Cartographie de l'hétérogénéité du paysage

Mapping of landscape heterogeneity

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(TETIS, Irstea)

CES " Biodiversité "

Includes engineers, researchers, remote sensors, ecologists, botanists

- UMR TETIS (Montpellier)
- LETG (Rennes)
- CESBIO (Toulouse)
- Laboratoire Charles Coulomb
- Conservatoires Botaniques (CBN Alpin, Méditerranéens)

Develop remote sensing **methods** and **tools** for biodiversity **mapping**, **monitoring** and **management**.

OBJECTIVES of the CES « Biodiversité »

- 1- Develop methods and tools to characterize vegetation biodiversity at various spatial and temporal scales.
- 2- Respond to the needs expressed by ecologists, natural space managers or in the context of public environmental policies.
- 3- Strengthen interdisciplinary collaborations between remote sensing experts and biodiversity stakeholders (botanists, managers, ecologists, etc.) in order to promote the exchange of expertise and data necessary for the calibration of prediction models.

Urgent need for monitoring tools to inform changes in landscape heterogeneity

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Biodiversity conservation

Landscape Heterogeneity

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Biodiversity conservation

Landscape Heterogeneity

Fire risk management

Urgent need for monitoring tools to inform changes in landscape heterogeneity

Biodiversity conservation

Pastoralism

Landscape Heterogeneity

Fire risk management

Urgent need for monitoring tools to inform changes in landscape heterogeneity

Biodiversity conservation

Pastoralism

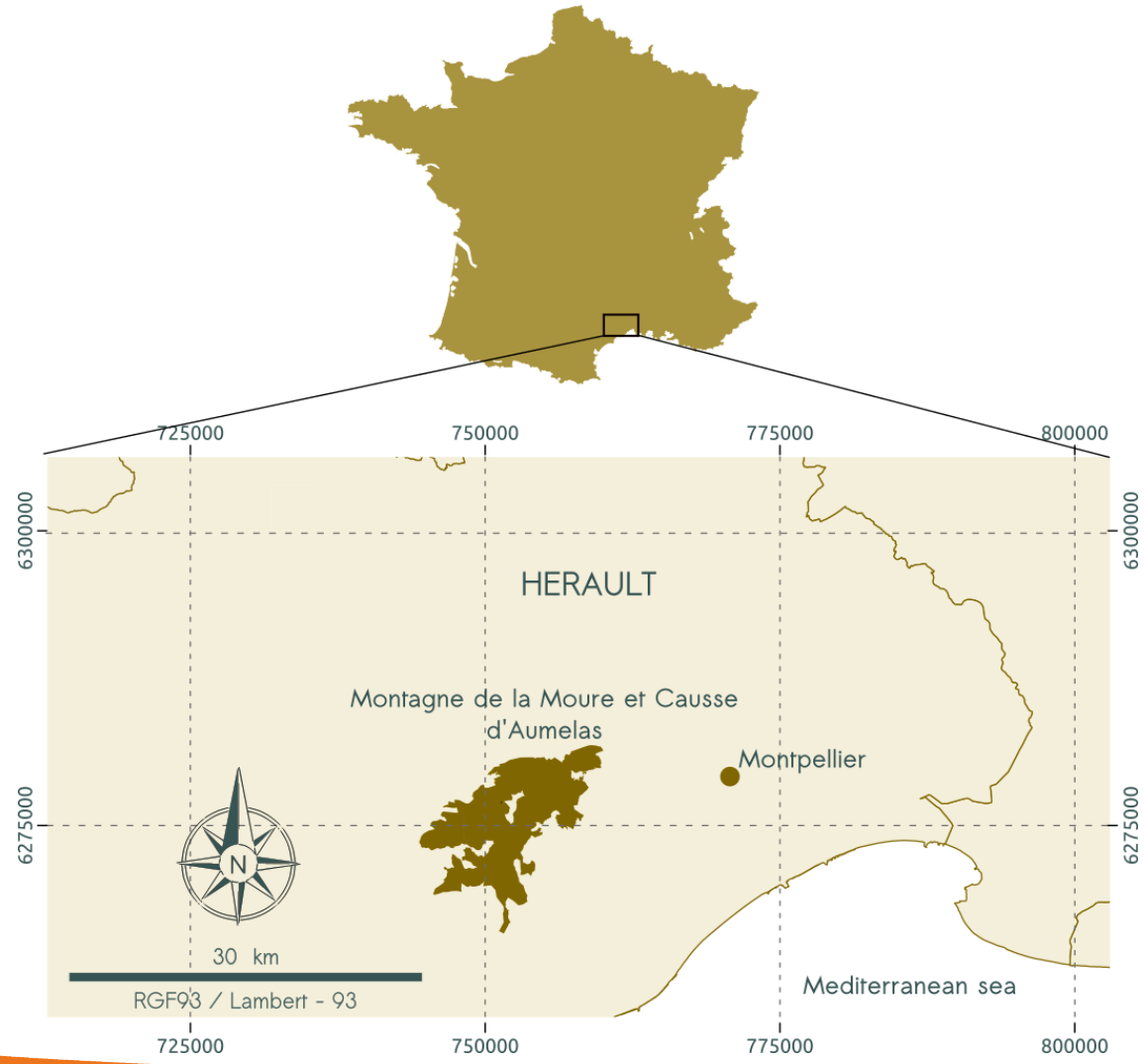
Landscape Heterogeneity

Fire risk management

Cultural heritage

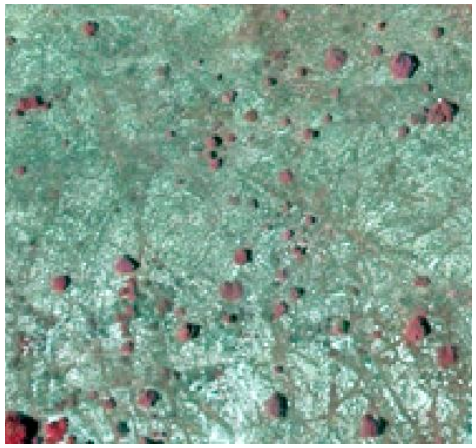
The mediterranean bassin illustrates the link between heterogeneity and biodiversity

Study site



Natura 2000 = 10 000 ha

A very complex and heterogeneous landscape



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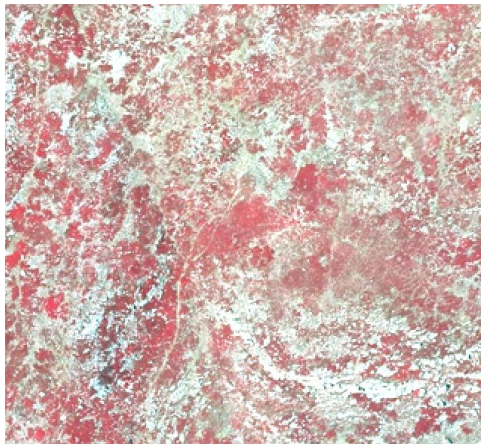

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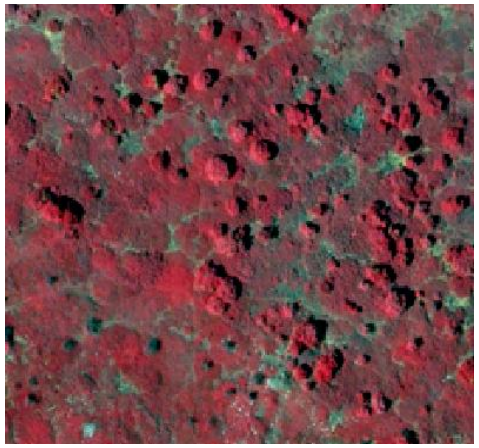

