LIÈGE université
Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen
Feel Wood
Forêt Pro Bos

Characterizing ligneous resources by using remote sensing

From trees outside forests to forest stands

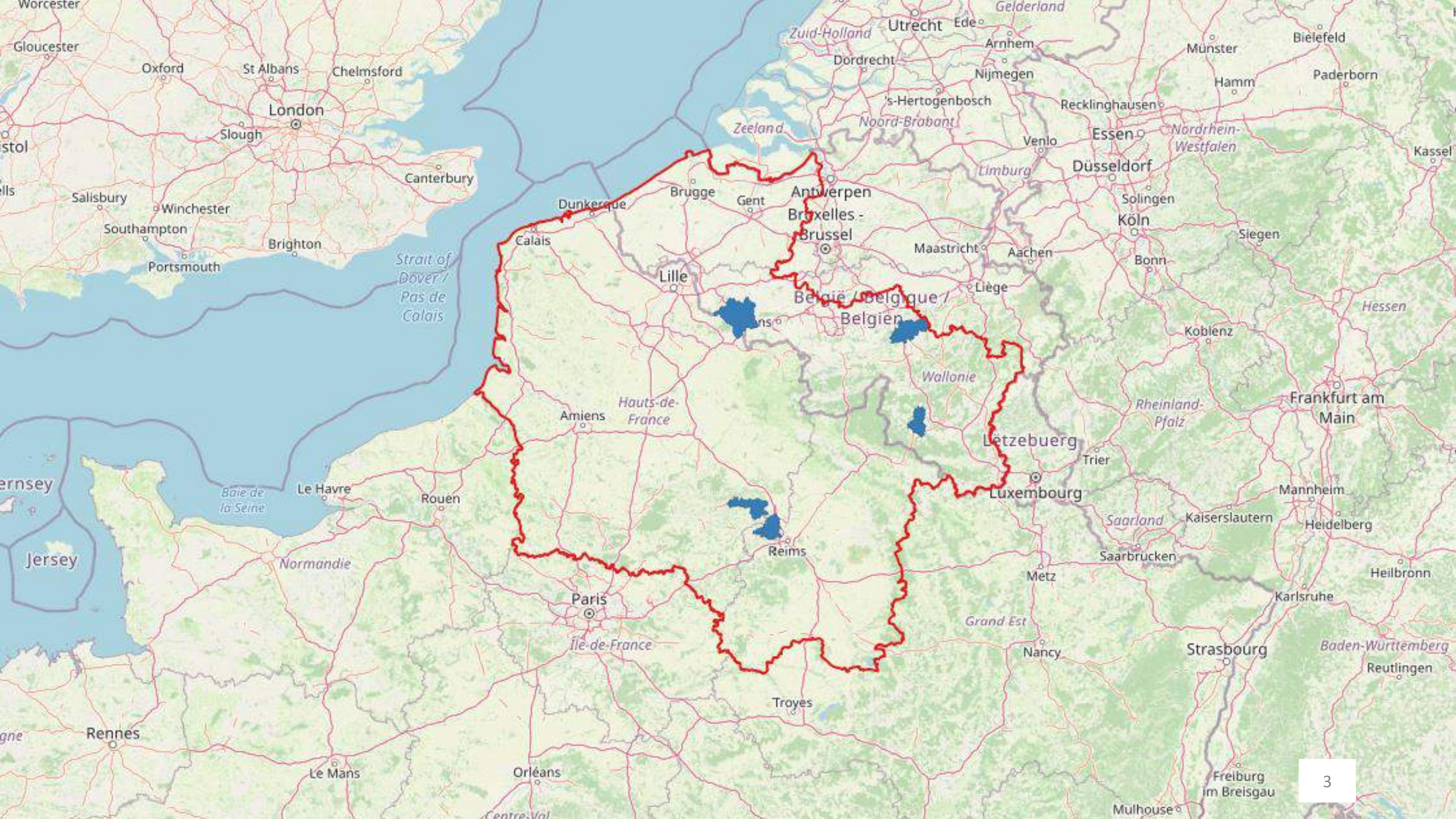
04/06/2020 – Corentin Bolyn

Interreg
France-Wallonie-Vlaanderen

UNION EUROPÉENNE
EUROPESE UNIE

Feel Wood

Forêt Pro Bos


Worcester
Gloucester
Oxford
St Albans
Chelmsford
London
Slough
Canterbury
Salisbury
Winchester
Southampton
Brighton
Portsmouth
Strait of Dover / Pas de Calais
Baie de la Seine
Jersey
Le Havre
Rouen
Normandie
Rennes
Le Mans
Orléans
Paris
Île-de-France
Amiens
Hauts-de-France
Calais
Dunkerque
Brugge
Gent
Antwerpen
Bruxelles - Brussel
Lille
België / Belgique / Belgien
Wallonie
Reims
Troyes
Zeeland
Zuid-Holland
Utrecht
Ede
Gelderland
Arnhem
Dordrecht
Nijmegen
's-Hertogenbosch
Noord-Brabant
Venlo
Limburg
Maastricht
Aachen
Liège
Münster
Bielefeld
Hamm
Paderborn
Recklinghausen
Essen
Nordrhein-Westfalen
Düsseldorf
Solingen
Köln
Siegen
Bonn
Kassel
Hessen
Koblenz
Rheinland-Pfalz
Frankfurt am Main
Lëtzebuerg
Trier
Luxembourg
Mannheim
Saarland
Kaiserslautern
Heidelberg
Saarbrücken
Metz
Heilbronn
Karlsruhe
Grand Est
Nancy
Strasbourg
Baden-Württemberg
Reutlingen
Freiburg im Breisgau
Mulhouse

Forêt Pro Bos – remote sensing as a tool for the good management of our territories

- Improve our knowledge about the distribution and evolution of timber resources located in the Interreg project area

- Three development goals related to remote sensing :
  - Mapping main timber resources forest species
  - Mapping ligneous elements outside forests
  - Characterizing the development stages of poplar stands

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

Ligneous elements in the landscape
From trees outside forests …

… to forest stands

According to their development stage, forestry plantations can belong to both categories

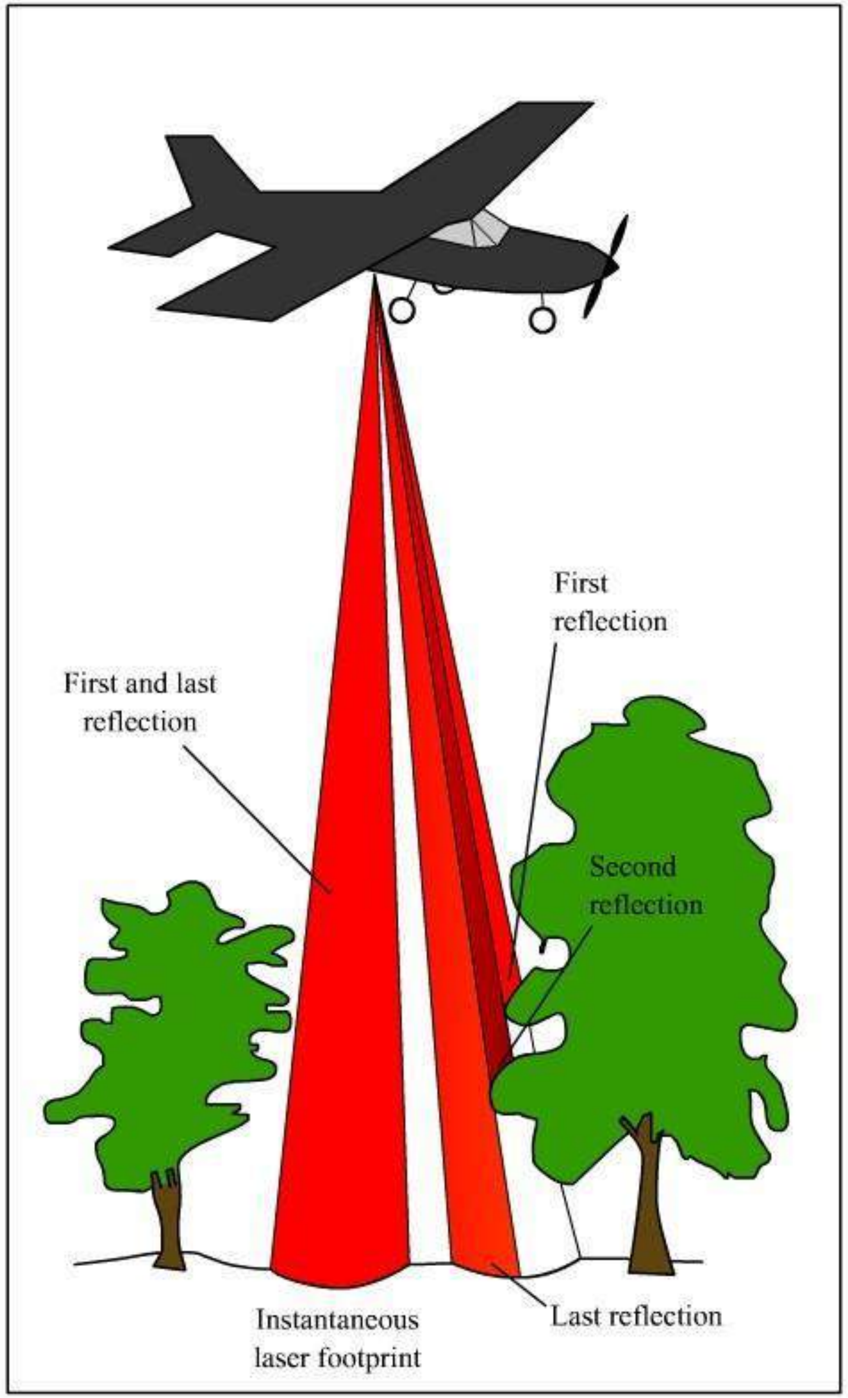
Mapping and characterizing trees outside forests by using the LiDAR technology

- Requires very high spatial resolution data
  - Delineating small ligneous elements
  - Differentiating immediate environment : herbaceous vegetation, man-made elements.

Mapping and characterizing trees outside forests by using the LiDAR technology

- Requires very high spatial resolution data
  - Delineating small ligneous elements
  - Differentiating immediate environment : herbaceous vegetation, man-made elements.

