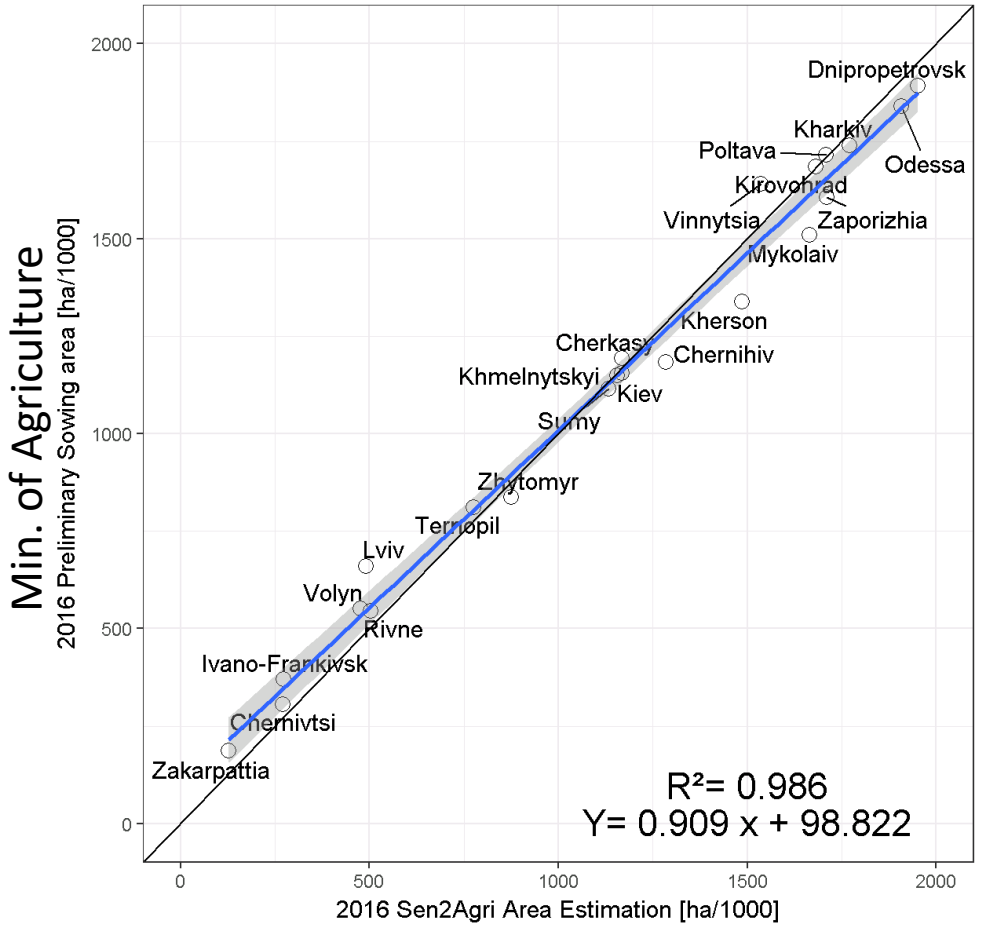
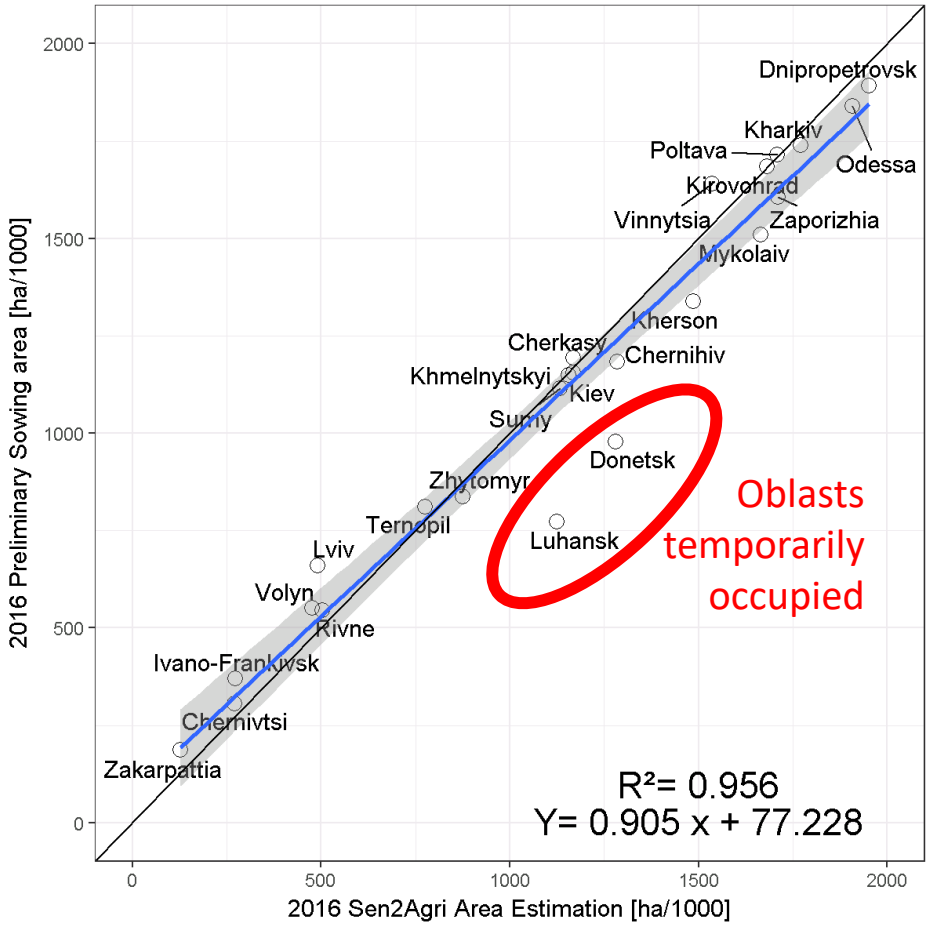
1st Sentinel-2 national cropland product at 10m (2016)