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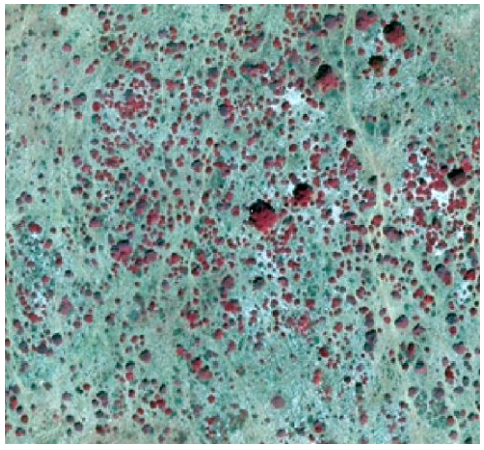

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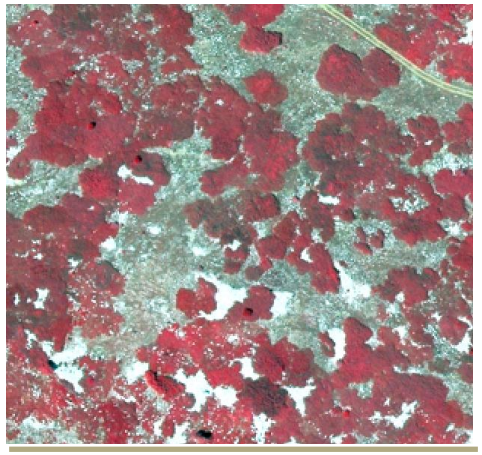

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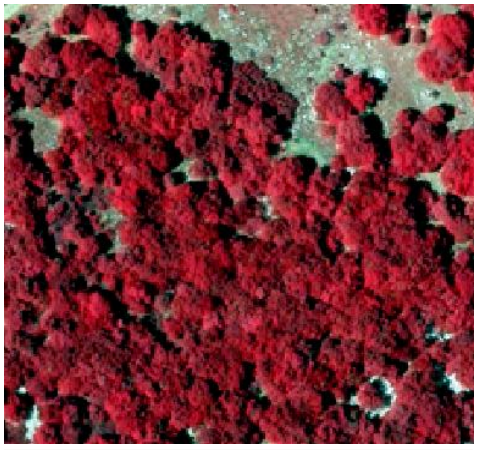

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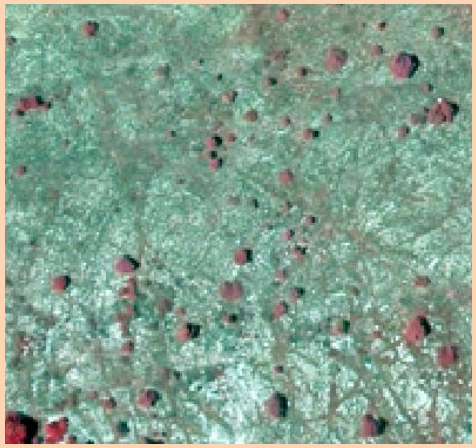

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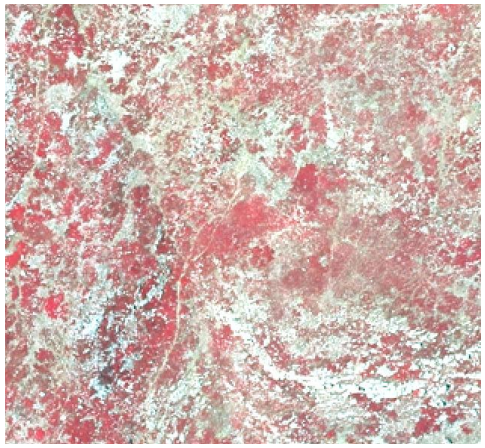

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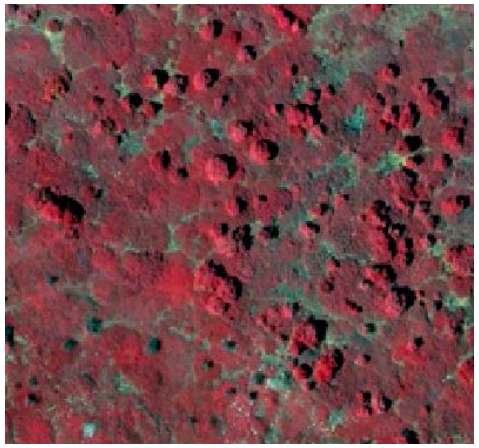

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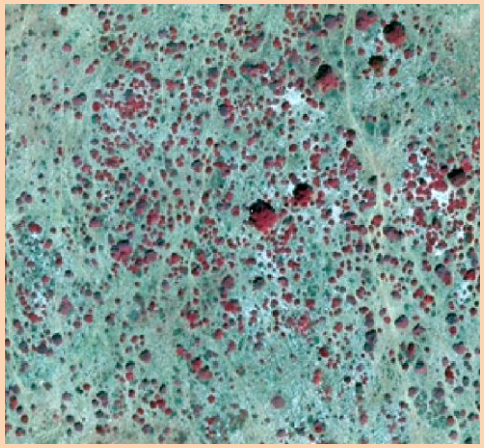

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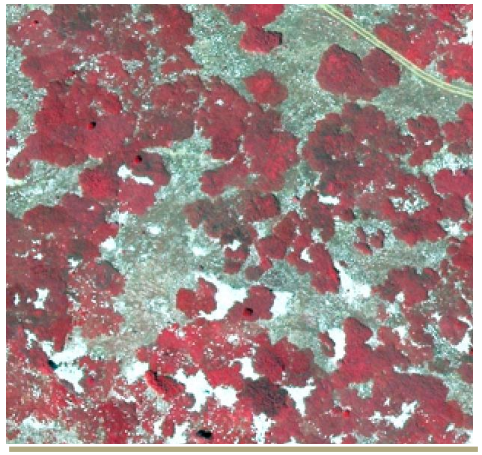

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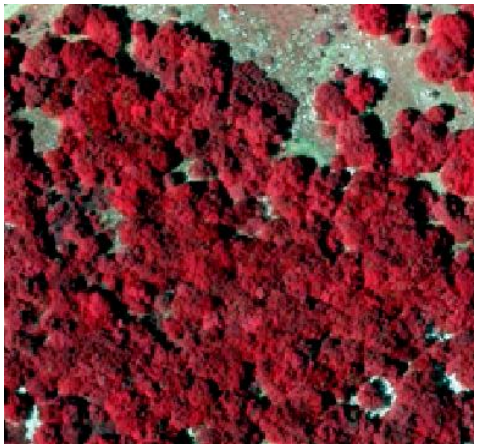

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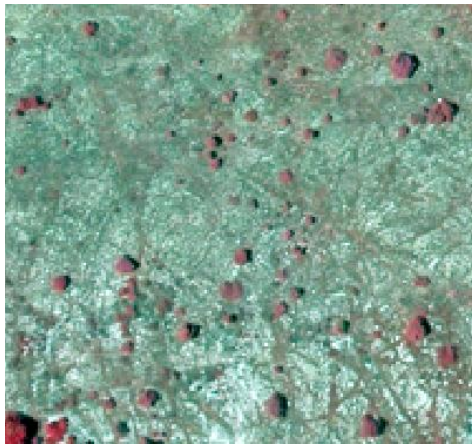