- Mapping method exclusively based on aerial LiDAR



LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

4 steps methodology

1. Identify « ground » points and normalize the point cloud

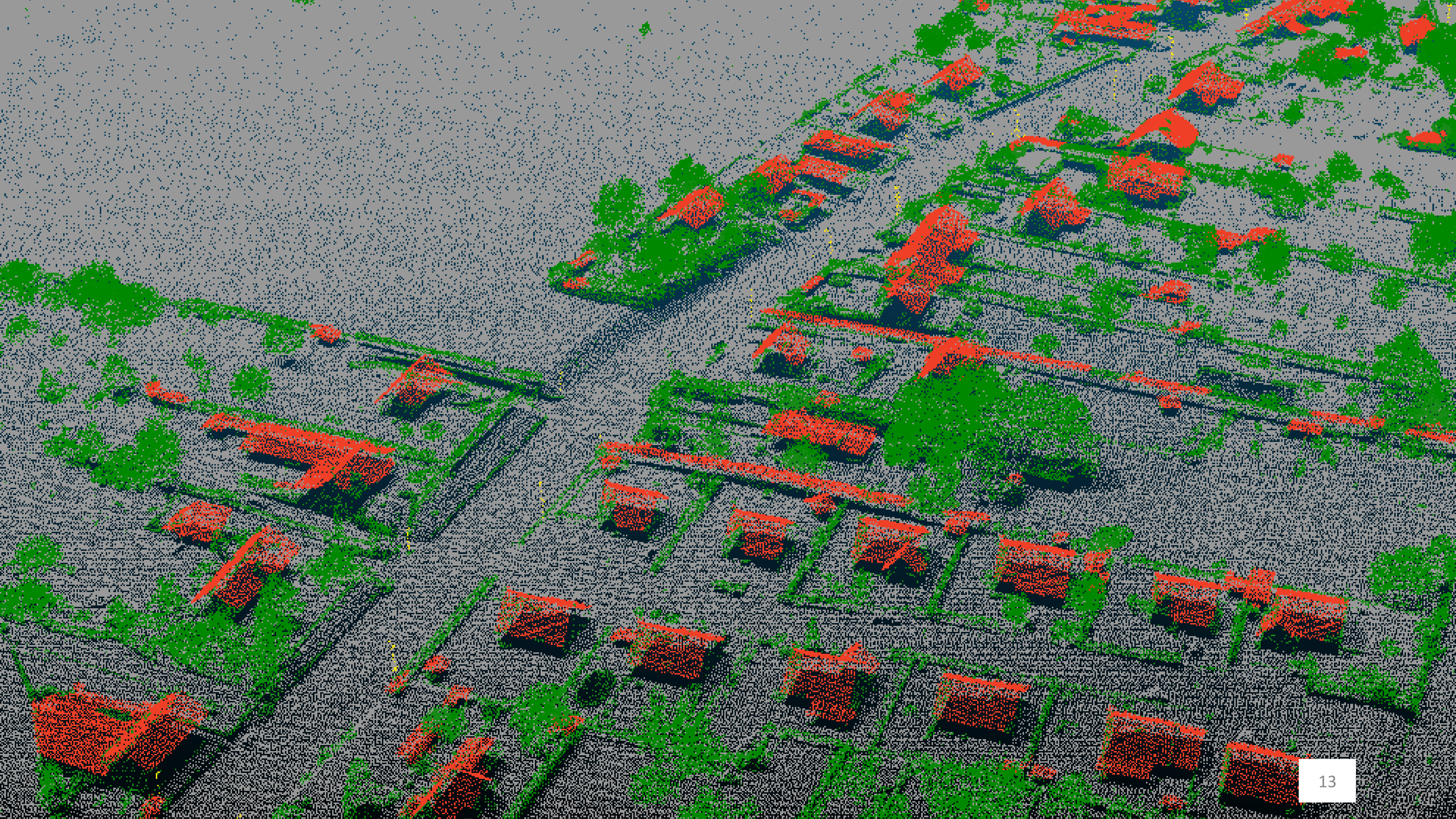
4 steps methodology

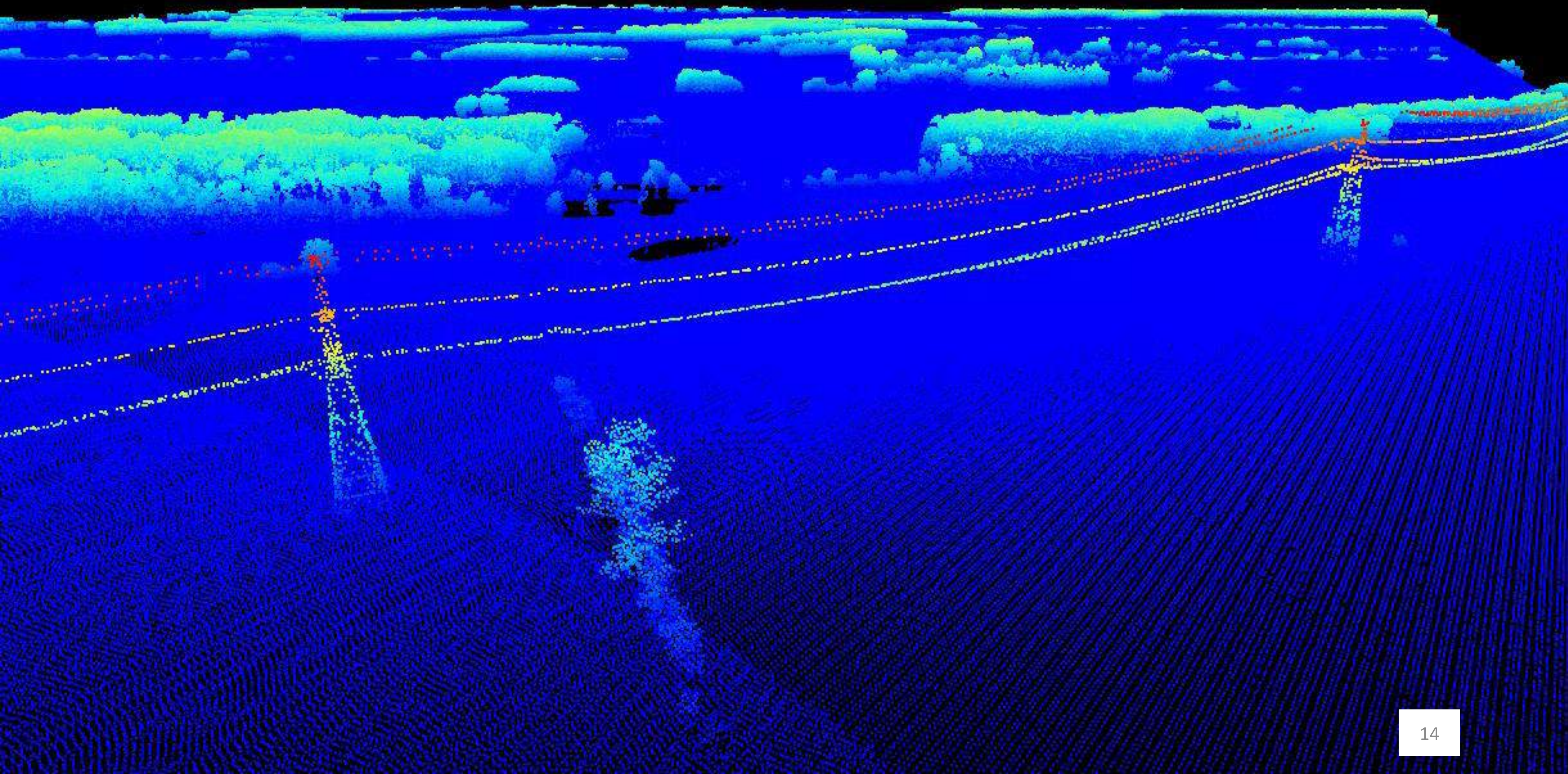
1. Identify « ground » points and normalize the point cloud
2. Identify all the points corresponding to ligneous elements

LIÈGE université
Gembloux
Agro-Bio Tech

Interreg
France-Wallonie-Vlaanderen

Feel Wood
Forêt Pro Bos





4 steps methodology

1. Identify « ground » points and normalize the point cloud
2. Identify all the points corresponding to ligneous elements

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

4 steps methodology

1. Identify « ground » points and normalize the point cloud
2. Identify all the points corresponding to ligneous elements
3. Make the distinction between forest stands and trees outside forests

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

Definition of a forest

- FAO definition
  - *Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ*

4 steps methodology

1. Identify « ground » points and normalize the point cloud
2. Identify all the points corresponding to ligneous elements
3. Make the distinction between forest stands and trees outside forests

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

4 steps methodology

1. Identify « ground » points and normalize the point cloud
2. Identify all the points corresponding to ligneous elements
3. Make the distinction between forest stands and trees outside forests
4. Classification of ligneous elements located outside forests

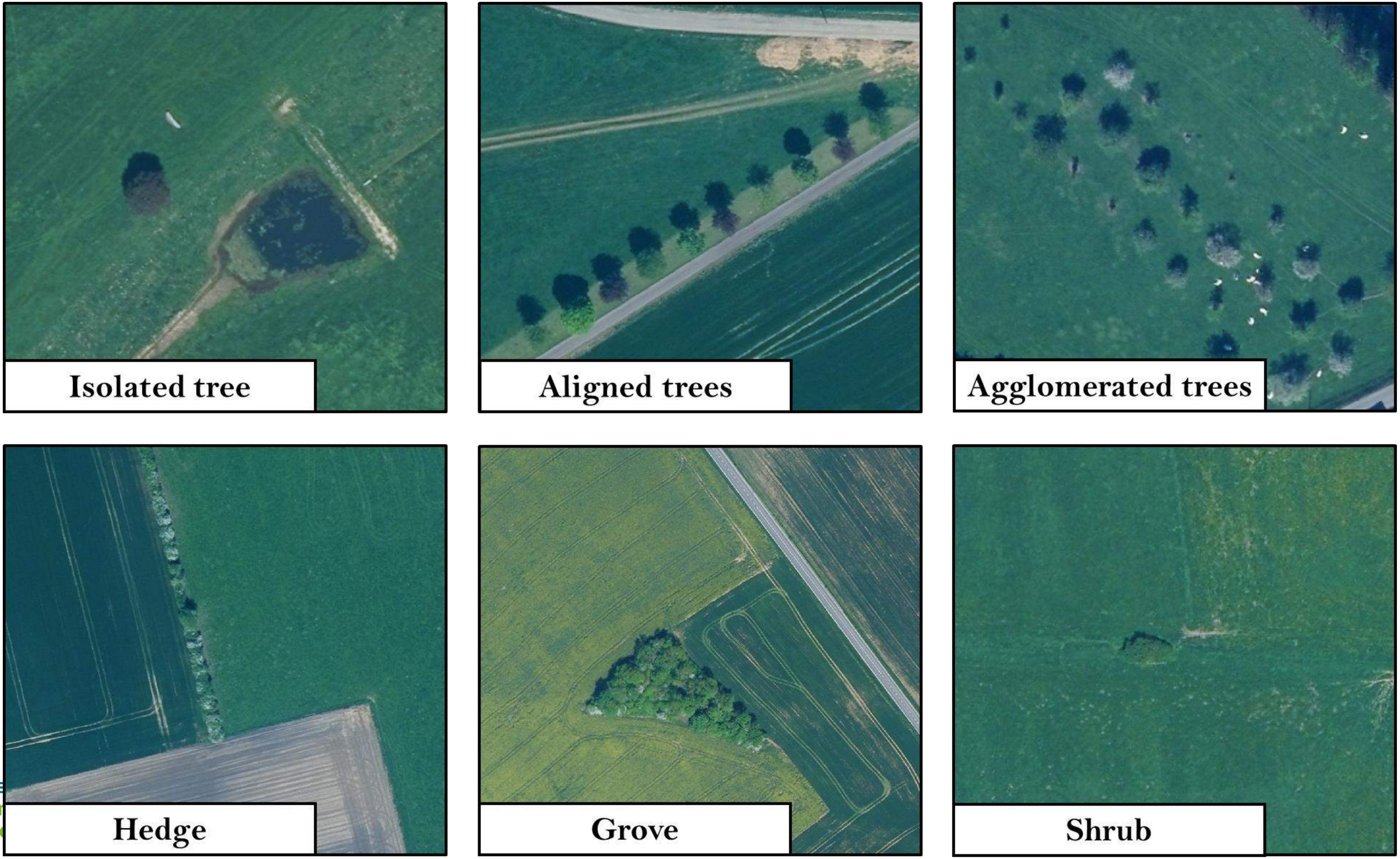
Typology of trees outside forests

- **Grove** : continuous and non-linear element spanning more than 400 m²
- **Agglomerated trees** : a group of ligneous elements standing less than 10 m apart and that are not aligned (e.g. orchards) ;
- **Aligned trees** : an alignment comprised of at least 5 ligneous elements standing less than 10 m apart ;
- **Hedges** : continuous and linear element being at least 10 m long and not exceeding 20 m in width. The length/width ratio is above 3. The hedge sections standing less than 5 m apart are considered as part of the same hedge ;
- **Isolated trees** : ligneous elements comprising only one tree, standing more than 5 m away from any other mapped element. The corona projected on the ground spans at least 12,6 m², corresponding to a 4 m diameter disk ;
- **Shrub** : isolated ligneous elements, standing more than 5 m away from a grove, a hedge or a forest and more than 10 m away from another ligneous element. This category includes shrubs, bushes and groves not exceeding a surface of 400 m² ;
- **Others** : comprises elements of over 2 m which are not meeting the above-mentioned criteria

LIÈGE université
Gembloux
Agro-Bio Tech

Interreg
France-Wallonie-Vlaanderen

Feel Wood
Forêt Pro Bos


Isolated tree
Aligned trees
Agglomerated trees
Hedge
Grove
Shrub

Classifying ligneous elements located outside the forest

- 1st step : classifying the various elements into three classes :
  - Small size ligneous elements
  - Groves (surface area > 400 m²)
  - Linear elements (minimum length : 10 m, maximum width : 20 m, (length/width) > 3)

Classifying ligneous elements located outside the forest

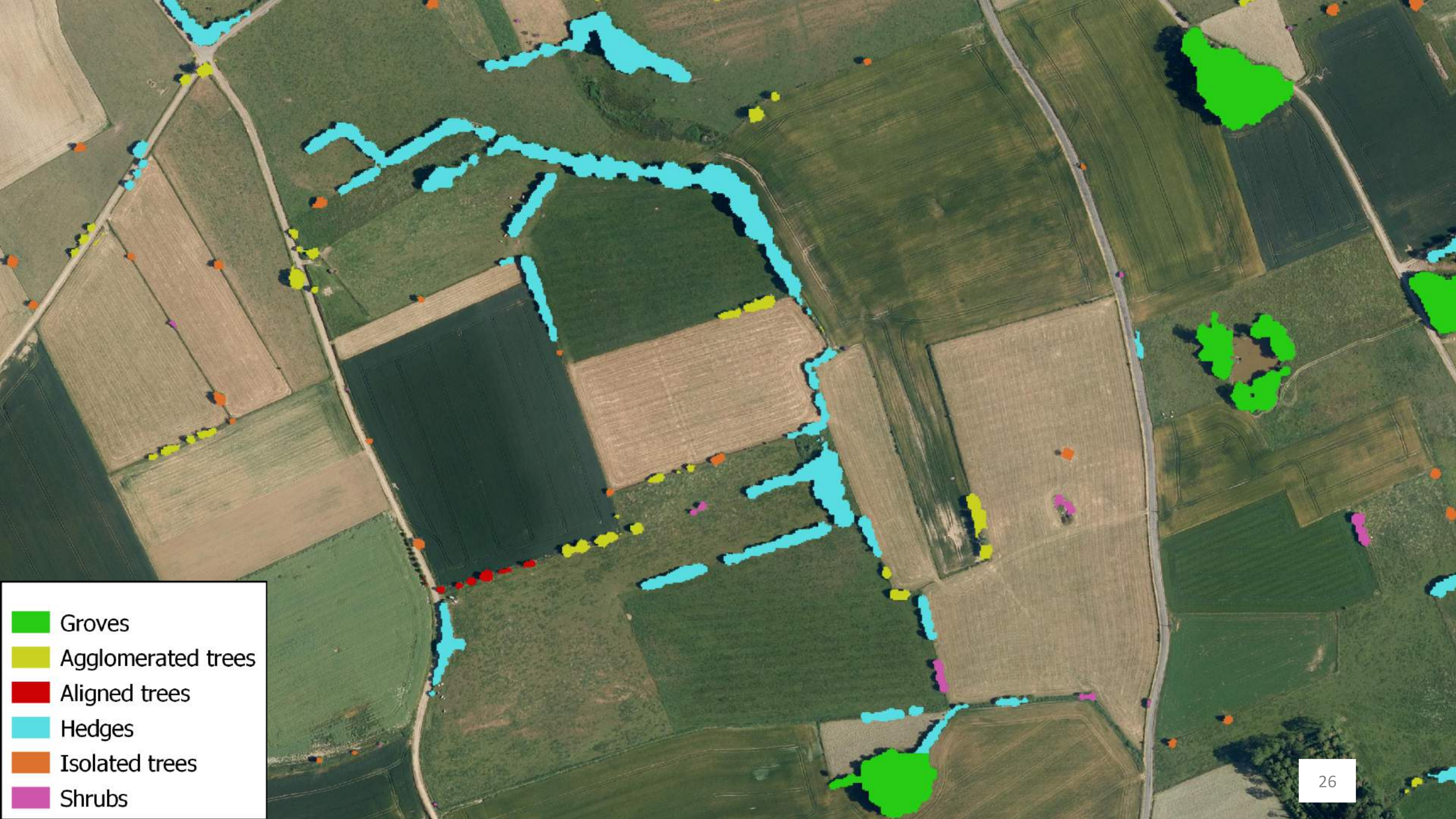
- 1st step : classifying the various elements into three classes :
  - Small size ligneous elements
  - Groves (surface area > 400 m²)
  - Linear elements (minimum length : 10 m, maximum width : 20 m, (length/width) > 3)

- 2d step : algorithm comprising proximity criteria in order to achieve the final classification into 6 categories

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos


Groves
Agglomerated trees
Aligned trees
Hedges
Isolated trees
Shrubs

Accuracy, strengths and weaknesses

- Strength: automated processing chain that can be applied to any other LiDAR data set

LIÈGE université
Gembloux
Agro-Bio Tech

Interreg
France-Wallonie-Vlaanderen
Feel Wood
Forêt Pro Bos

Accuracy, strengths and weaknesses

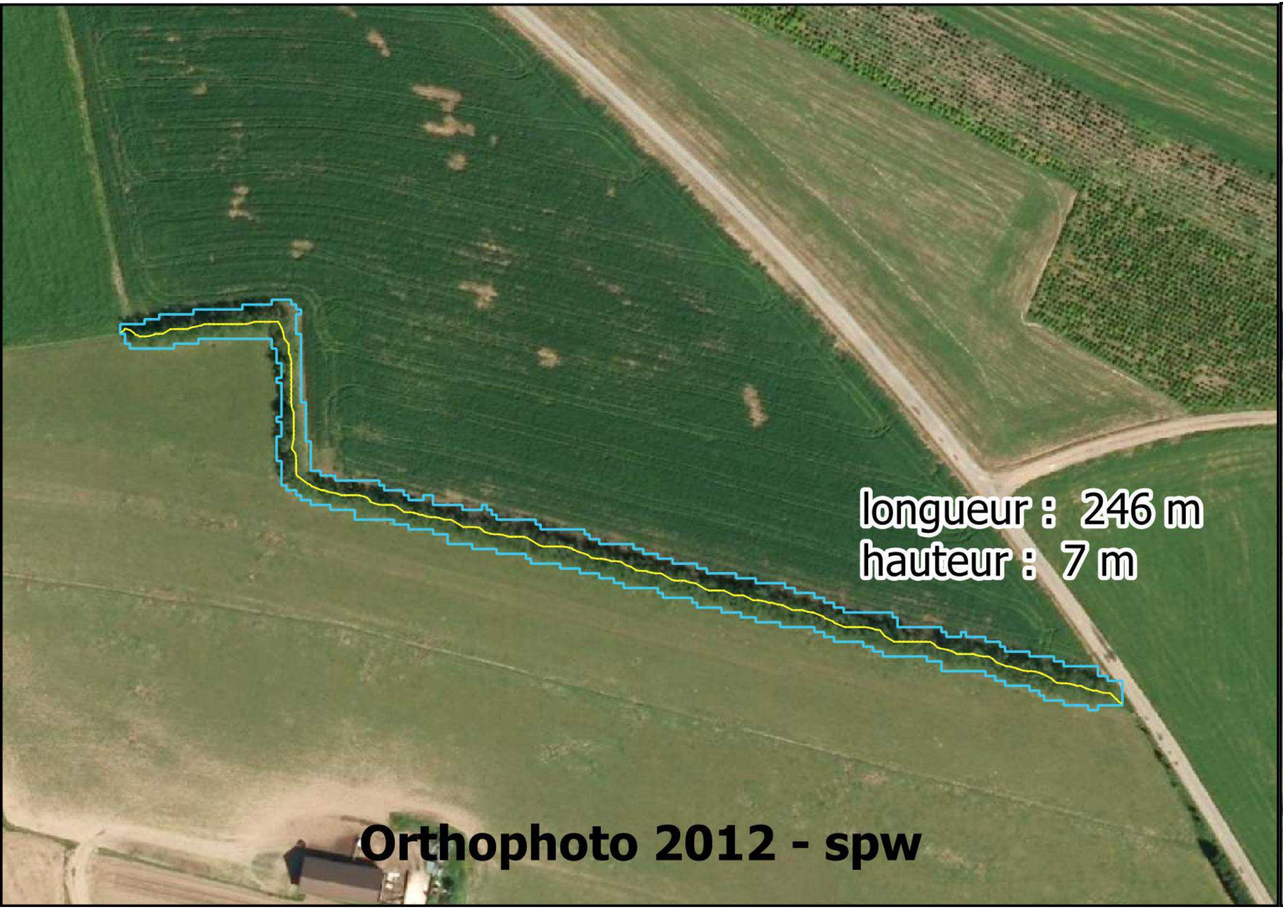
- Strength: automated processing chain that can be applied to any other LiDAR data set
- Source of error : confusion between ligneous elements and non-ligneous elements exceeding 2 m