Early estimates of sowing areas for Ukraine (2016): Sen2Agri matching figures of Ministry of Agriculture

...and providing estimates for unaccessible oblasts





AI from the perspective of our EO fields of application

Three successes

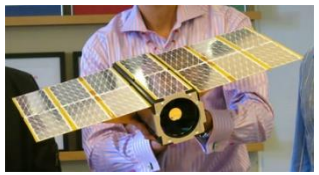
Three questions (to contribute to the problem definition)**:**

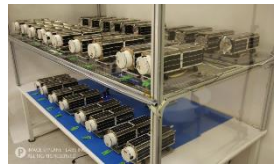
4. How to identify current issues where AI could lead to operational solution ?

5. What kind of new unexplored data AI would be able to handle ?

6. What concepts to be developped in our thematic discipline to take advantage of AI ?

Q1. AI for what - Could AI interpret poor quality satellite images ?

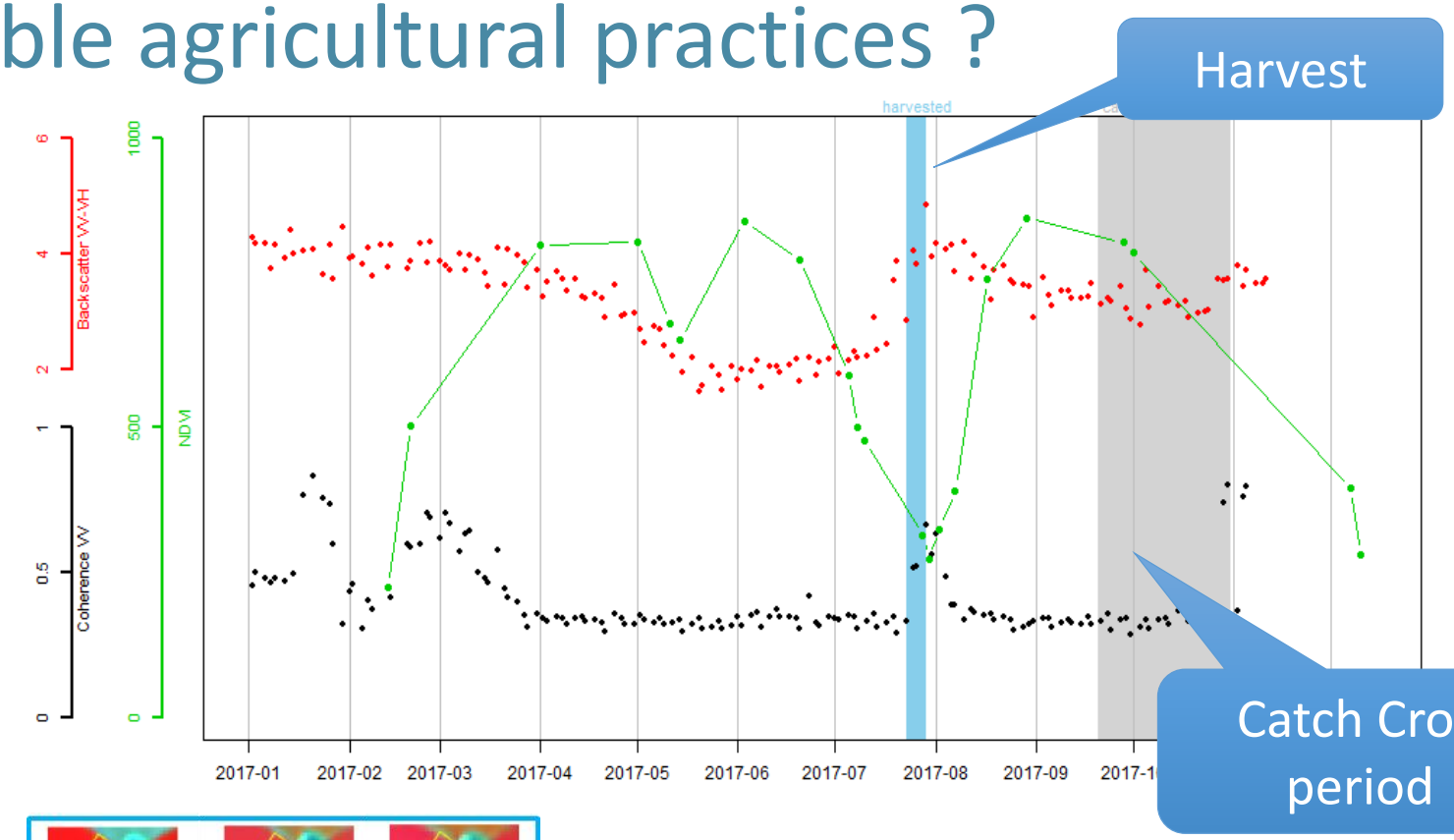


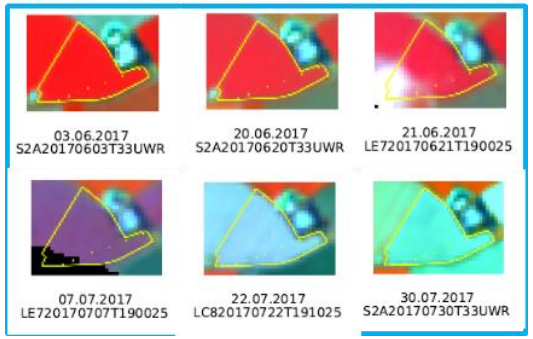


‘Daily’ observation from Planet dove constellation for tedious visual interpretation

Q1. AI for what - Could AI use Sentinel-1/2 metrics to map sustainable agricultural practices ?

- Crop type mapping
- Growing vegetation indicators
- Grassland mowing detection
- Agricultural practices monitoring