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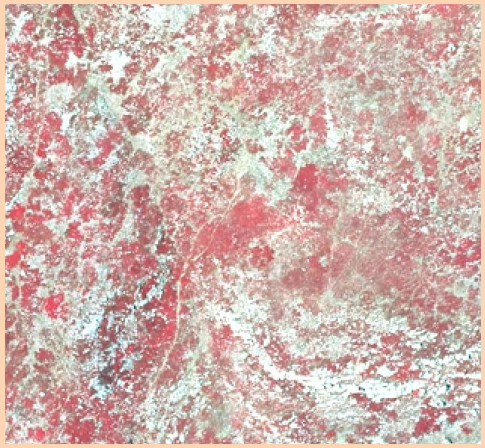

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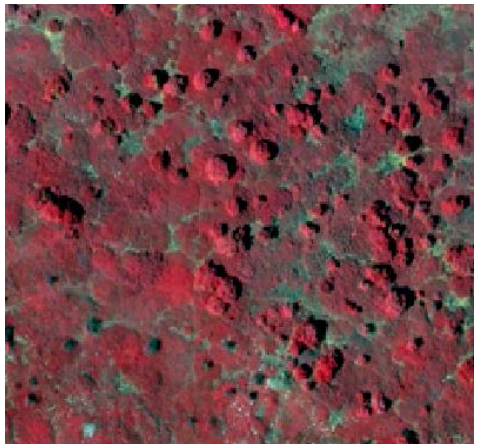

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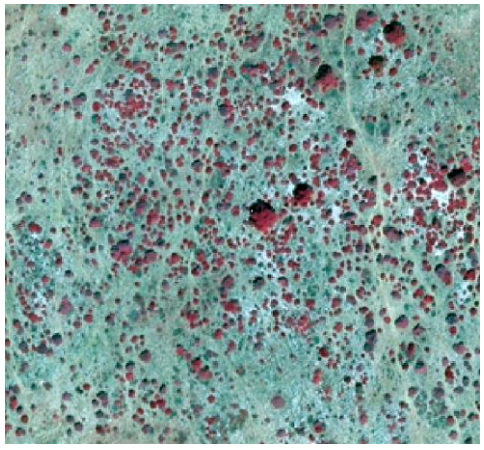

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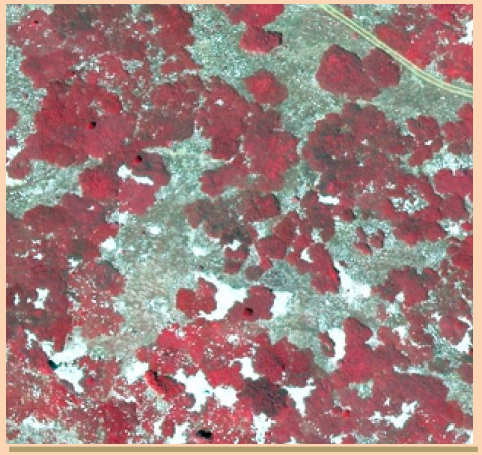

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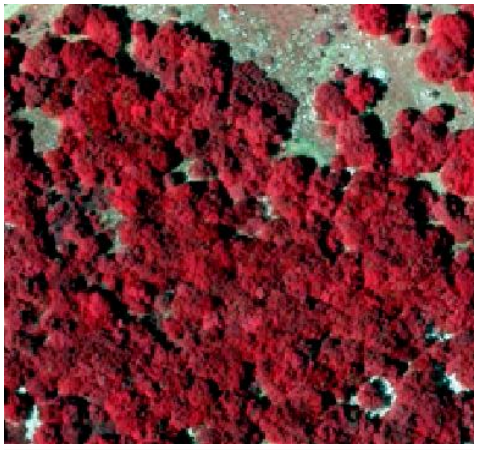

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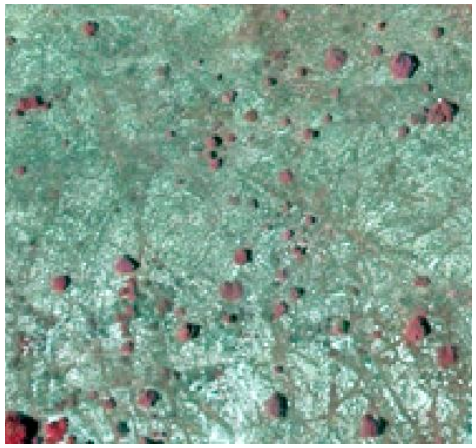

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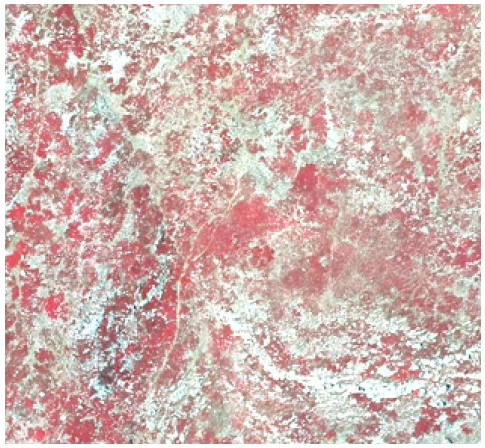

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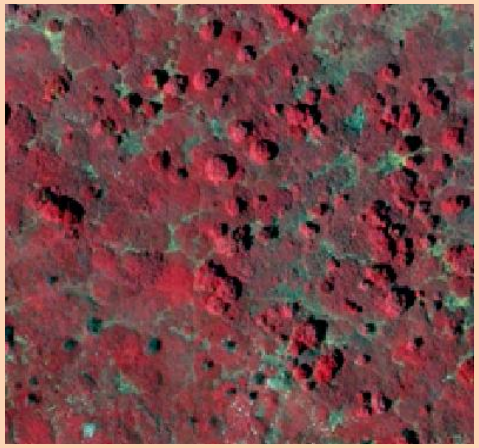

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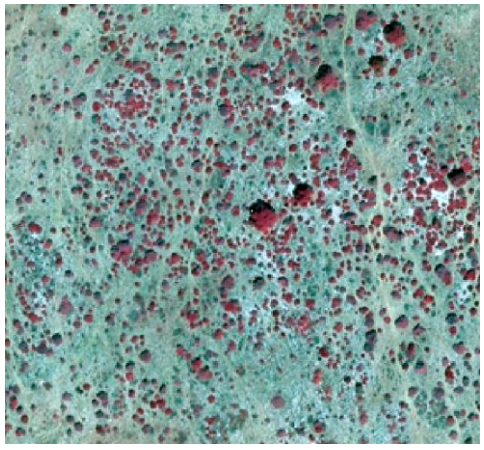

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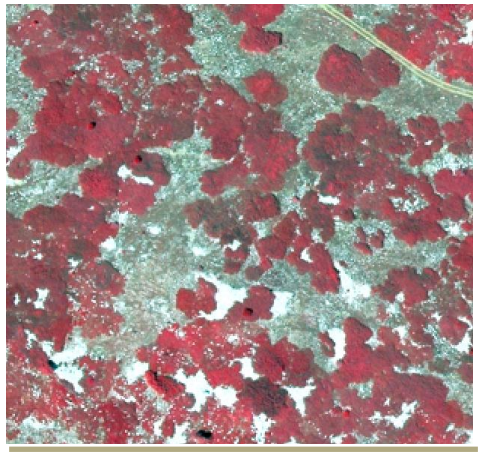

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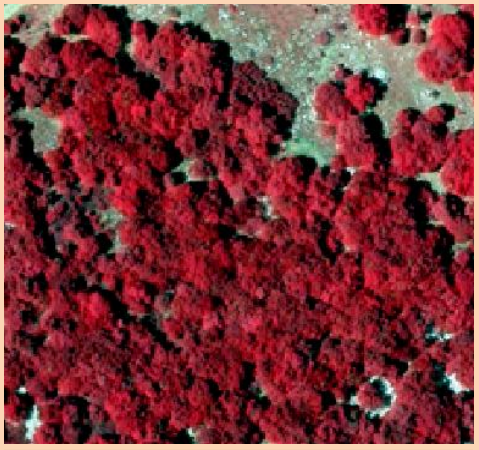

100m

How to characterize Heterogeneity ?