Accuracy, strengths and weaknesses

- Strength: automated processing chain that can be applied to any other LiDAR data set
- Source of error : confusion between ligneous elements and non-ligneous elements exceeding 2 m
- Using photointerpretation in order to assess the classification of ligneous elements in agricultural areas : 93 % accuracy

Further analyses

Detection of changes over time

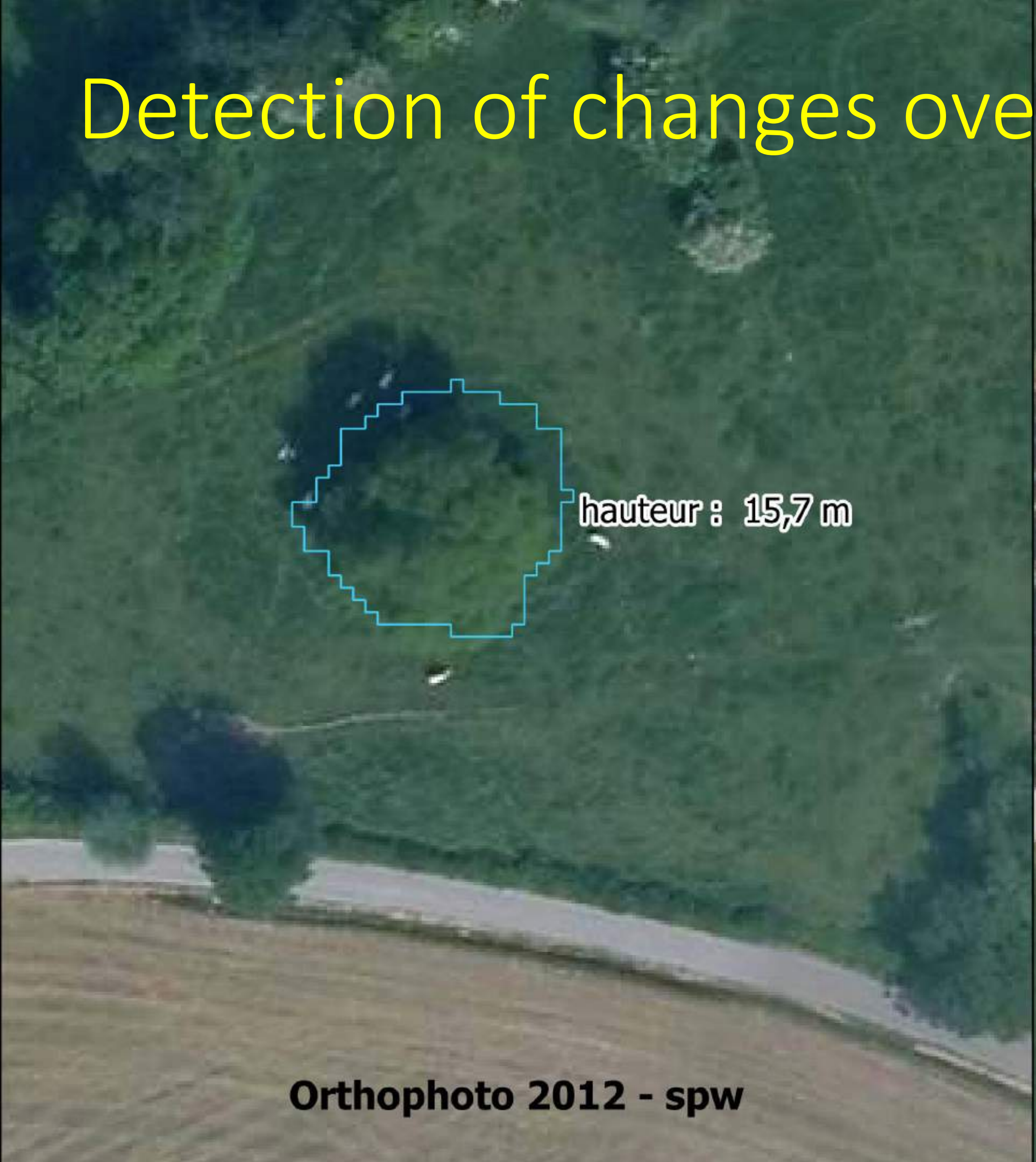


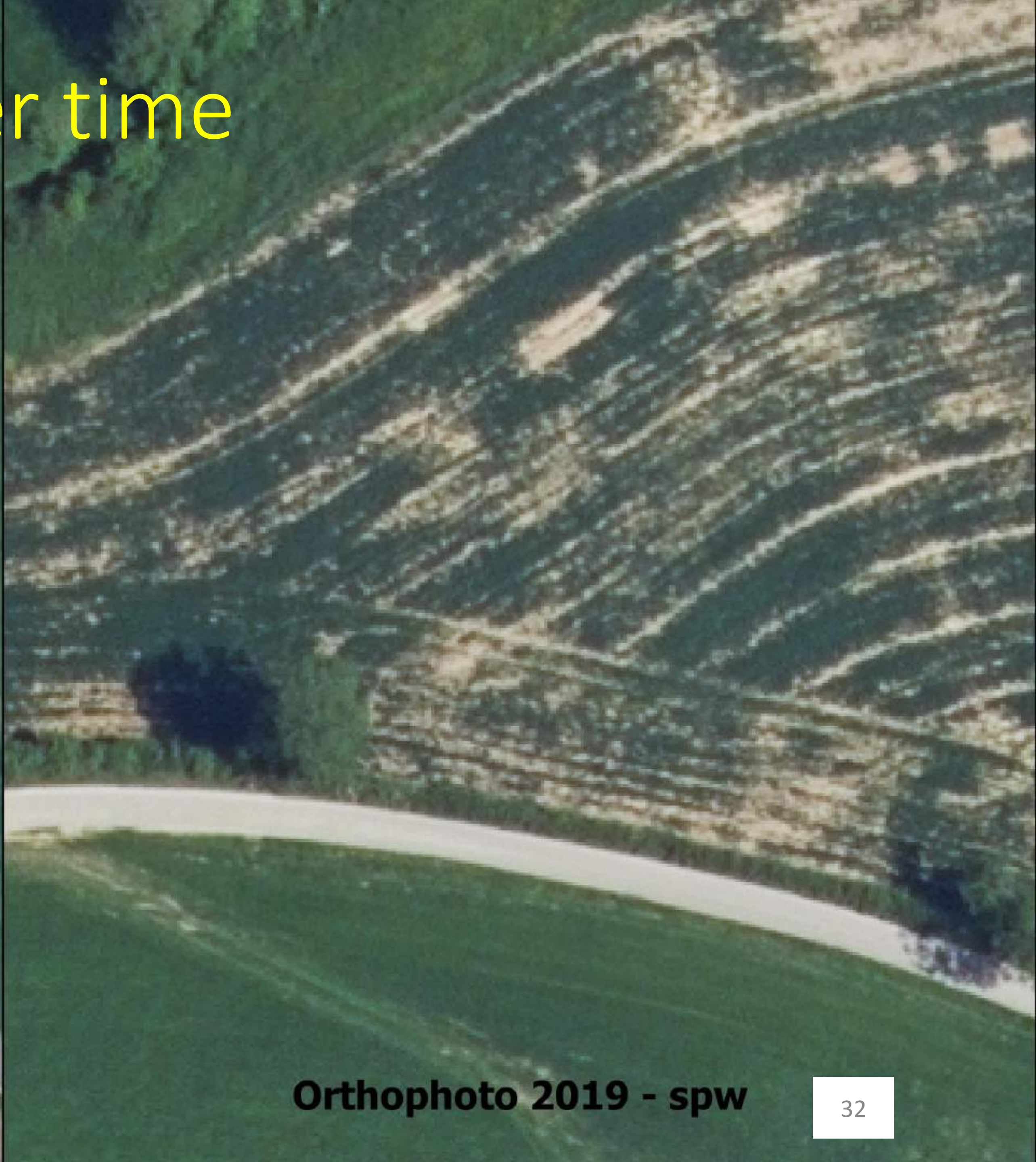
LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

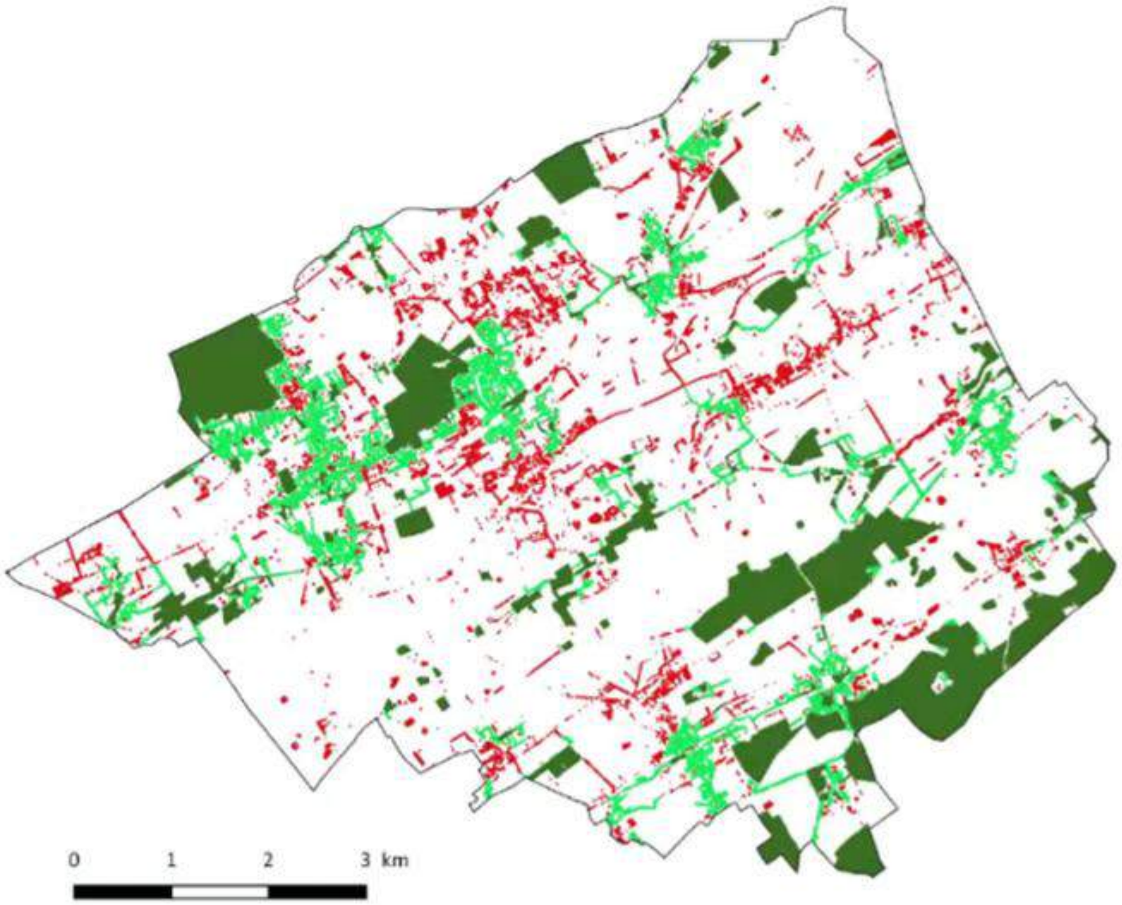
Feel Wood Forêt Pro Bos

Detection of changes over time

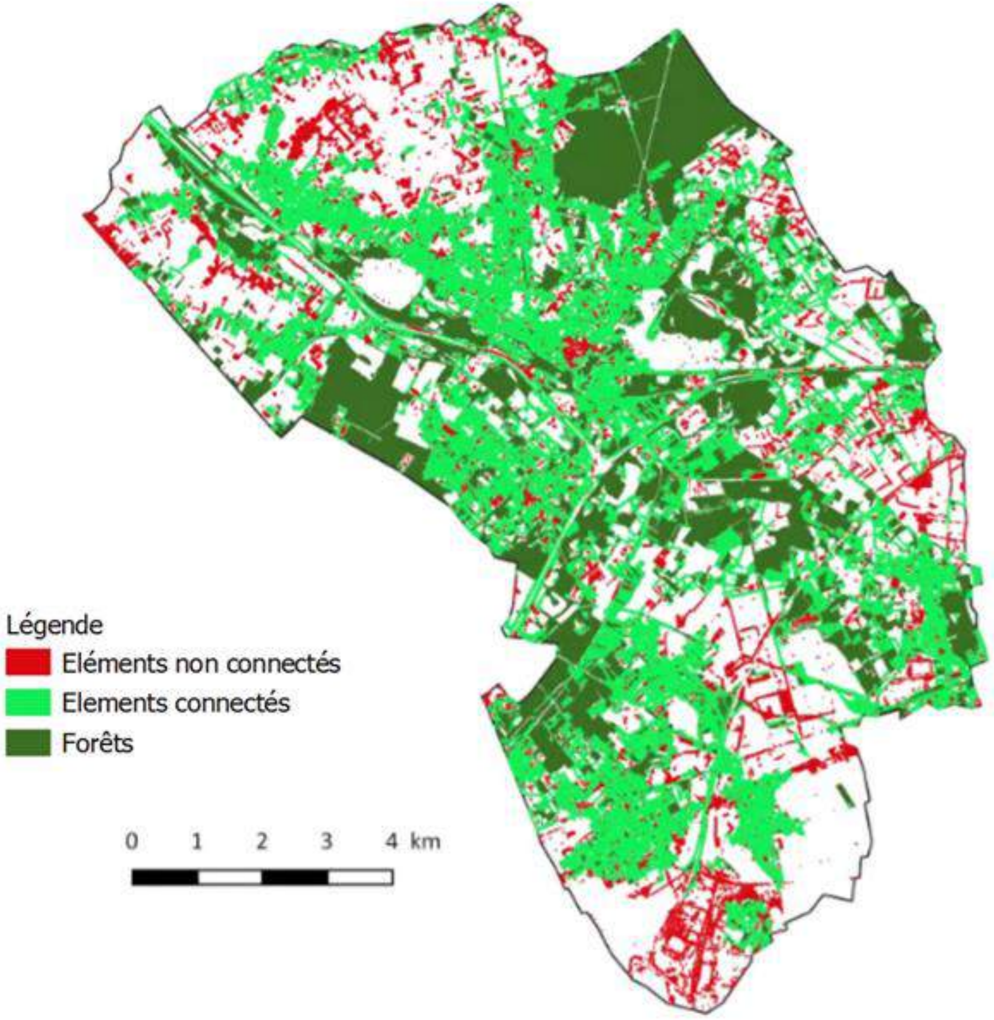




Connectivity analysis



Ohey municipality : 55 %



Condé sur l’escaut area : 84 %

Results in young plantations ?