Harvest – Visual check

Sen4CAP system currently produces in NRT **130 meaningful metrics per parcel per month** for 7 EU countries

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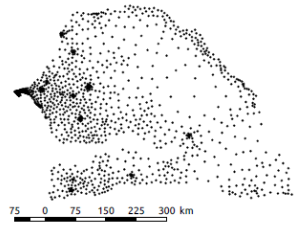
UCLouvain Earth and Life Institute - *Geomatics*

Q2 AI for new data AI to exploit faster new kinds of data along EO ?

Millet price modeling for the different markets in Senegal by merging mobile phone data with EO

Call Data Record (CDR)

Who? When? Where?



$\hat{P}_i$ =200 FCFA/kg

$$IC_{i,j} \times \frac{\hat{P}_j - \hat{P}_i}{d_{i,j}+1} > TC$$

$\hat{P}_j$ =300 FCFA/kg

Social capital and transaction cost

based on calls intensity between markets

Social capital and transaction costs in millet markets

Damien Christophe Jacques [a,*], Eduardo Marinho [b], Raphaël d'Andrimont [a], François Waldner [a,c], Julien Radoux [a], Frédéric Gaspart [a], Pierre Defourny [a]

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Q2 AI for new data AI to exploit faster new kinds of data along EO

Crowdsourcing as new source of training data for not obvious labeling ?