At different scales :

Large scale

Landsat imagery (30m) for :

habitat mapping

Cropping system

How to characterize Heterogeneity ?

At different scales :

Large scale

Landsat imagery (30m) for :

habitat mapping

Cropping system

Very fine scale

UAV optical imagery (5cm) or Lidar for :

Forest spatial structure

How to characterize Heterogeneity ?

At different scales :

Large scale	Fine scale	Very fine scale
Landsat imagery (30m) for :	Aerial imagery (50cm) for :	UAV optical imagery (5cm) or Lidar for :
habitat mapping	Estimation of Vegetation Heterogeneity	Forest spatial structure
Cropping system		

How to characterize Heterogeneity ?

At different scales :

Large scale

Landsat imagery (30m) for :

habitat mapping

Cropping system

Fine scale

Aerial imagery (50cm) for :

Estimation of Vegetation Heterogeneity

Very fine scale

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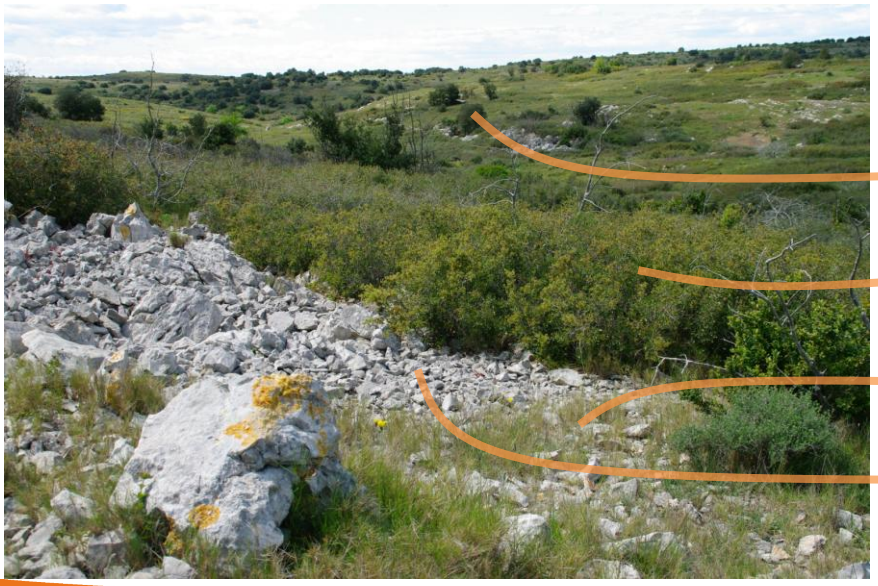
Forest spatial structure

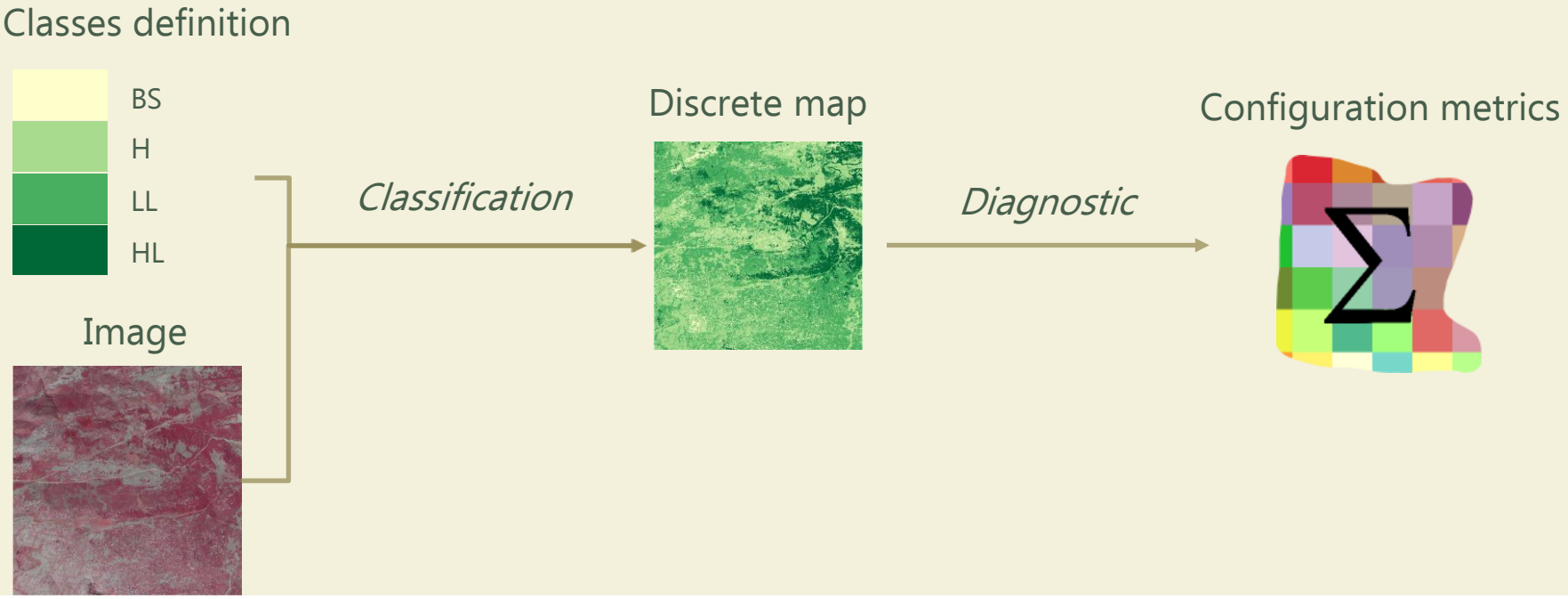


Four strata of interest :

- High ligneous (HL)
- Low ligneous (LL)
- Herbs (H)
- Bare soil (BS)

How to characterize Heterogeneity ?

Approach traditionnaly used :



How to characterize Heterogeneity ?