LIÈGE université
Gembloux
Agro-Bio Tech

Interreg
France-Wallonie-Vlaanderen

Feel Wood
Forêt Pro Bos


Groves
Agglomerated trees
Aligned trees
Hedges
Isolated trees
Shrubs

Sensing of poplar plantations

- Requires very high spatial resolution data
  - Accurate positioning of trees inside the plantation
  - Detecting plants that have a small crown
  - Differentiating the immediate environment : regrows

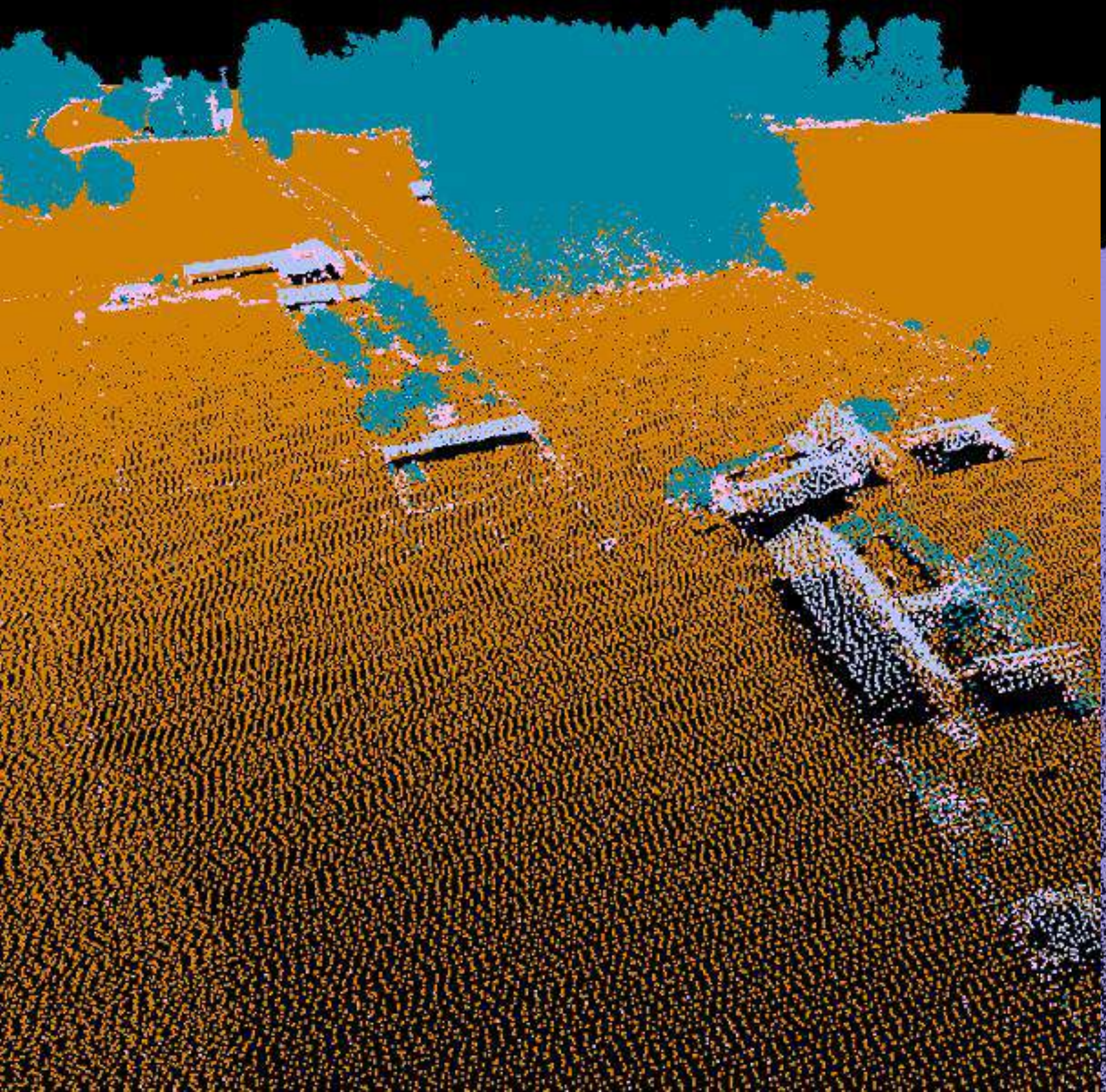
Sensing of poplar plantations

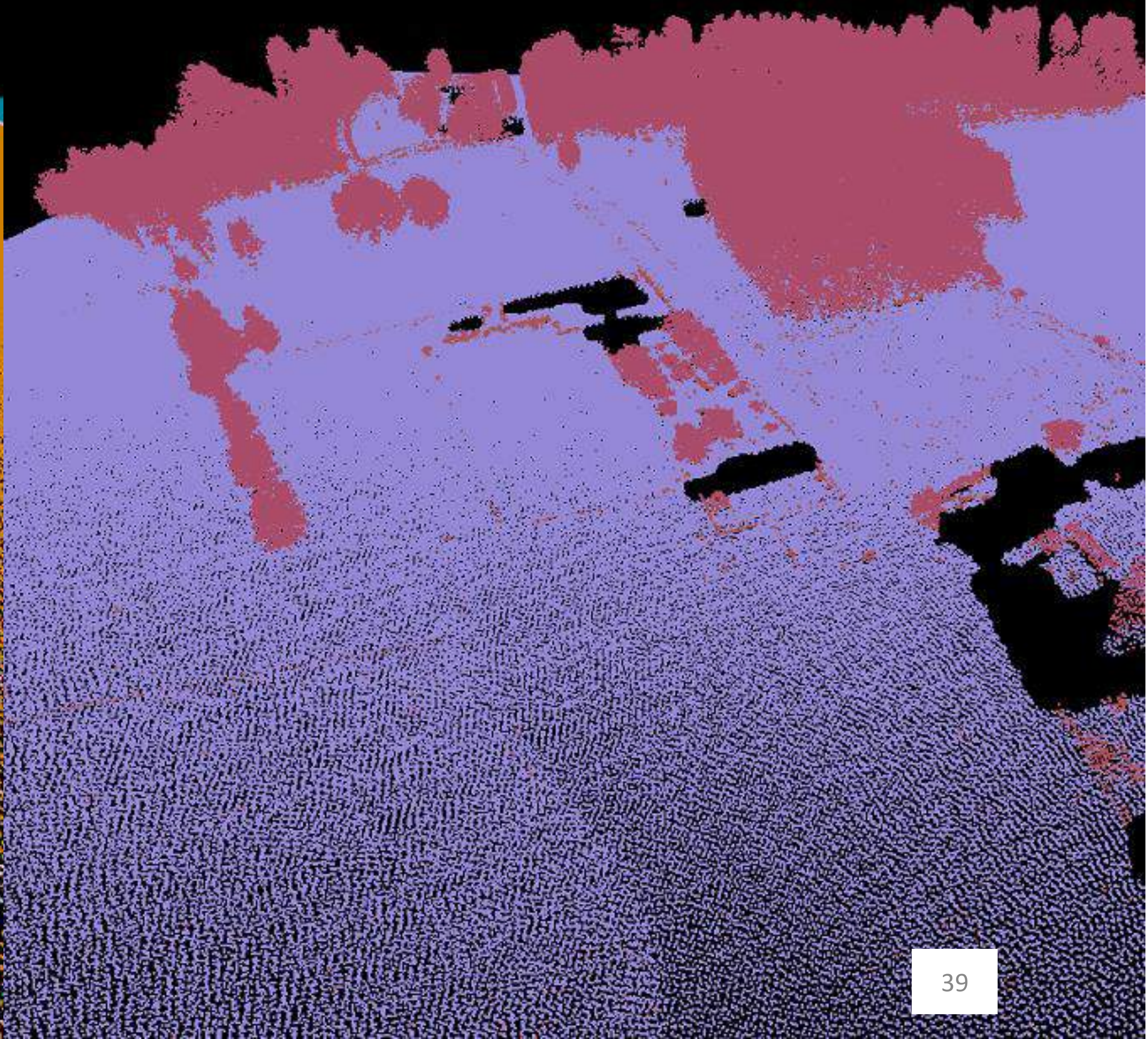
- Requires very high spatial resolution data
  - Accurate positioning of trees inside the plantation
  - Detecting plants that have a small crown
  - Differentiating the immediate environment : regrows

- Mapping method exclusively based on aerial LiDAR

Methodology

1. Identify « ground » points and normalize the point cloud
2. Identify all the points corresponding to ligneous elements





Methodology

1. Identify « ground » points and normalize the point cloud
2. Identify all the points corresponding to ligneous elements

Methodology

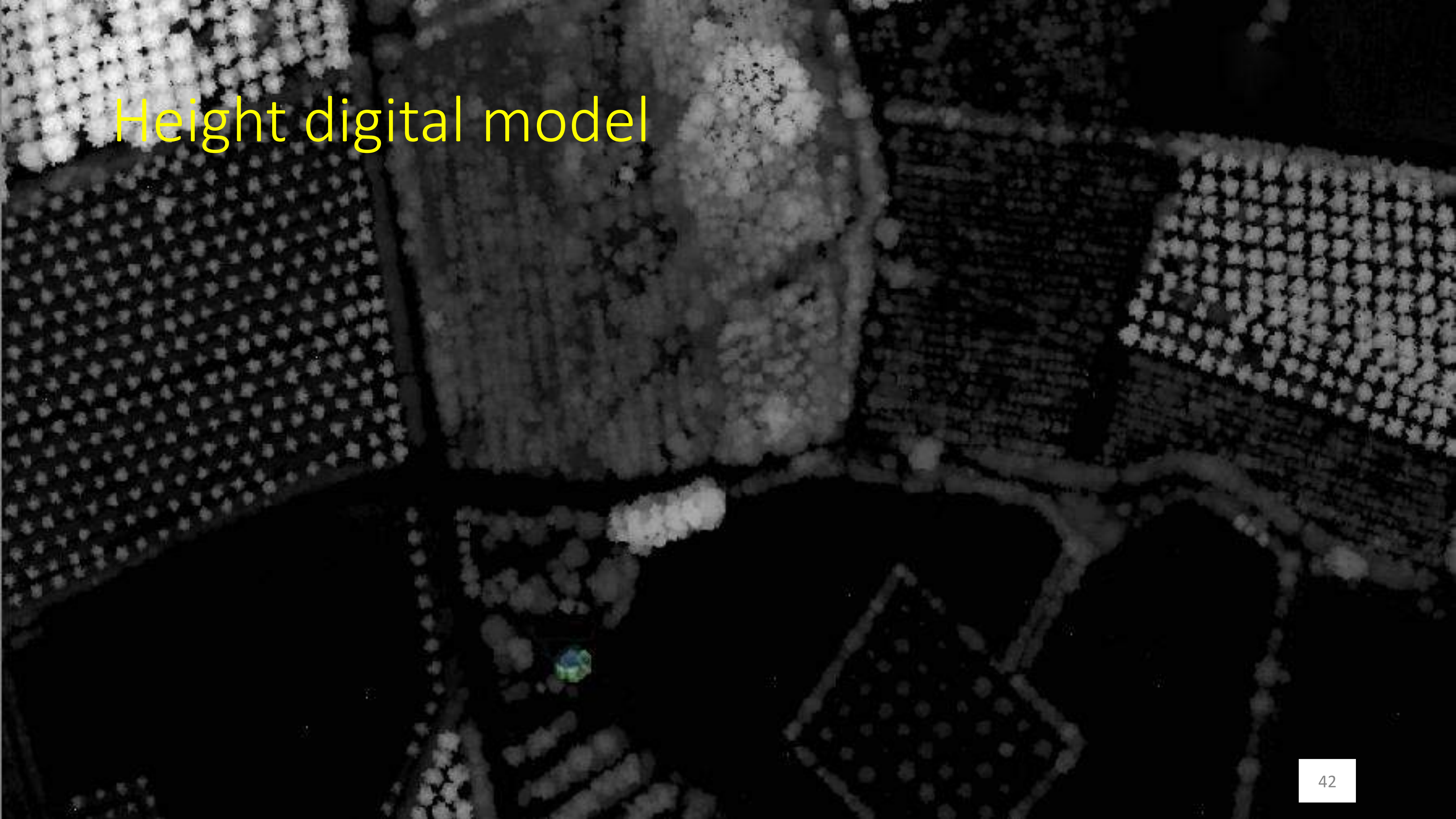
1. Identify « ground » points and normalize the point cloud
2. Identify all the points corresponding to ligneous elements
3. Sensing the location of trees and per stratum clustering
    - Geographic proximity (x, y, z)
    - Proximity of texture indexes measured around the tree

LIÈGE université Gembloux Agro-Bio Tech

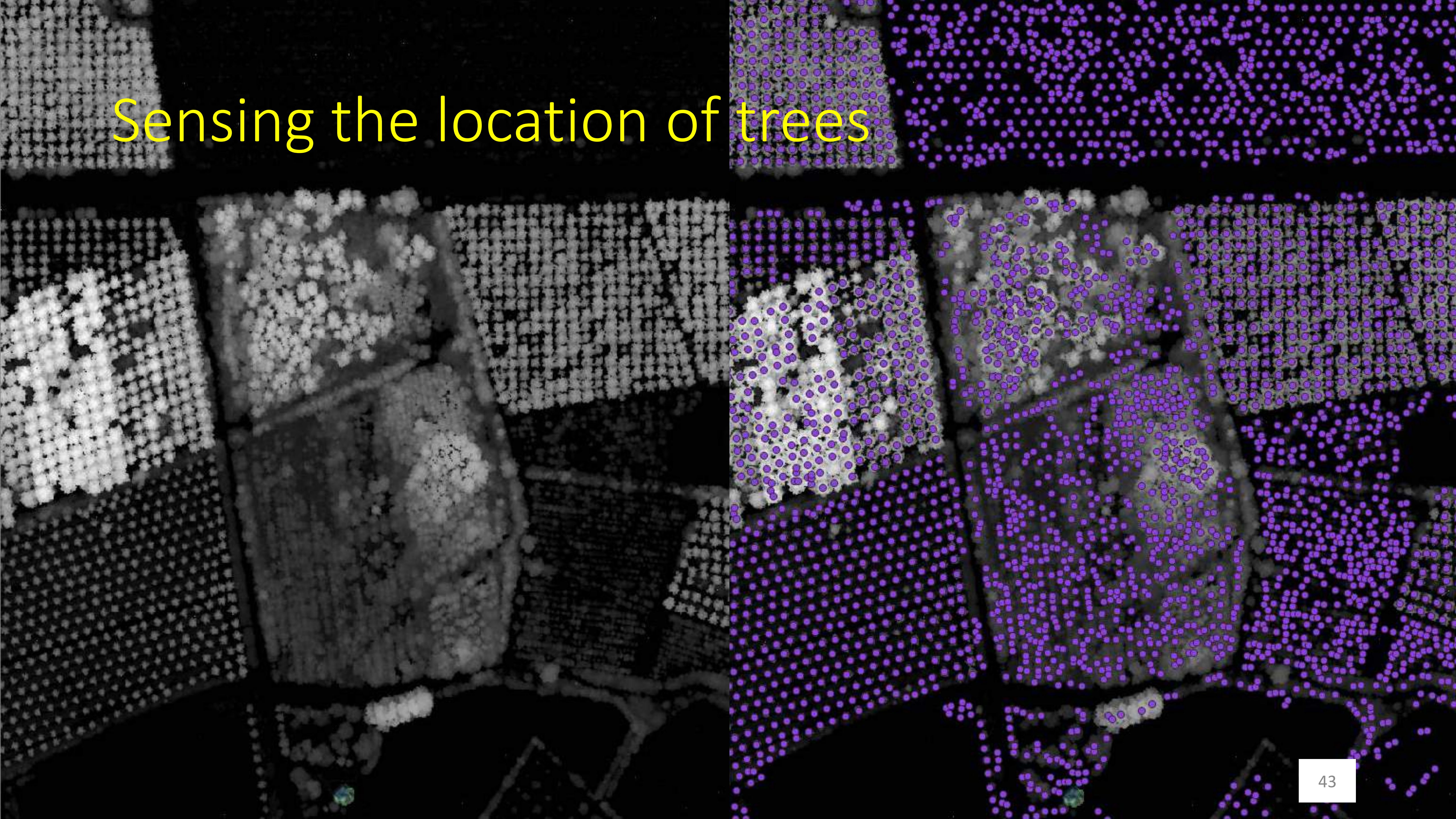
Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