Increasing Quality

Expert

CIMMYT
International Maize and Wheat Improvement Center

Crowd

Treated Crowd

ELSEVIER
Remote Sensing of Environment
Volume 221, February 2019, Pages 235-246

Conflation of expert and crowd reference data to validate global binary thematic maps

Francois Waldner [a, b], Anne Schucknecht [c, d], Myroslava Lesiv [e], Javier Gallego [c], Linda See [e], Ana Pérez-Margareth Simões [i, q], ... Pierre Defourny [a]

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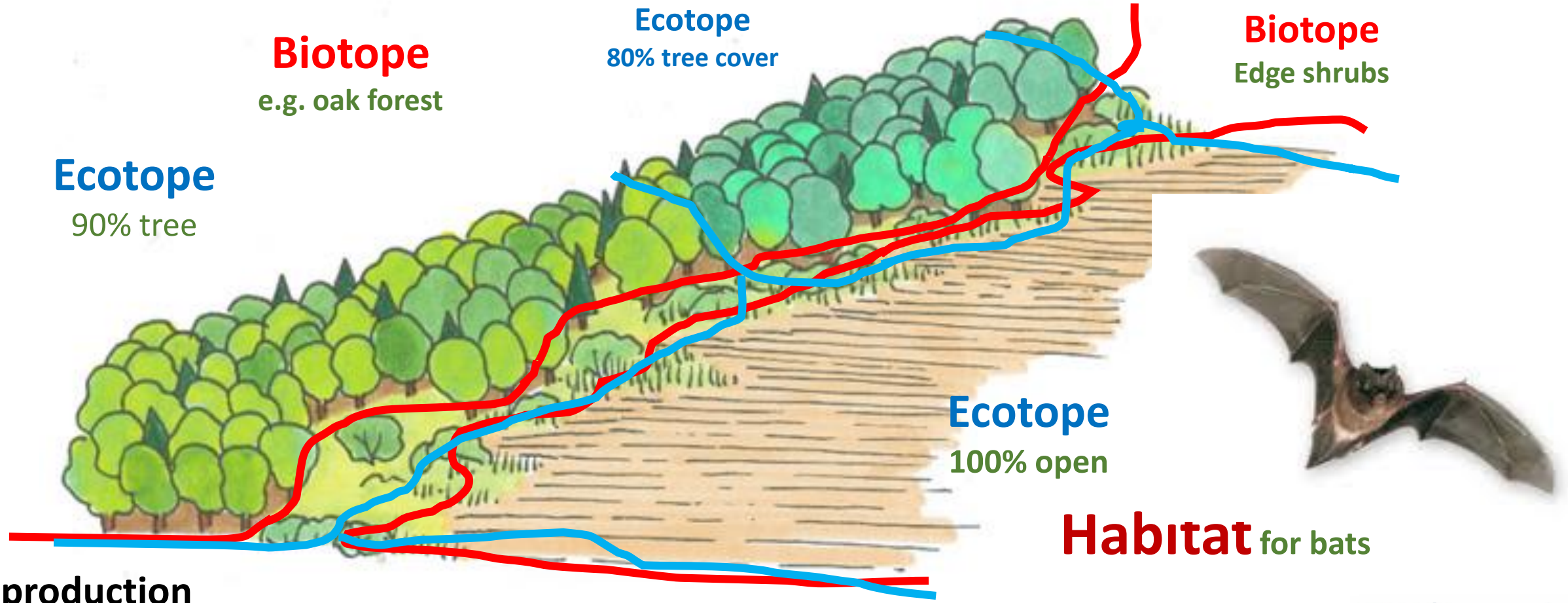
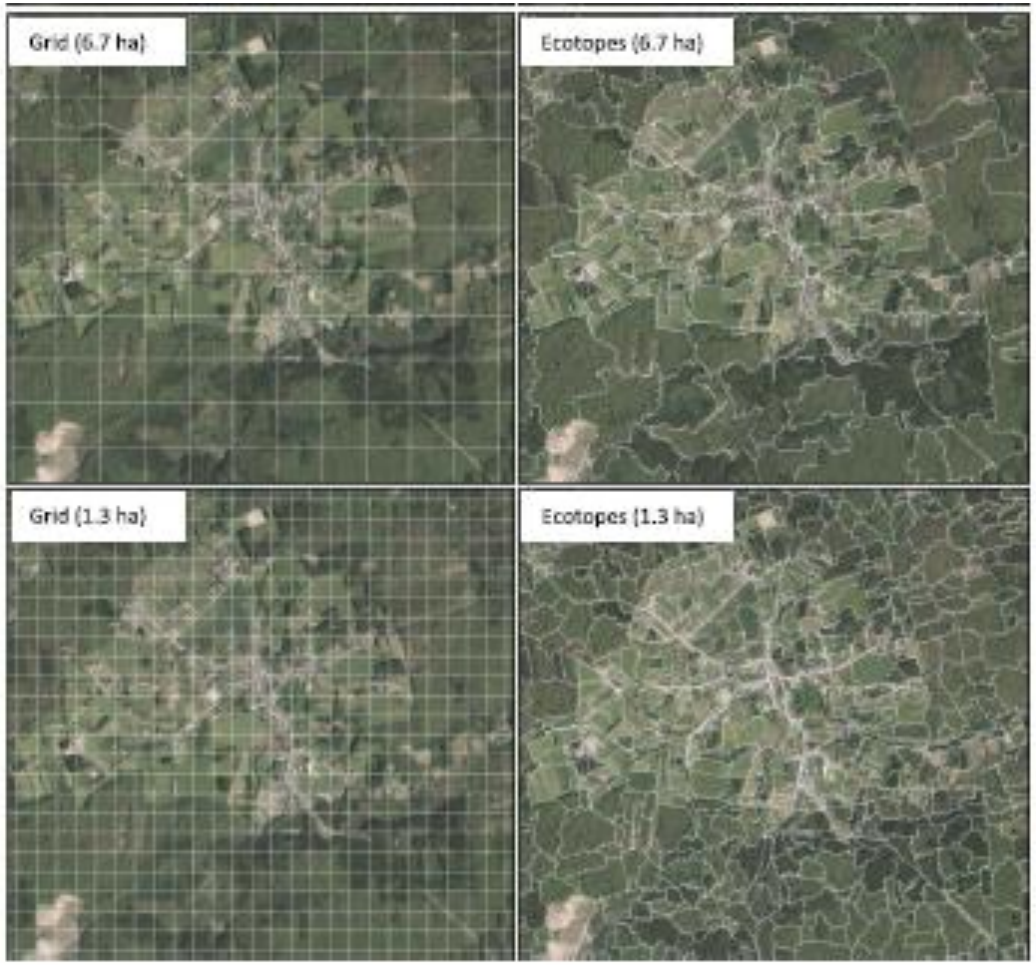
AI and new data sources bring changes !