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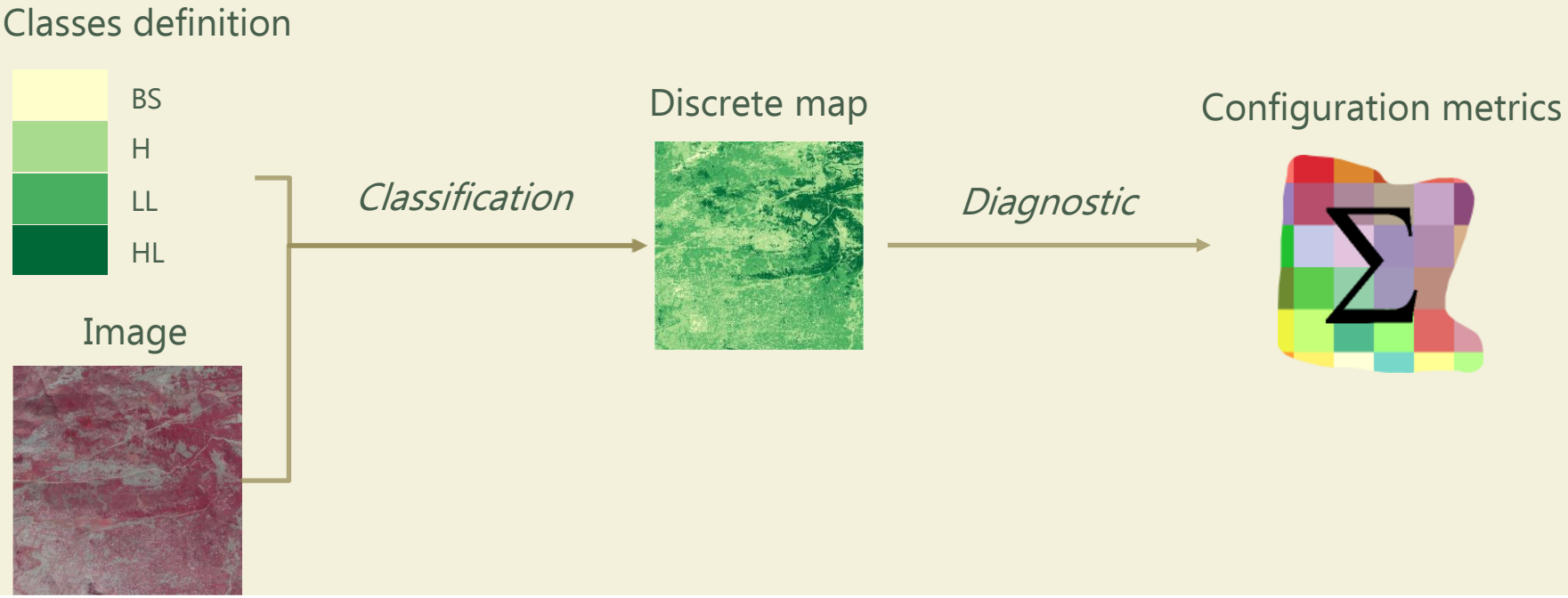
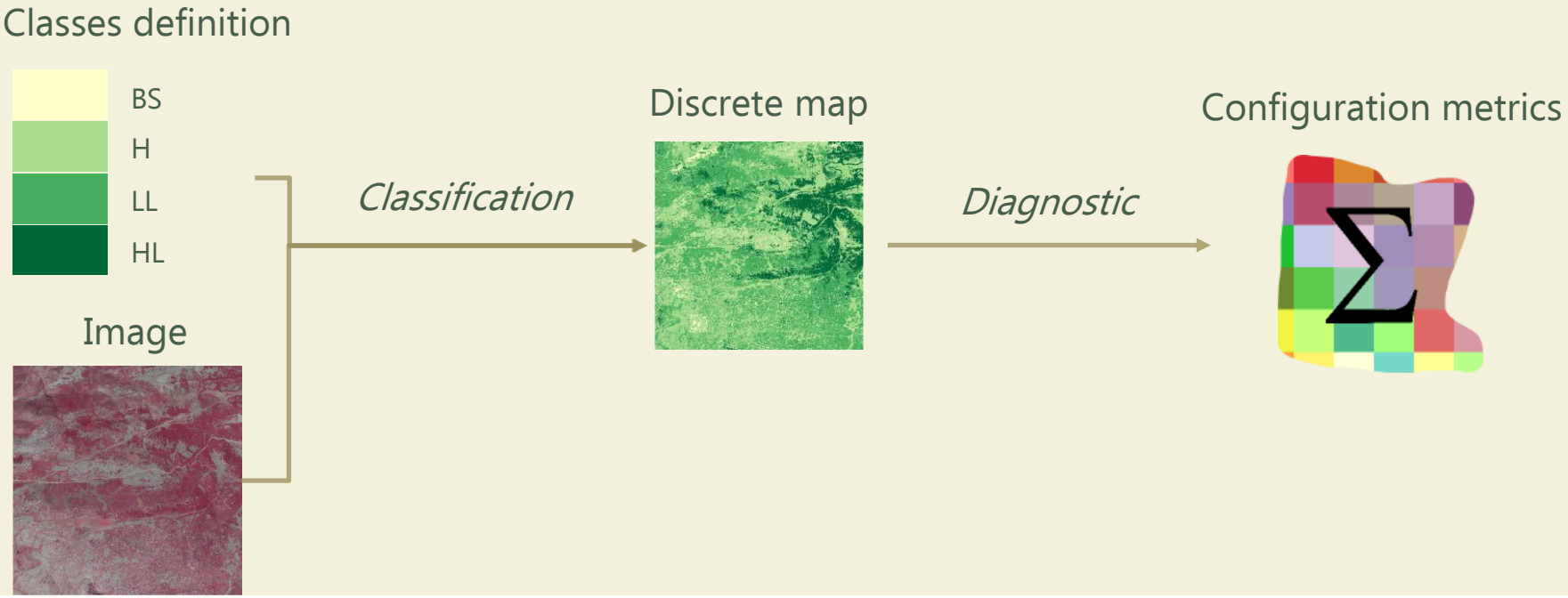


Pros

- Widely used
- Easy to interpret
- Easy to implement

How to characterize Heterogeneity ?

Approach traditionnaly used :



Pros

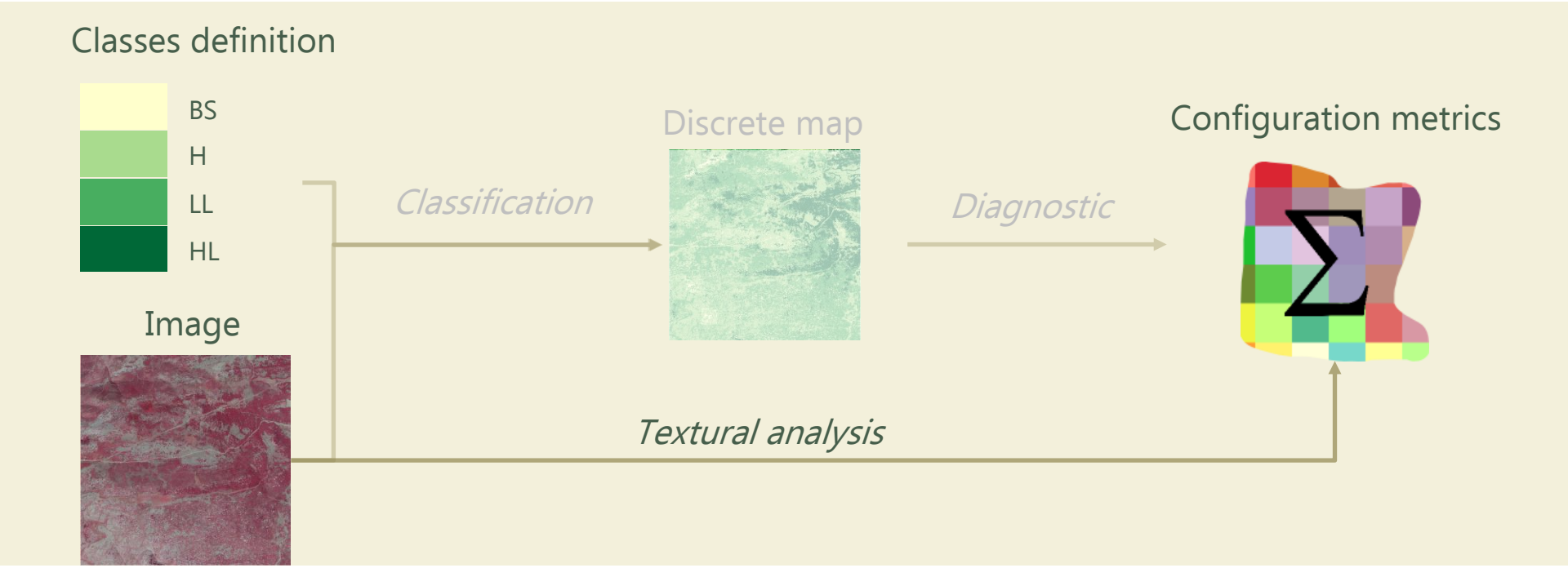
- Widely used
- Easy to interpret
- Easy to implement