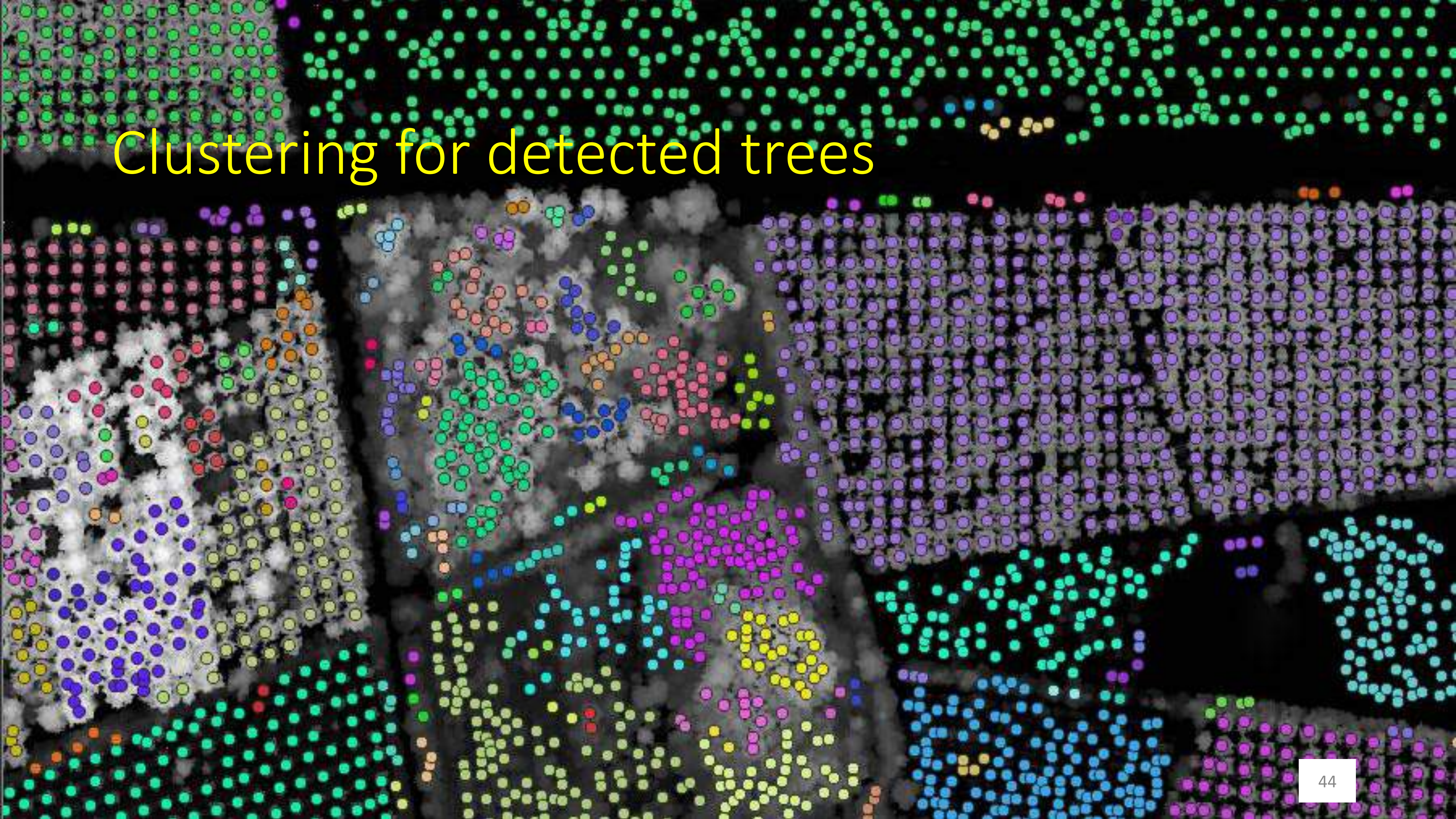
Height digital model



Sensing the location of trees



Clustering for detected trees

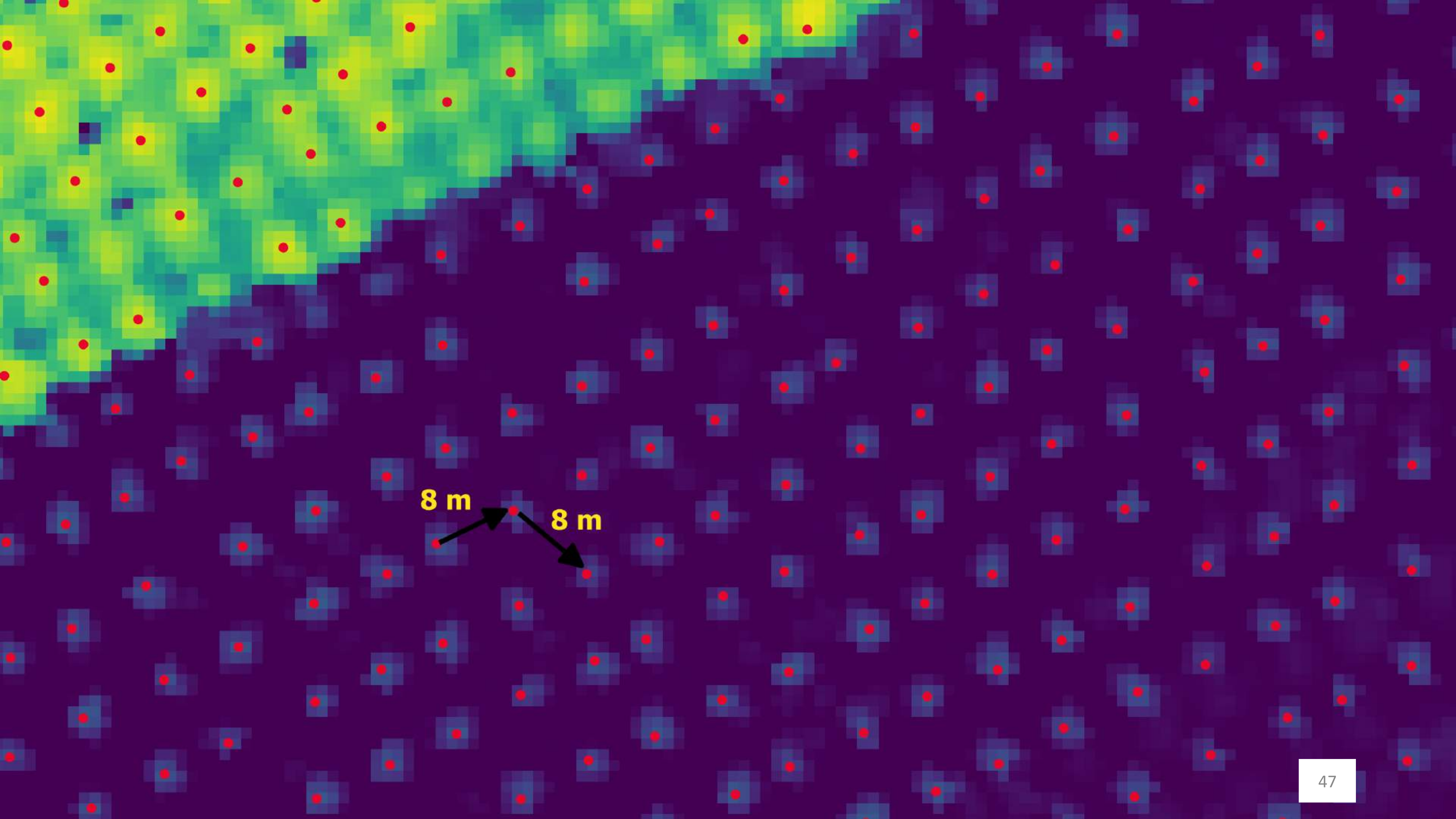


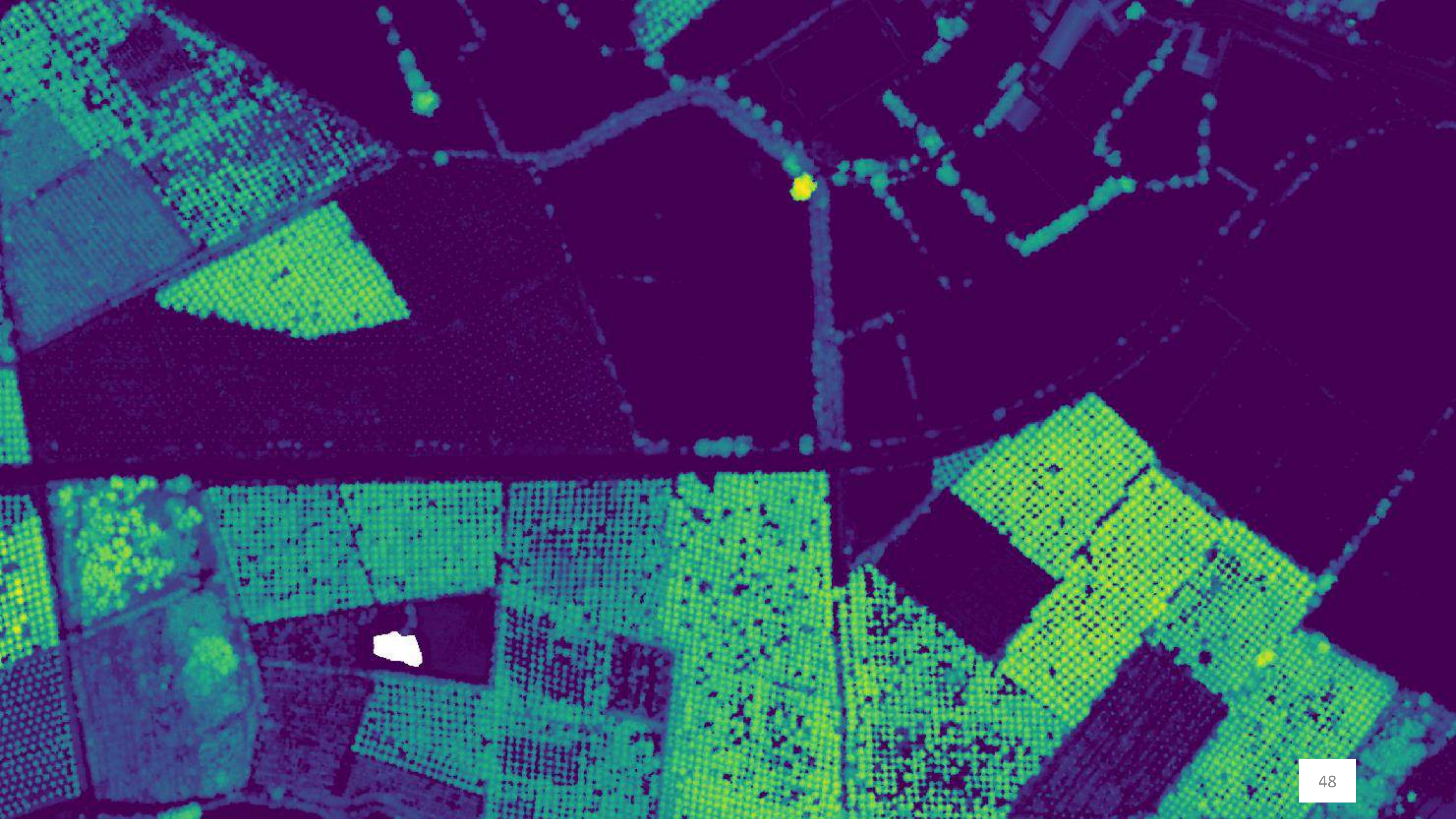
Methodology

1. Identify « ground » points and normalize the point cloud
2. Identify all the points corresponding to ligneous elements
3. Sensing the location of trees and per stratum clustering

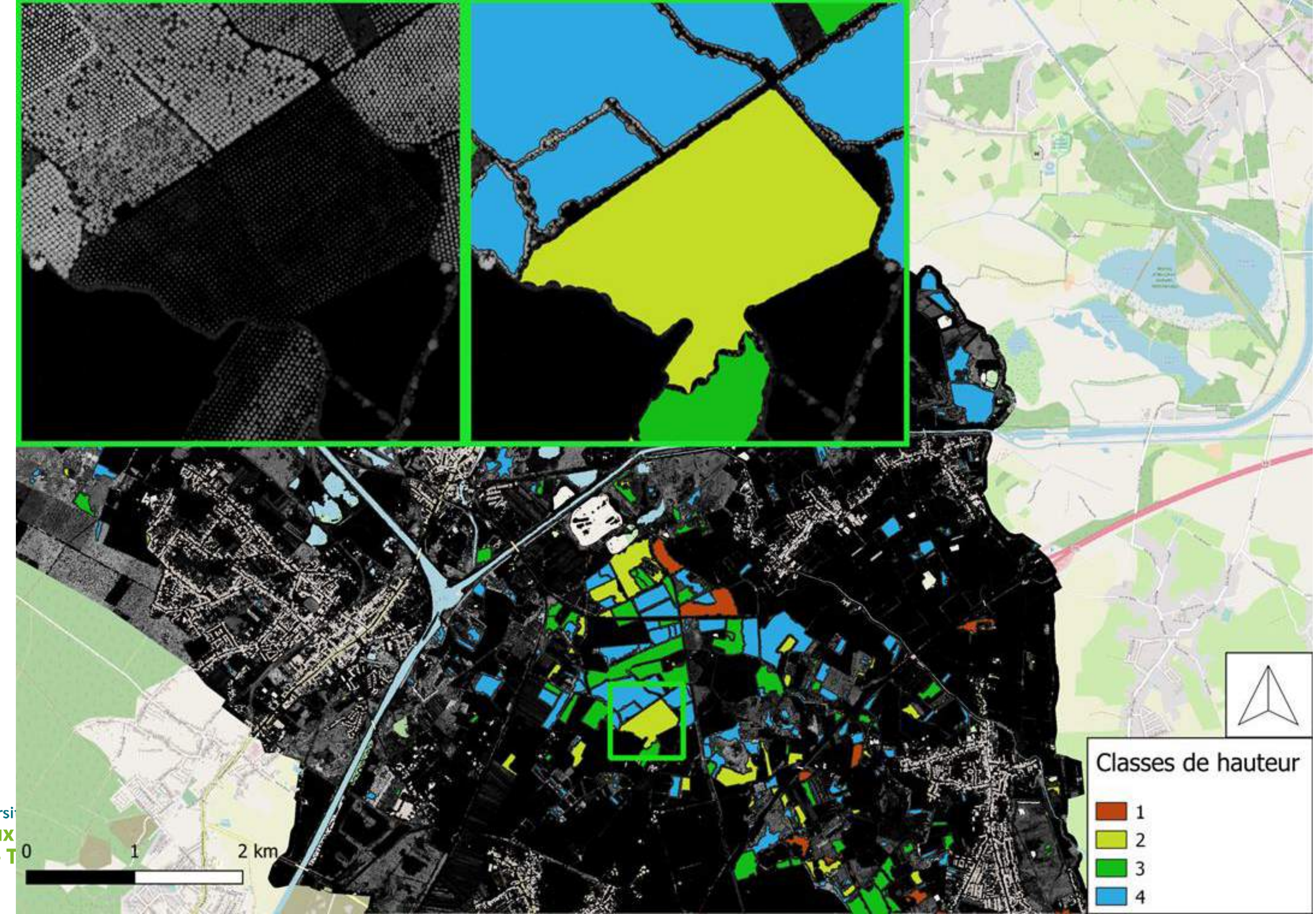
Methodology

1. Identify « ground » points and normalize the point cloud
2. Identify all the points corresponding to ligneous elements
3. Sensing the location of trees and per stratum clustering
4. Sensing the « plantation » pattern (8 X 8 m)
    - Algorithm comprising distance matrices
    - Tree group index representing the proportion of points laid out in a 8 X 8 m grid