Q3. what new concepts ? - thematic concepts should also evolve not only the IT/AI technology !

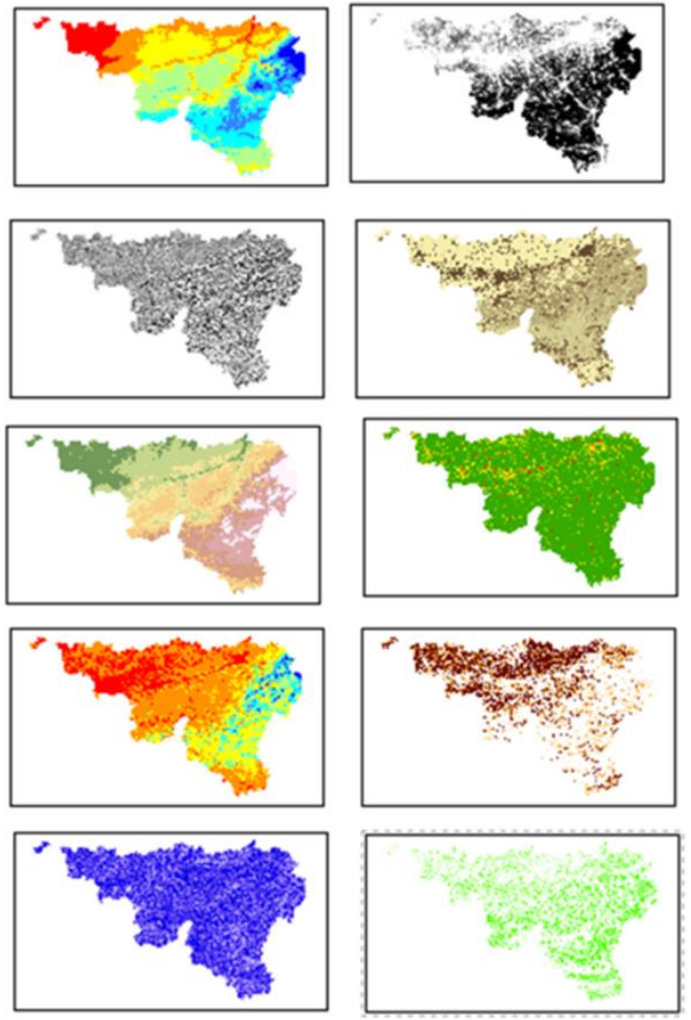
Nature is more complex that its current scientific description