Cons

- Many indices
- Very sensitive to classification scheme

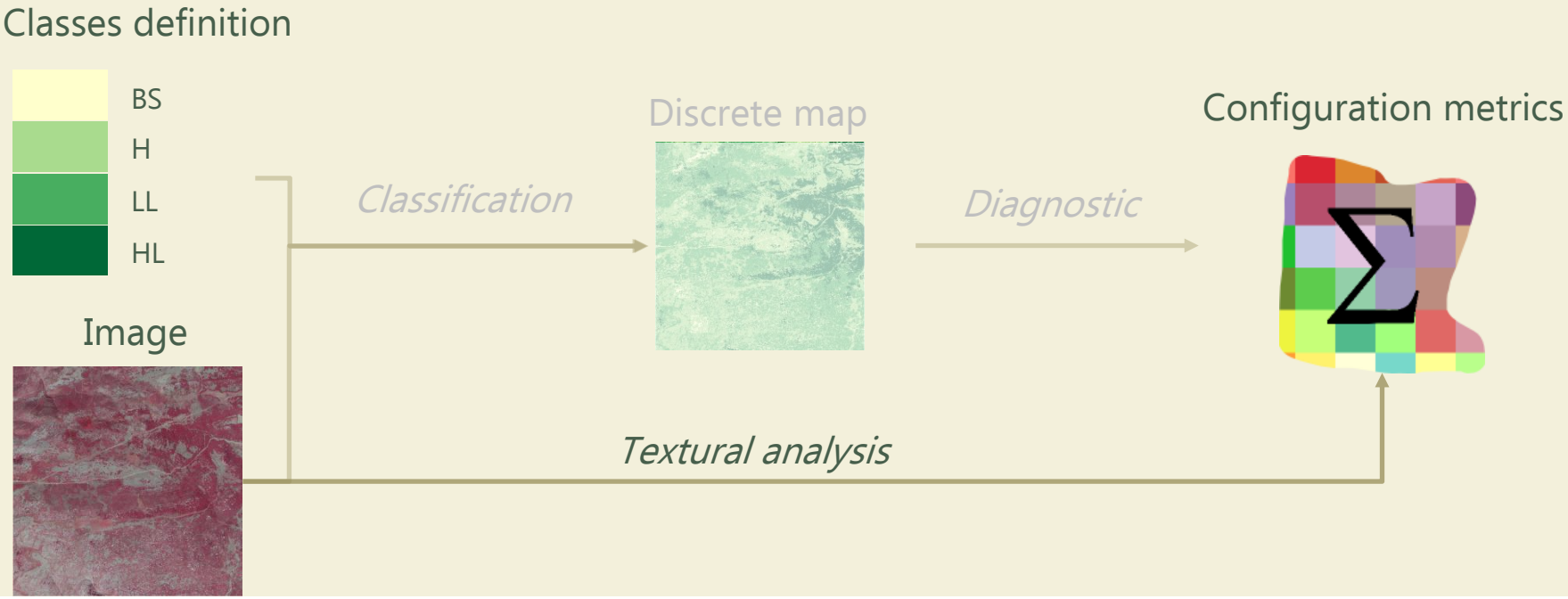
How to characterize Heterogeneity ?

Using textural analysis (continuous approach):



How to characterize Heterogeneity ?

Using textural analysis (continuous approach):

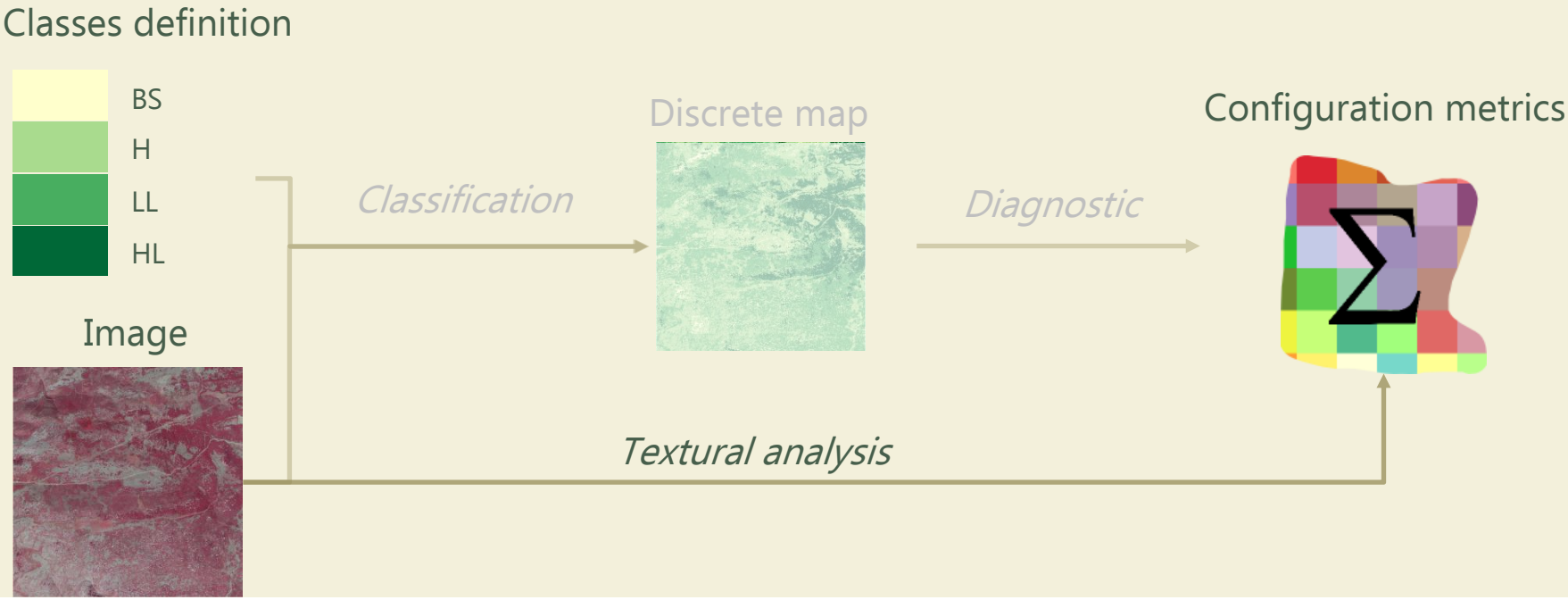


Pros

- Unspervised
- Unsensitive to classification scheme

How to characterize Heterogeneity ?

Using textural analysis (continuous approach):



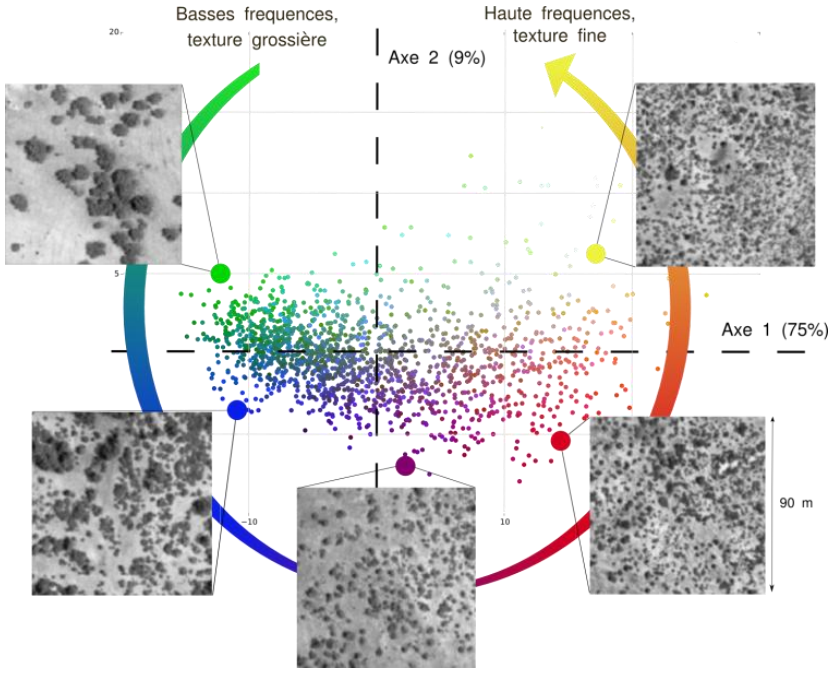
Pros

- Unspervised
- Unsensitive to classification scheme

Cons

- Hard to interpret
- Not easy to implement

Continuous textural indices to characterize vegetation heterogeneity



Analysing vegetation structure using Fourier-based textural ordination (FOTO, Couteron 2006)

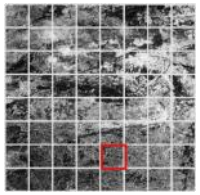
?