8 m
8 m




< 4 m
[4 m , 12 m [
[12 m, 20 m [
> 20 m



LIÈGE université
Gembloux
Agro-Bio Tech

Accuracy, strengths and weaknesses

- Strength: automated processing chain that can be applied to any LiDAR data set

LIÈGE université
Gembloux
Agro-Bio Tech

Interreg
France-Wallonie-Vlaanderen

Feel Wood
Forêt Pro Bos

Accuracy, strengths and weaknesses

- Strength: automated processing chain that can be applied to any LiDAR data set
- Weakness: solely based on the trees layout, noise-sensitive

Accuracy, strengths and weaknesses

- Strength: automated processing chain that can be applied to any LiDAR data set
- Weakness: solely based on the trees layout, noise-sensitive
- Accuracy analysis: based on MNH LiDAR photointerpretation and knowledge of the ground

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

- Grid 100 x 100 m
- Sensing accuracy for the plantations by height categories

Class	Nord	Marne	Aisne
1	0.996	1.000	0.999
2	0.976	0.986	0.966
3	0.970	0.963	0.927
4	0.884	0.946	0.926

Results in mature forest plants ?

LIÈGE université
Gembloux
Agro-Bio Tech

Interreg
France-Wallonie-Vlaanderen
Feel Wood
Forêt Pro Bos


< 4 m
[4 m , 12 m [
[12 m, 20 m [
> 20 m

Results in mature forest plants ?

- Complementary approach combined with the mapping of timber species through satellite imagery

Mapping of timber species through the use of Sentinel-2 satellite imagery

- Mapping of forest stands
  - Less constraining spatial resolution
  - Work undertaken at the Interreg territory level

Mapping of timber species through the use of Sentinel-2 satellite imagery

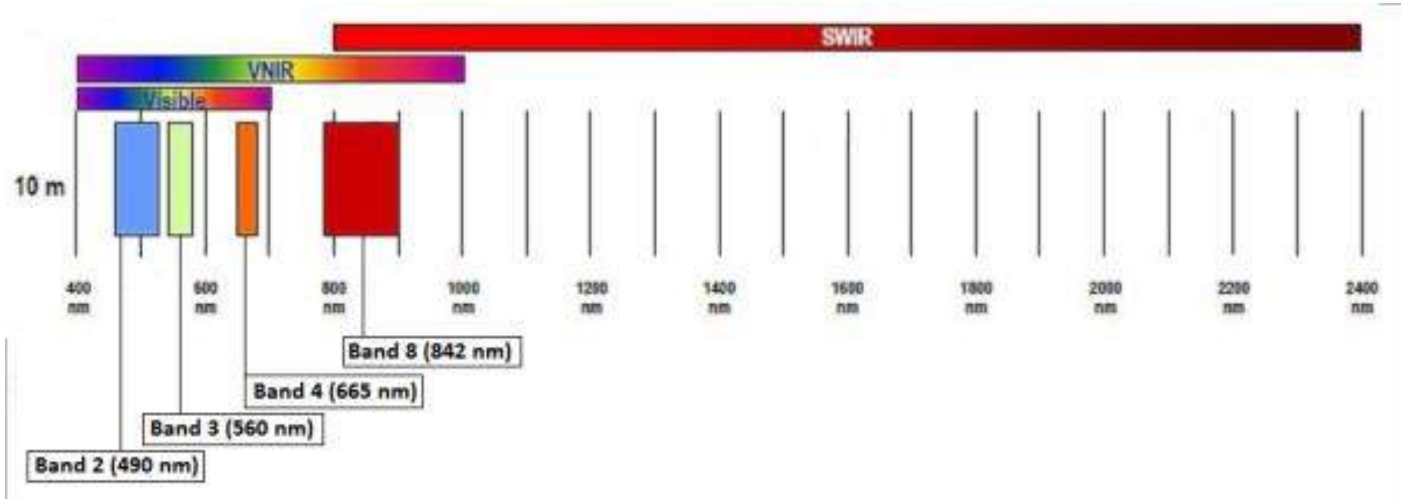
- Mapping of forest stands
  - Less constraining spatial resolution
  - Work undertaken at the Interreg territory level
- Sentinel-2 imagery
  - Available for the entire area
  - Continuous aquisition, return time : 5 days
  - High spectral resolution for 10 bands

LIÈGE université Gembloux Agro-Bio Tech

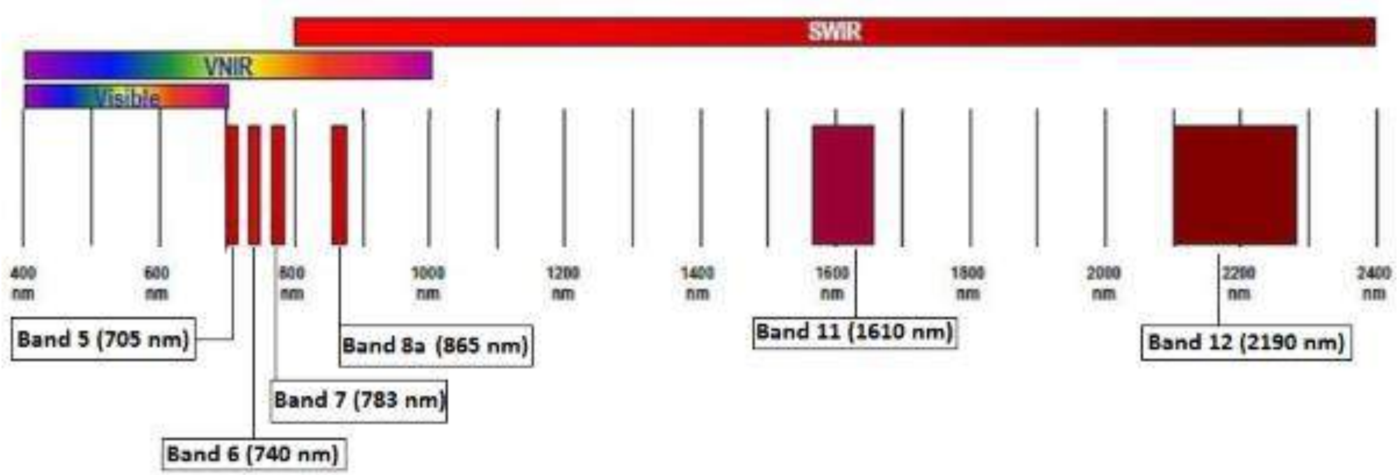
Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

- 10 m bands



- 20 m bands

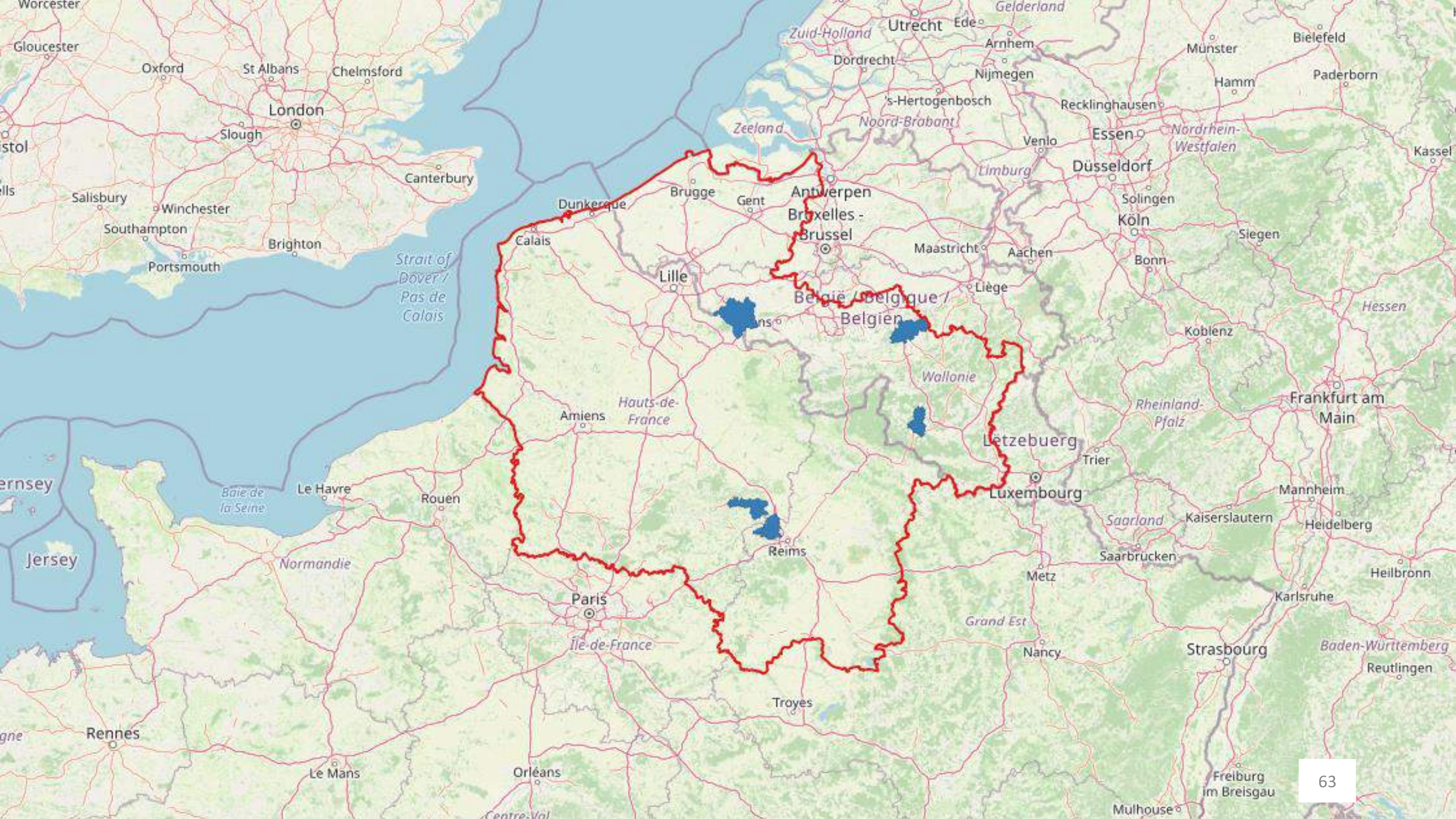


LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen
Feel Wood
Forêt Pro Bos

Technical constraint related to satellite imagery

- At the Interreg project level
  - Impossible to have no clouds for a definite period
  - Use the available images without a cloud?
    - Poorly reproducible approach


Worcester
Gloucester
Oxford
St Albans
Chelmsford
London
Slough
Canterbury
Salisbury
Winchester
Southampton
Brighton
Portsmouth
Strait of Dover / Pas de Calais
Baie de la Seine
Jersey
Le Havre
Rouen
Normandie
Rennes
Le Mans
Orléans
Paris
Île-de-France
Amiens
Hauts-de-France
Calais
Dunkerque
Brugge
Gent
Lille
Antwerpen
Bruxelles - Brussel
België / Belgique / Belgien
Wallonie
Zeeland
Zuid-Holland
Utrecht
Ede
Gelderland
Arnhem
Dordrecht
Nijmegen
's-Hertogenbosch
Noord-Brabant
Limburg
Venlo
Maastricht
Aachen
Liège
Lëtzebuerg
Luxembourg
Trier
Reims
Troyes
Grand Est
Metz
Nancy
Saarland
Saarbrücken
Kaiserslautern
Strasbourg
Mulhouse
Freiburg im Breisgau
Karlsruhe
Heilbronn
Heidelberg
Mannheim
Reutlingen
Baden-Württemberg
Frankfurt am Main
Rheinland-Pfalz
Koblenz
Hessen
Bonn
Siegen
Köln
Solingen
Düsseldorf
Essen
Nordrhein-Westfalen
Recklinghausen
Hamm
Münster
Bielefeld
Paderborn
Kassel

Technical constraint related to satellite imagery

- Developing a S2 mosaic without a cloud for the vegetation period (from 2018-05-01 to 2018-09-30)

Technical constraint related to satellite imagery

- Developing a S2 mosaic without a cloud for the vegetation period (from 2018-05-01 to 2018-09-30)

  - Downloading all the S2 images (cloud cover < 50 %)

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

Technical constraint related to satellite imagery

- Developing a S2 mosaic without a cloud for the vegetation period (from 2018-05-01 to 2018-09-30)

  - Downloading all the S2 images (cloud cover < 50 %)
  - Excluding « cloud » pixels (Theia cloud mask)

Technical constraint related to satellite imagery

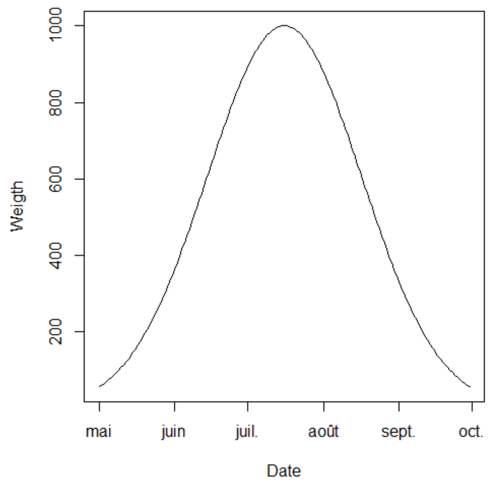
- Developing a S2 mosaic without a cloud for the vegetation period (from 2018-05-01 to 2018-09-30)

  - Downloading all the S2 images (cloud cover < 50 %)
  - Excluding « cloud » pixels (Theia cloud mask)
  - For each spectral band : weighted average of the pixel values available for the given period

Technical constraint related to satellite imagery

- Developing a S2 mosaic without a cloud for the vegetation period (from 2018-05-01 to 2018-09-30)

    - Downloading all the S2 images (cloud cover < 50 %)
    - Excluding « cloud » pixels (Theia cloud mask)
    - For each spectral band : weighted average of the pixel values available for the given period



LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

Technical constraint related to satellite imagery

- Developing a S2 mosaic without a cloud for the vegetation period (from 2018-05-01 to 2018-09-30)