Moving from regular grid model to meaningful shape for habitat modeling



From land cover to context, association and 100+ variables



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Open e-Data for Biodiversity

Ecosystem dynamics

Ecotopes

2006 | 2015

Ecotope content | Thematic legend | Variables alone | Mix variables | Query variables

Land cover variables

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

detail in the ecotope:

73% | 9 | 17%

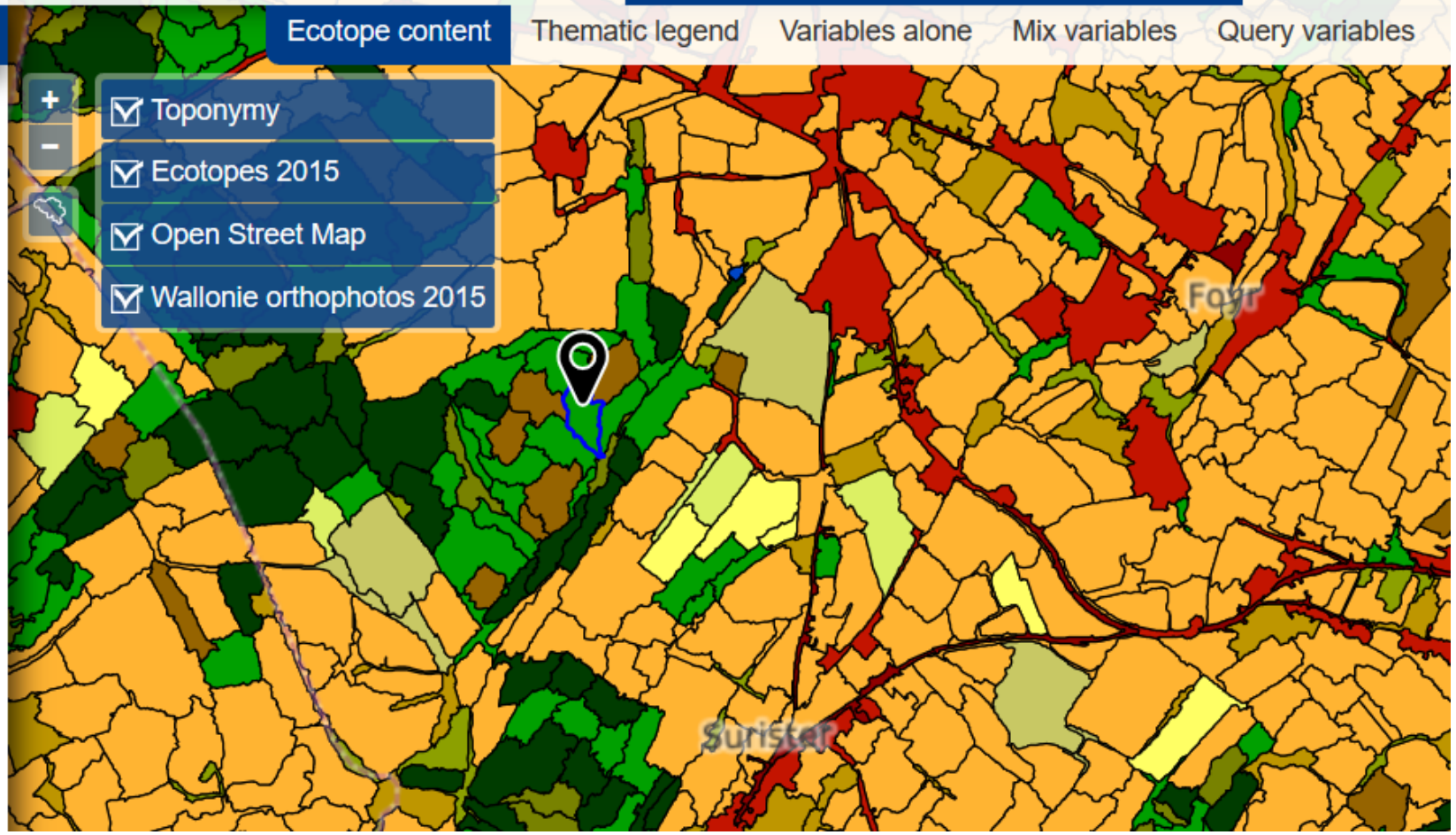
250m around the ecotope:

41% | 14% | 18% | 26%

500m around the ecotope:

23% | 15% | 7 | 46% | 10

Soil variables



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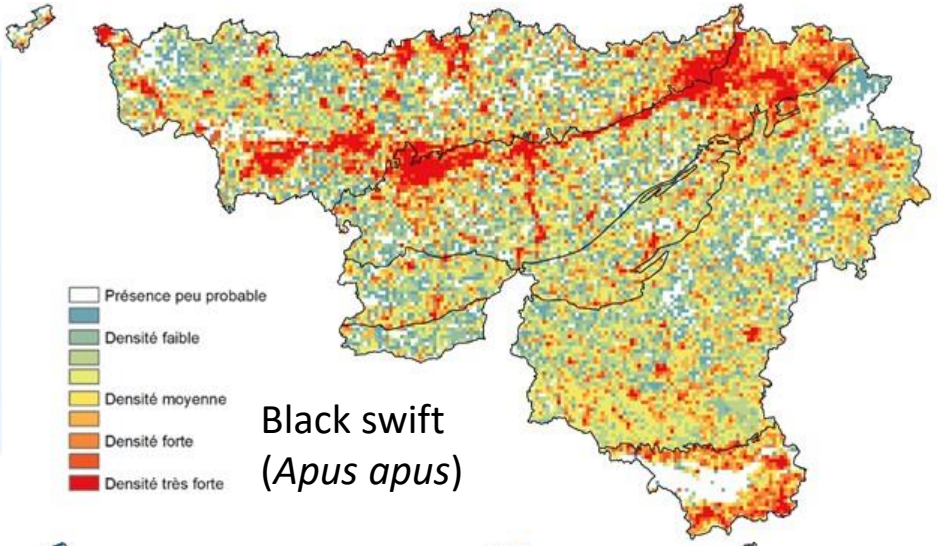
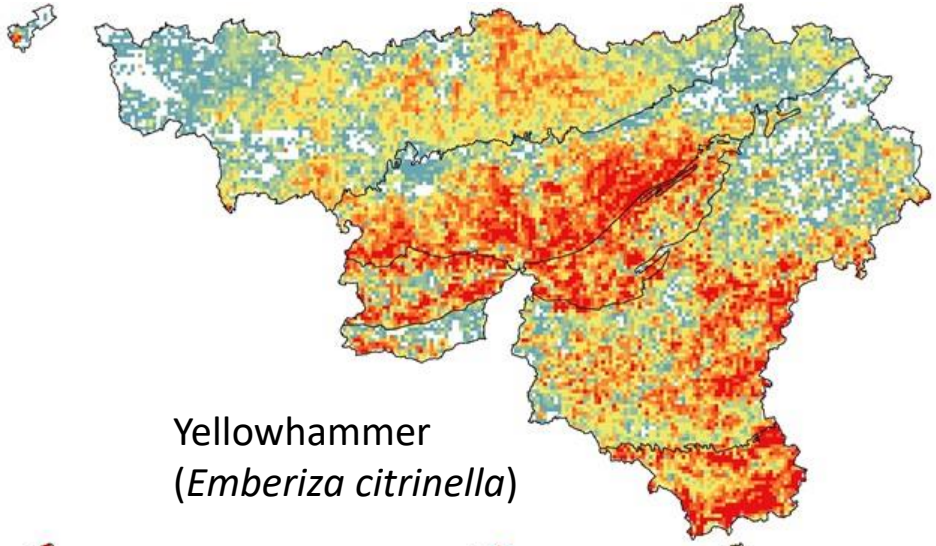
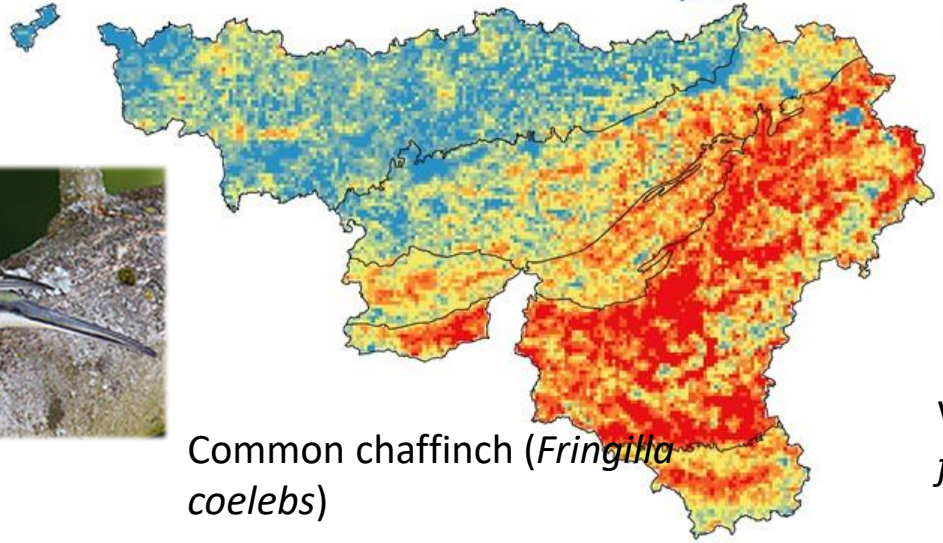
Ecotope concept for a better biodiversity habitat model