- Land cover proportion
- Patch density
- Fragmentation

NDVI

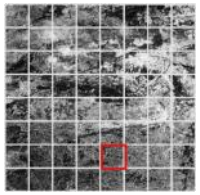
NDVI

Windowing



NDVI

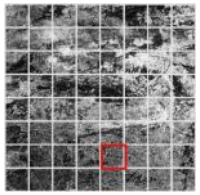
Windowing



Textural analysis

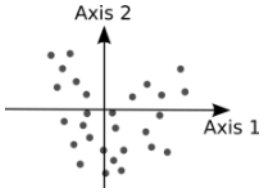
NDVI

Windowing

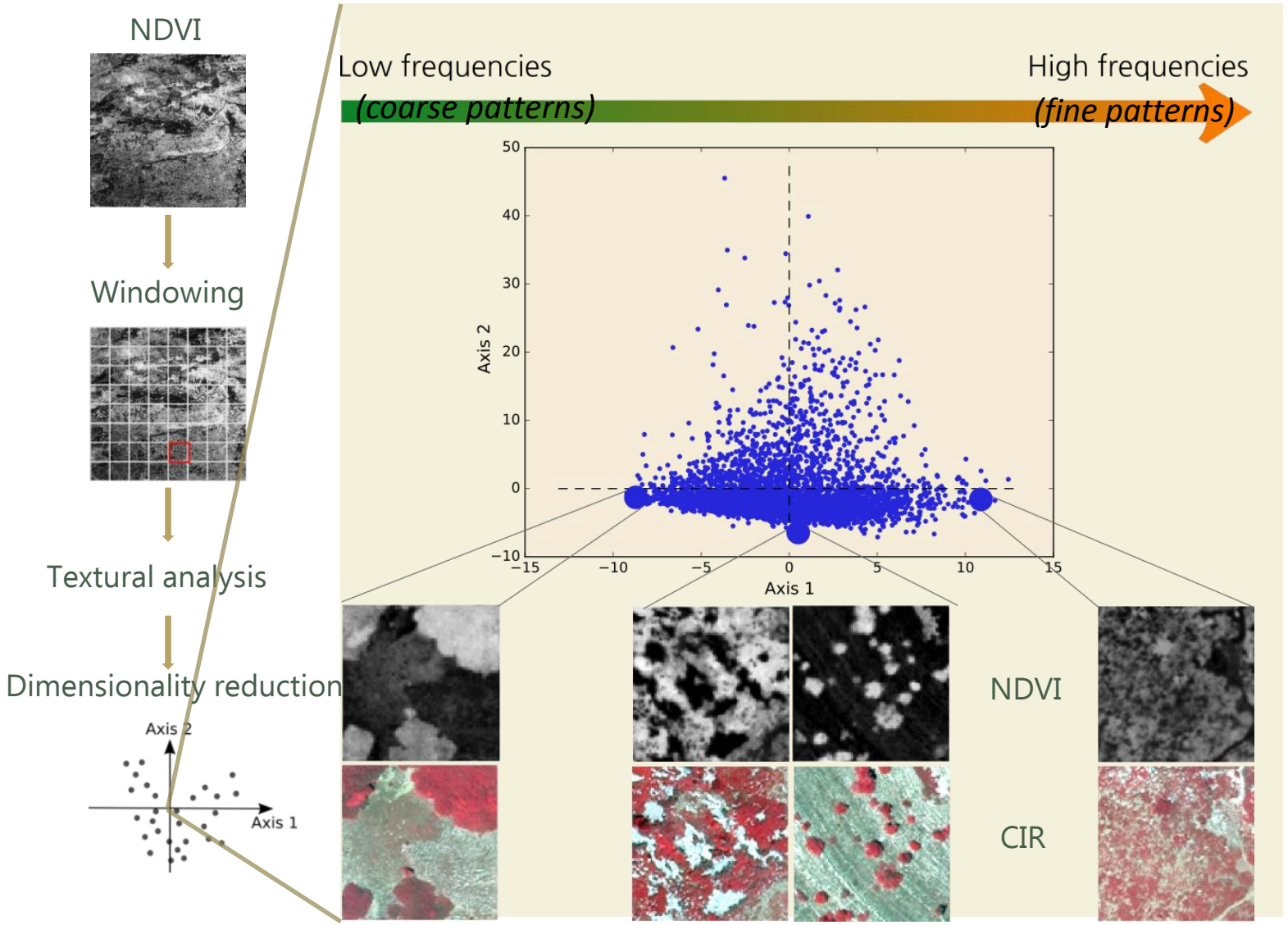


Textural analysis

Dimensionality reduction



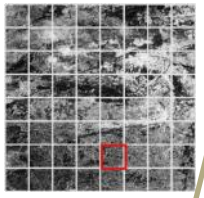
PCA axe 1


NDVI
Windowing
Textural analysis
Dimensionality reduction
Axis 2
Axis 1
Low frequencies
(coarse patterns)
High frequencies
(fine patterns)
Axis 2
Axis 1
NDVI
CIR