  - Downloading all the S2 images (cloud cover < 50 %)
  - Excluding « cloud » pixels (Theia cloud mask)
  - For each spectral band : weighted average of the pixel values available for the given period
  - Normalizing the bands

Technical constraint related to satellite imagery

- Developing a S2 mosaic without a cloud for the vegetation period (from 2018-05-01 to 2018-09-30)

  - Downloading all the S2 images (cloud cover < 50 %)
  - Excluding « cloud » pixels (Theia cloud mask)
  - For each spectral band : weighted average of the pixel values available for the given period
  - Normalizing the bands

$$brightness = mean(bands)$$

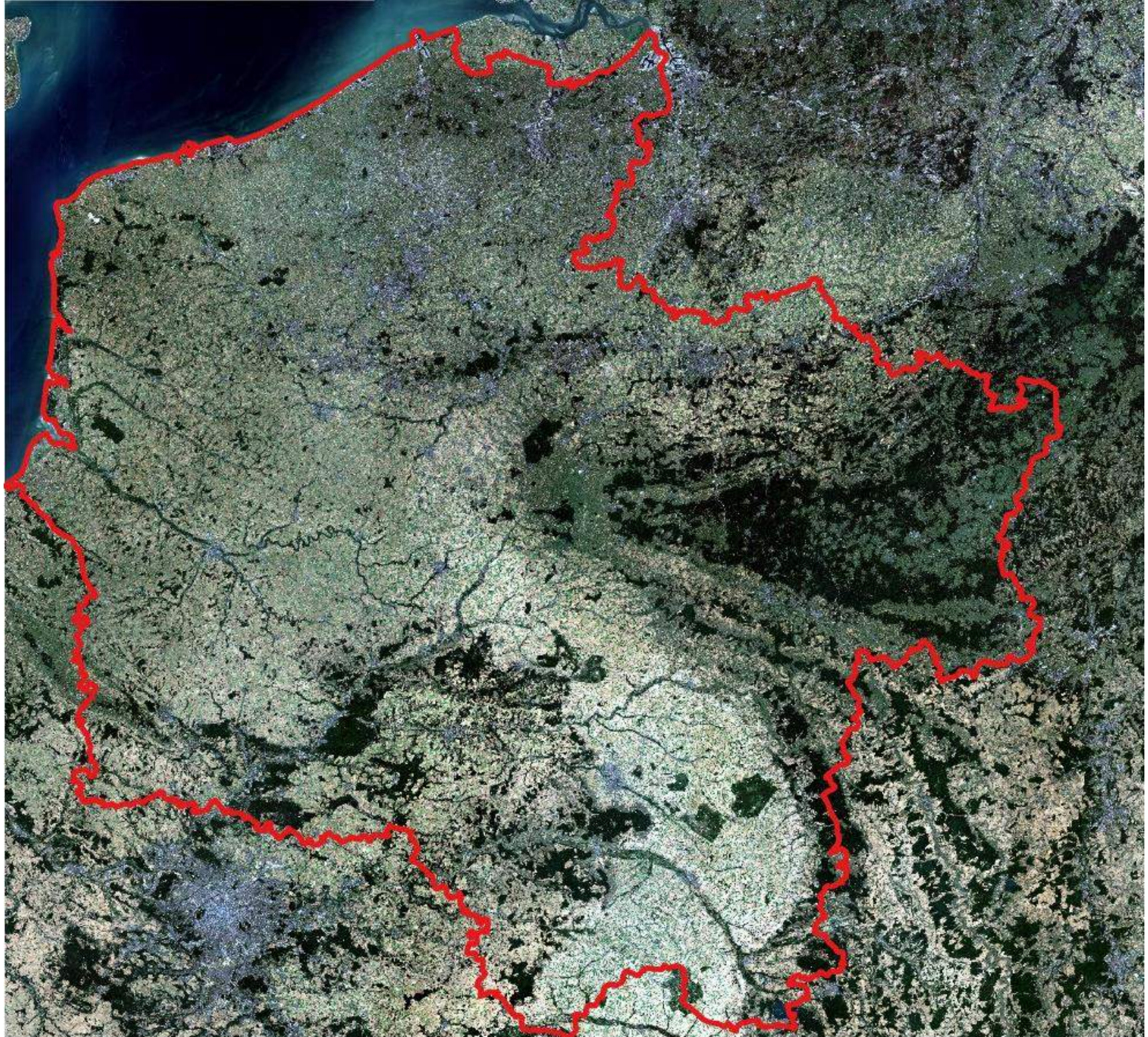
$$Normalized\ band = \frac{Band\ - brightness}{Band + brightness}$$

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

Mosaic S2
RGB



Mosaic S2
Nir SWIR SWIR

Supervised per pixel classification

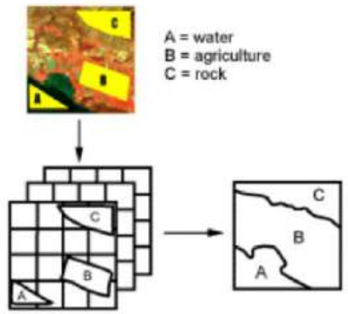
- Imagery : Sentinel-2 mosaic without cloud (2018-05-01 to 2018-09-30)

Supervised per pixel classification

- Imagery : Sentinel-2 mosaic without cloud (2018-05-01 to 2018-09-30)
- Training data :
  - Geodatabase of the Department of Nature and Forests (Public Service of Wallonia)
  - Data from the Interreg Transpop project
  - Digitalized data from the project's partners

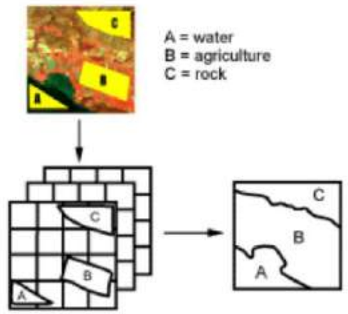
Supervised per pixel classification

- Imagery : Sentinel-2 mosaic without cloud (2018-05-01 to 2018-09-30)
- Training data :
  - Geodatabase of the Department of Nature and Forests (Public Service of Wallonia)
  - Data from the Interreg Transpop project
  - Digitalized data from the project's partners



Supervised per pixel classification

- Imagery : Sentinel-2 mosaic without cloud (2018-05-01 to 2018-09-30)
- Training data :
  - Geodatabase of the Department of Nature and Forests (Public Service of Wallonia)
  - Data from the Interreg Transpop project
  - Digitalized data from the project’s partners



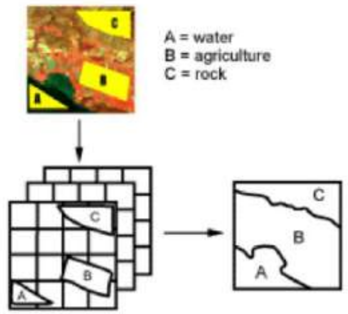
- Random forest model

LIÈGE université Gembloux Agro-Bio Tech

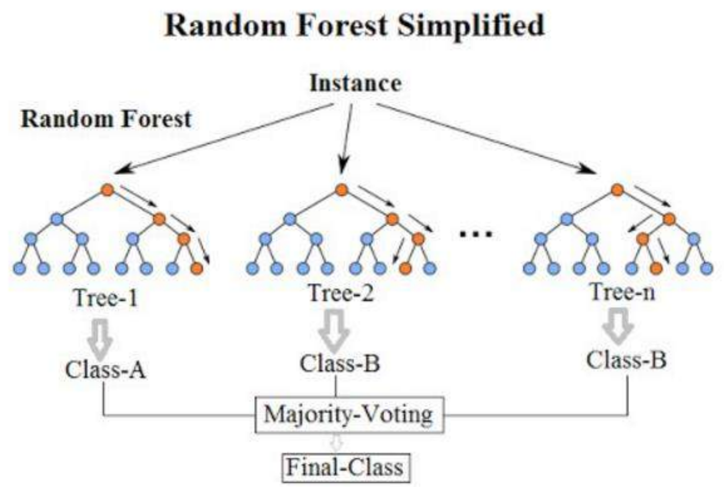
Interreg France-Wallonie-Vlaanderen
Feel Wood Forêt Pro Bos

Supervised per pixel classification

- Imagery : Sentinel-2 mosaic without cloud (2018-05-01 to 2018-09-30)
- Training data :
  - Geodatabase of the Department of Nature and Forests (Public Service of Wallonia)
  - Data from the Interreg Transpop project
  - Digitalized data from the project's partners



- Random forest model



LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

Method

1. Model aimed at generating a ligneous mask in the Interreg area

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

Method

1. Model aimed at generating a ligneous mask in the Interreg area
2. 1 model per timber species to be mapped:
   - Deciduous trees: oak, beech, poplar, other deciduous trees
   - Softwood trees: spruce, douglas, larch, pine tree, other softwood trees

Method

1. Model aimed at generating a ligneous mask in the Interreg area
2. 1 model per timber species to be mapped:
   - Deciduous trees: oak, beech, poplar, other deciduous trees
   - Softwood trees: spruce, douglas, larch, pine tree, other softwood trees

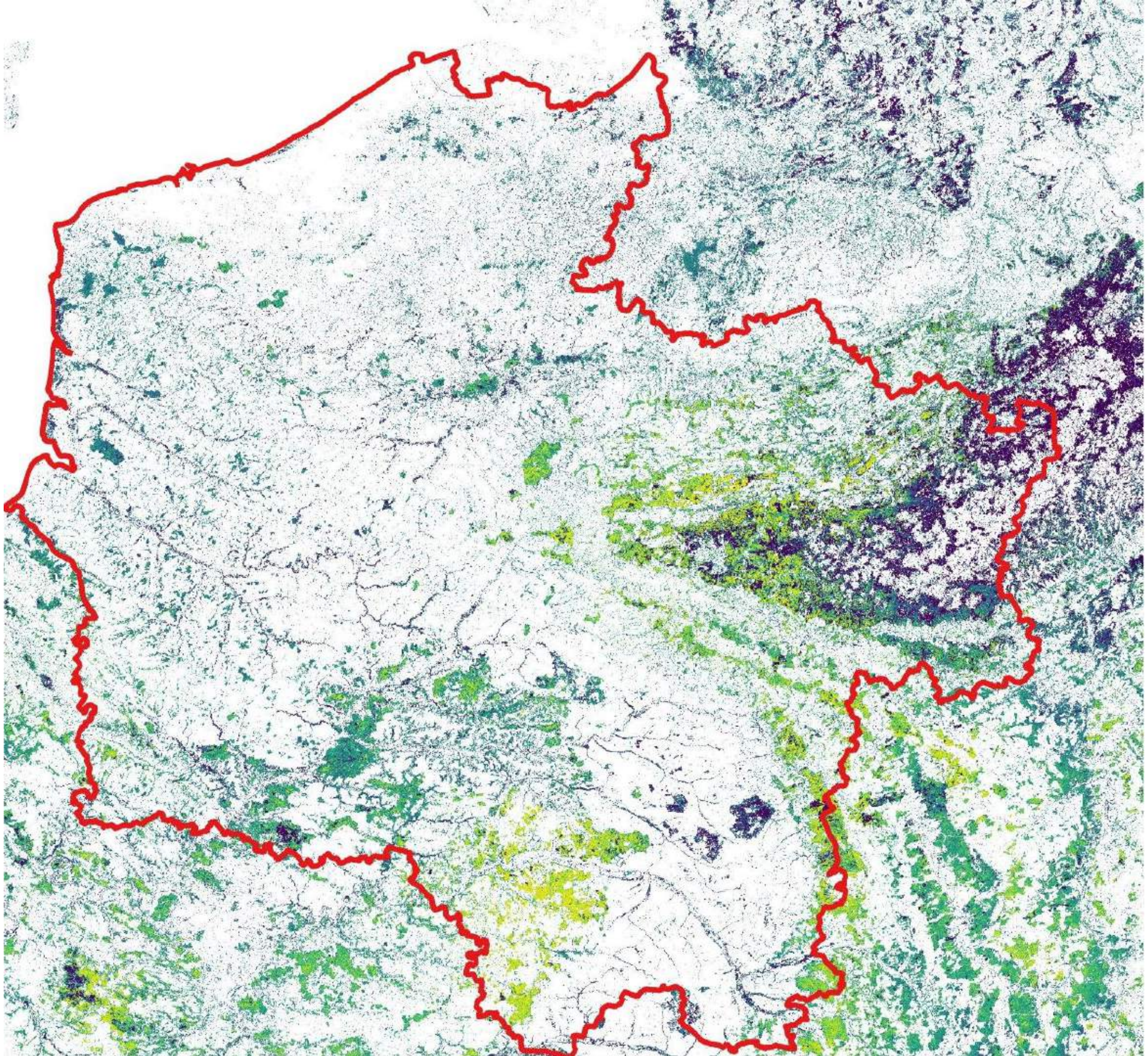
3. Produce maps showing the presence probability according to random forest model

Mosaic S2
Nir SWIR SWIR

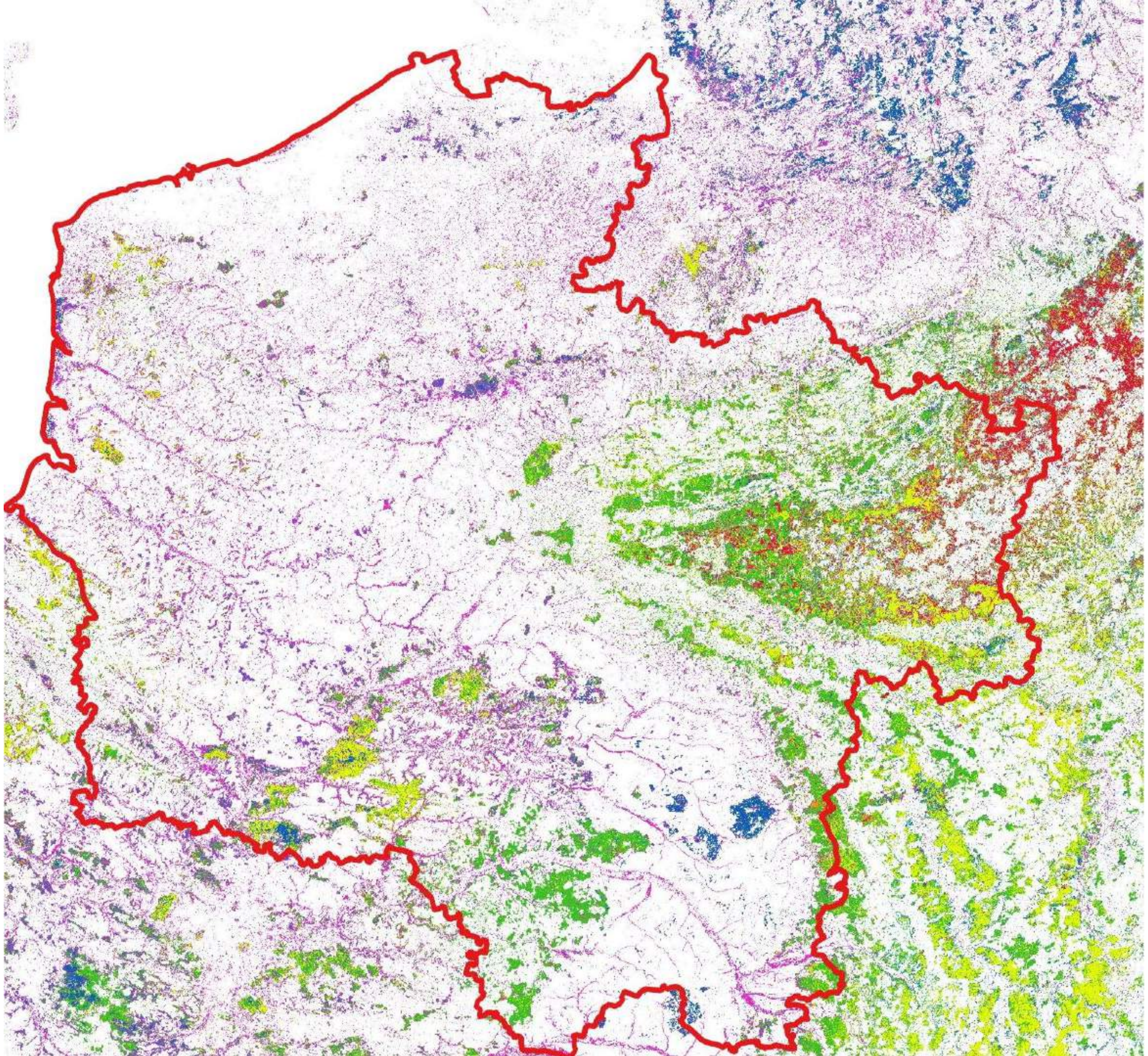
Result:

Ligneous mask

Result:
Presence probability of oak



Result:
Combination of the probability maps



- Quercus sp
- Pseudotsuga menziesii
- Picea sp
- other broad-leaved
- Fagus sylvatica
- Larix sp
- Populus sp
- Pinus sp
- Other needle-leaved

Accuracy, strengths and weaknesses

- Strengths :
  - Reproducibility from one year to another
  - Workable for large study areas (whole Interreg area)

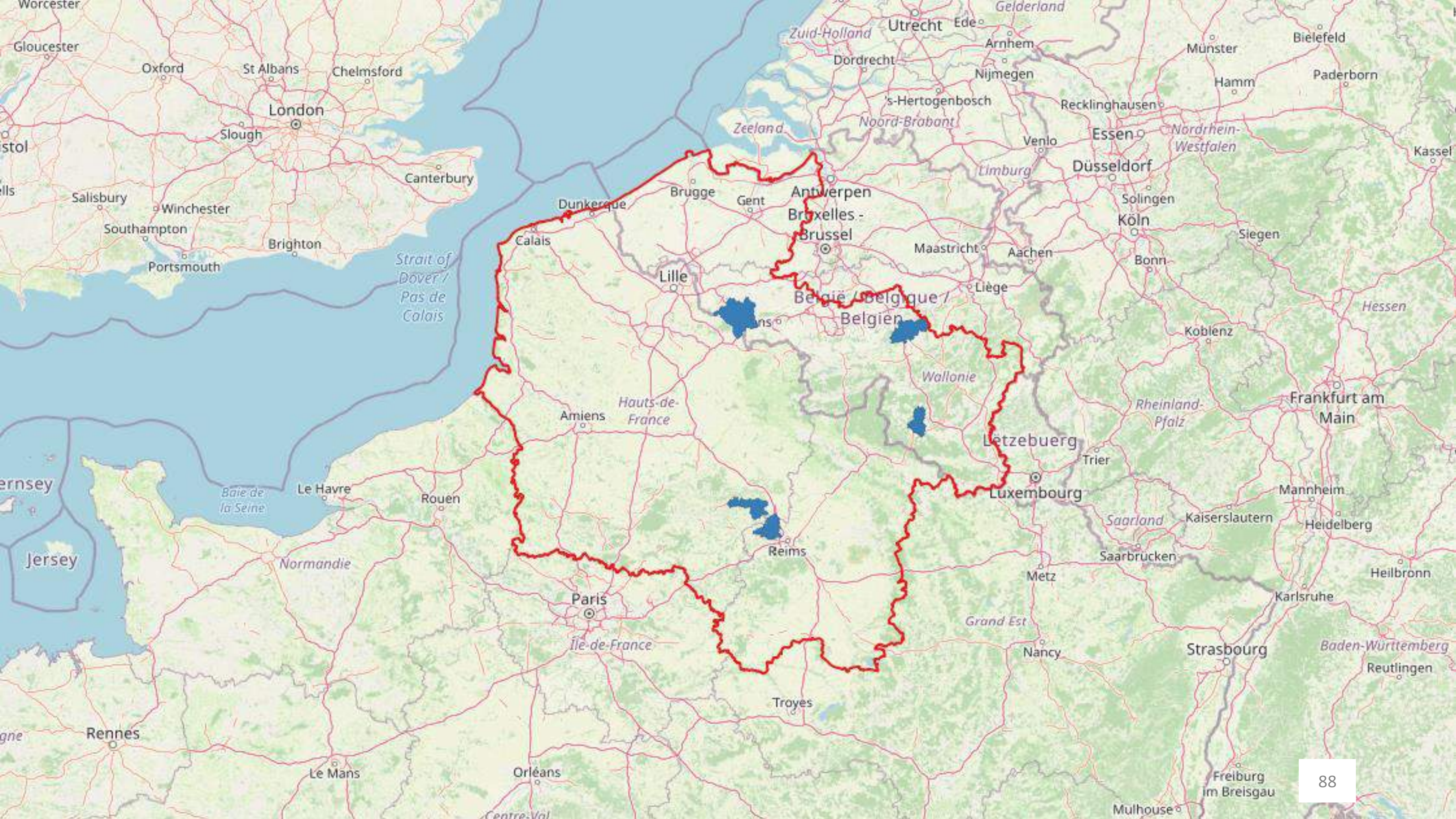
Accuracy, strengths and weaknesses

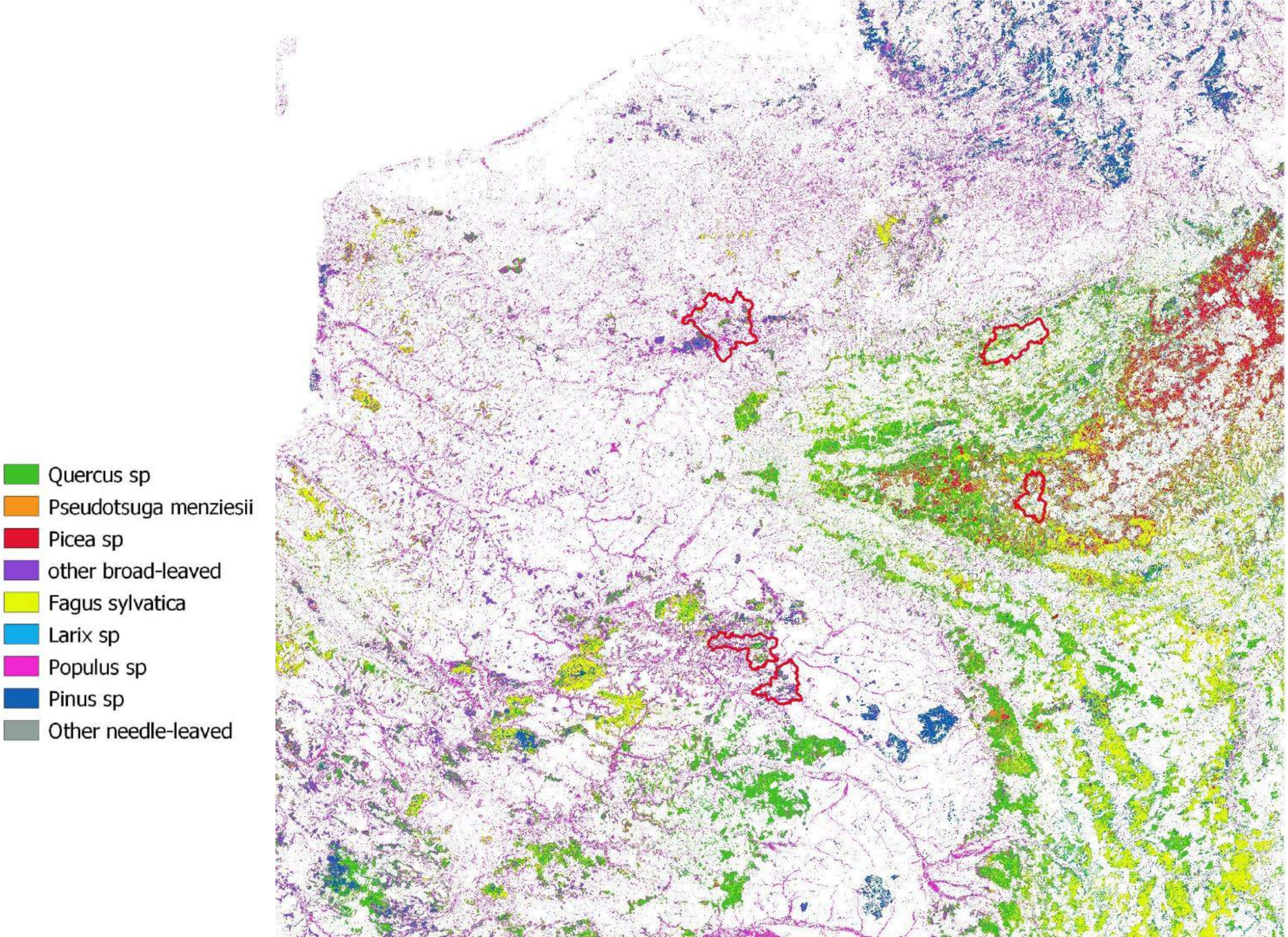
- Strengths :
  - Reproducibility from one year to another
  - Workable for large study areas (whole Interreg area)

- Weaknesses :
  - Training data for the models
  - Ligneous mask solely defined on the basis of satellite imagery
    - Possible confusion with other types of soil occupation

Accuracy, strengths and weaknesses

- Assessment of the accuracy :
  - Field inventory undertaken in the framework of the project for 5 pilot areas
  - 751 plots inventoried in the field by the task officers and forest technicians for the Pro Bos Forest project


Worcester
Gloucester
Oxford
St Albans
Chelmsford
London
Slough
Canterbury
Salisbury
Winchester
Southampton
Brighton
Portsmouth
Strait of Dover / Pas de Calais
Baie de la Seine
Jersey
Le Havre
Rouen
Normandie
Rennes
Le Mans
Orléans
Paris
Île-de-France
Amiens
Hauts-de-France
Calais
Dunkerque
Brugge
Gent
Lille
Antwerpen
Bruxelles - Brussel
Zeeland
Zuid-Holland
Utrecht
Ede
Gelderland
Dordrecht
Arnhem
Nijmegen
's-Hertogenbosch
Noord-Brabant
Limburg
Venlo
Maastricht
Aachen
Liège
België / Belgique / Belgien
Wallonie
Lëtzebuerg
Luxembourg
Trier
Reims
Troyes
Metz
Nancy
Grand Est
Strasbourg
Saarland
Saarbrücken
Kaiserslautern
Mannheim
Heidelberg
Heilbronn
Karlsruhe
Baden-Württemberg
Reutlingen
Freiburg im Breisgau
Mulhouse
Rheinland-Pfalz
Koblenz
Frankfurt am Main
Hessen
Siegen
Bonn
Köln
Solingen
Düsseldorf
Essen
Nordrhein-Westfalen
Recklinghausen
Hamm
Münster
Bielefeld
Paderborn
Kassel


Quercus sp
Pseudotsuga menziesii
Picea sp
other broad-leaved
Fagus sylvatica
Larix sp
Populus sp
Pinus sp
Other needle-leaved

Accuracy, strengths and weaknesses

- Detection of
  the most dominant species

- Detection of
  one of the dominant species

LIÈGE université
Gembloux
Agro-Bio Tech

Interreg
France-Wallonie-Vlaanderen
Feel Wood
Forêt Pro Bos

Accuracy, strengths and weaknesses

- Detection of
  the most dominant species

Prediction	Reference CH	DO	EP	FE	HE	MZ	PE	PI	RE
CH	167	0	1	70	10	1	3	3	0
DO	0	31	12	0	0	0	0	0	1
EP	0	6	62	0	2	1	0	0	0
FE	65	0	1	115	4	1	4	0	0
HE	52	1	4	59	111	1	0	2	0
MZ	6	4	5	14	5	25	1	7	1
PE	27	0	1	100	2	0	48	2	1
PI	16	10	14	37	12	6	5	40	16
RE	4	3	34	1	4	1	0	1	6

- Detection of
  one of the dominant species

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

Accuracy, strengths and weaknesses

- Detection of
  the most dominant species

Prediction	Reference CH	DO	EP	FE	HE	MZ	PE	PI	RE
CH	167	0	1	70	10	1	3	3	0
DO	0	31	12	0	0	0	0	0	1
EP	0	6	62	0	2	1	0	0	0
FE	65	0	1	115	4	1	4	0	0
HE	52	1	4	59	111	1	0	2	0
MZ	6	4	5	14	5	25	1	7	1
PE	27	0	1	100	2	0	48	2	1
PI	16	10	14	37	12	6	5	40	16
RE	4	3	34	1	4	1	0	1	6

Class	UA	PA
CH	0.6549020	0.4955490
DO	0.7045455	0.5636364
EP	0.8732394	0.4626866
FE	0.6052632	0.2904040
HE	0.4826087	0.7400000
MZ	0.3676471	0.6944444
PE	0.2651934	0.7868852
PI	0.2564103	0.7272727
RE	0.1111111	0.2400000

- Detection of
  one of the dominant species

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

Accuracy, strengths and weaknesses

- Detection of
  the most dominant species

Prediction	Reference CH	DO	EP	FE	HE	MZ	PE	PI	RE
CH	167	0	1	70	10	1	3	3	0
DO	0	31	12	0	0	0	0	0	1
EP	0	6	62	0	2	1	0	0	0
FE	65	0	1	115	4	1	4	0	0
HE	52	1	4	59	111	1	0	2	0
MZ	6	4	5	14	5	25	1	7	1
PE	27	0	1	100	2	0	48	2	1
PI	16	10	14	37	12	6	5	40	16
RE	4	3	34	1	4	1	0	1	6

Class	UA	PA
CH	0.6549020	0.4955490
DO	0.7045455	0.5636364
EP	0.8732394	0.4626866
FE	0.6052632	0.2904040
HE	0.4826087	0.7400000
MZ	0.3676471	0.6944444
PE	0.2651934	0.7868852
PI	0.2564103	0.7272727
RE	0.1111111	0.2400000

- Detection of
  one of the dominant species

Class	UA	PA
CH	0.827	0.754
DO	0.773	0.673
EP	0.887	0.567
FE	0.916	0.465
HE	0.670	0.813
MZ	0.456	0.694
PE	0.309	0.787
PI	0.410	0.764
RE	0.222	0.44

LIÈGE université Gembloux Agro-Bio Tech

Interreg France-Wallonie-Vlaanderen

Feel Wood Forêt Pro Bos

Conclusion

- Developments made in the framework of the Pro Bos Forest project show the potential of existing remote sensing data in order to map and characterize timber resources in all their forms
- The acquisition of aerial LiDAR data is a major asset in order to characterize the territory and monitor the evolution of our resources in the future
- All of the three topics addressed here show concrete ways for improvement. One of the biggest challenges is the improvement of the training database used for generating forest species mapping models.

Thank you

Bolyn Corentin
Phd student - Uliege Gembloux Agro-Bio Tech
Project officer at OEWB and Carah for the Forêt pro Bos project
cbolyn@uliege.be

Bolyn, C., Michez, A., Gaucher, P., Lejeune, P., Bonnet, S., 2018. Forest mapping and species composition using supervised per pixel classification of Sentinel-2 imagery. Biotechnol. Agron. Soc. Environ. 16.

Bolyn, C.; Lejeune, P.; Michez, A.; Latte, N. Automated Classification of Trees outside Forest for Supporting Operational Management in Rural Landscapes. Remote Sens. 2019, 11, 1146.