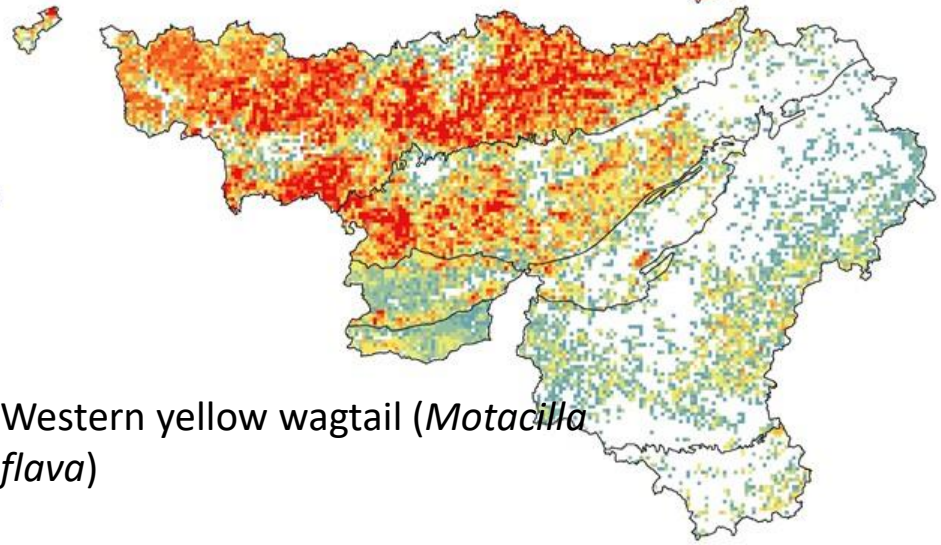
Black swift (*Apus apus*)



Yellowhammer (*Emberiza citrinella*)



Common chaffinch (*Fringilla coelebs*)



Western yellow wagtail (*Motacilla flava*)

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Perspectives

- Recent EO applications concerns the Big Data challenges
- AI as disruptive technology for EO when put into context
  - to adress actual challenging questions (problem definition !)
  - to handle new unexplored sources of data
    - Crowdsourcing
    - Mobilephone CDRs
    - New space EO
    - Internet of Things

  - to define concepts combine of the versality AI while still relying on process-based or knowledge-based modelling


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sen4cap
common agricultural policy
sen4stat