PCA axe 2

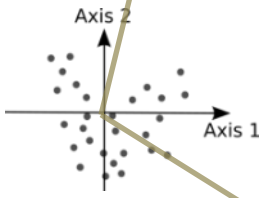
NDVI

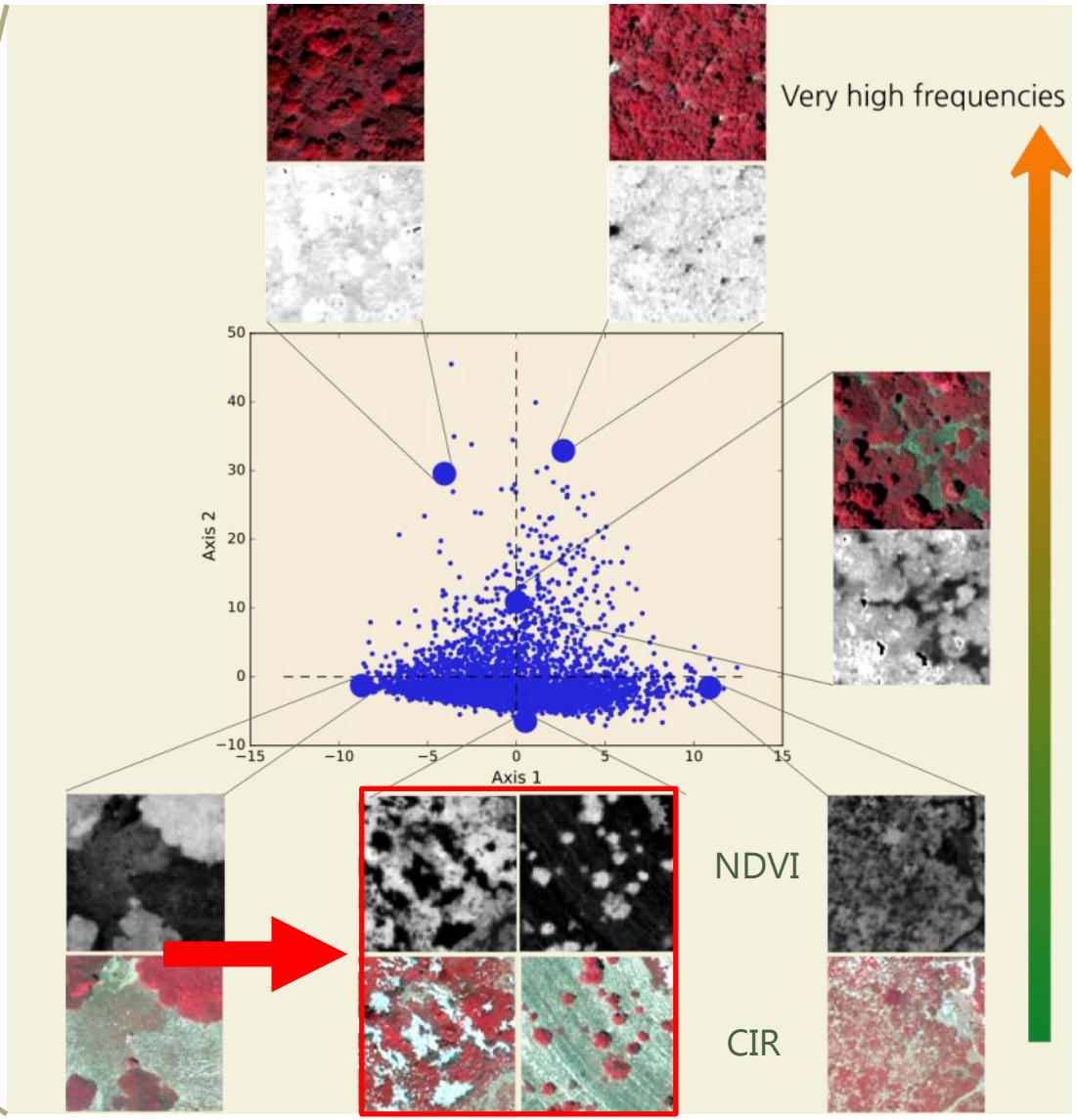
Windowing



Textural analysis

Dimensionality reduction





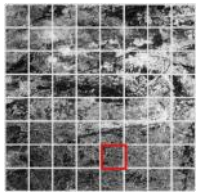
(very fine patterns)

Marc Lang (marc.lang@inrae.fr)

Results : Texture enhanced with NDVI

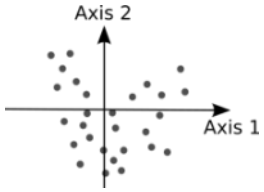
NDVI

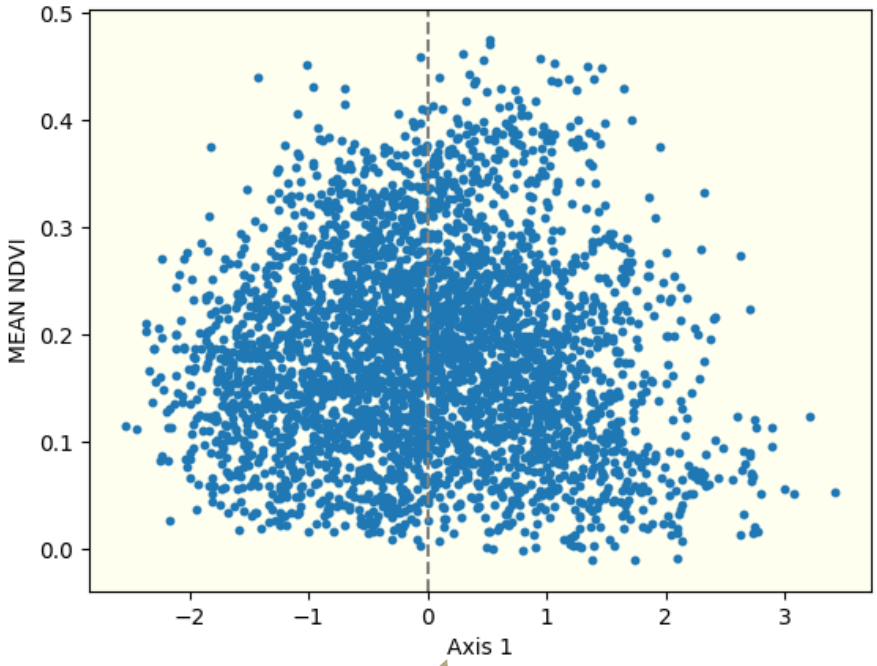
Windowing



Textural analysis

Dimensionality reduction





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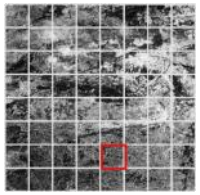
Results : Texture enhanced with NDVI

NDVI

Windowing



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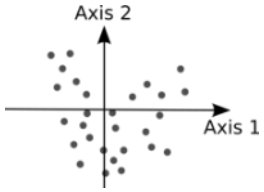

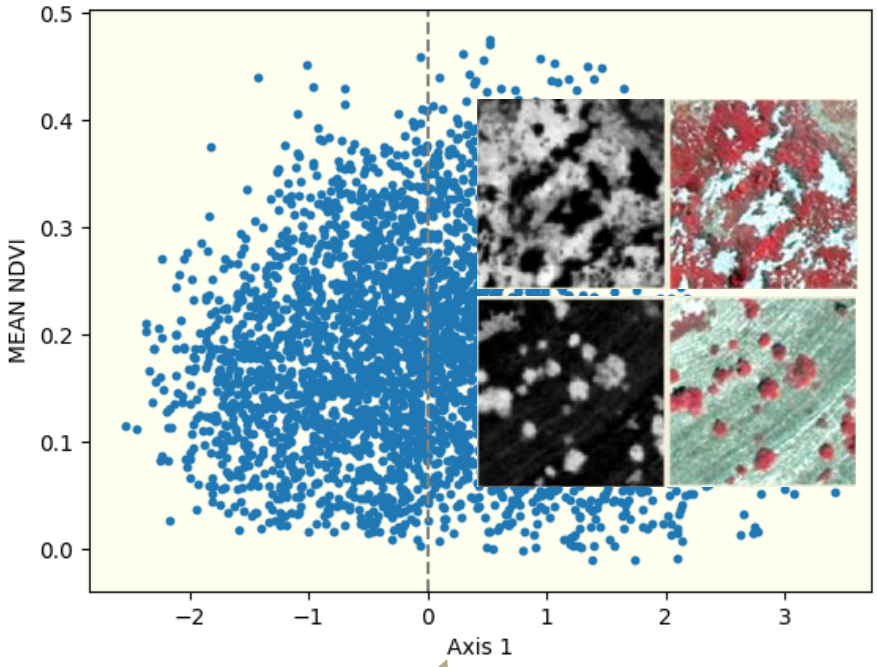

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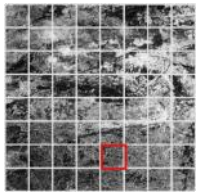
Windowing



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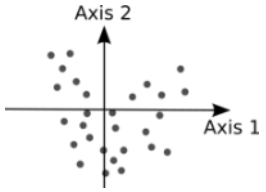

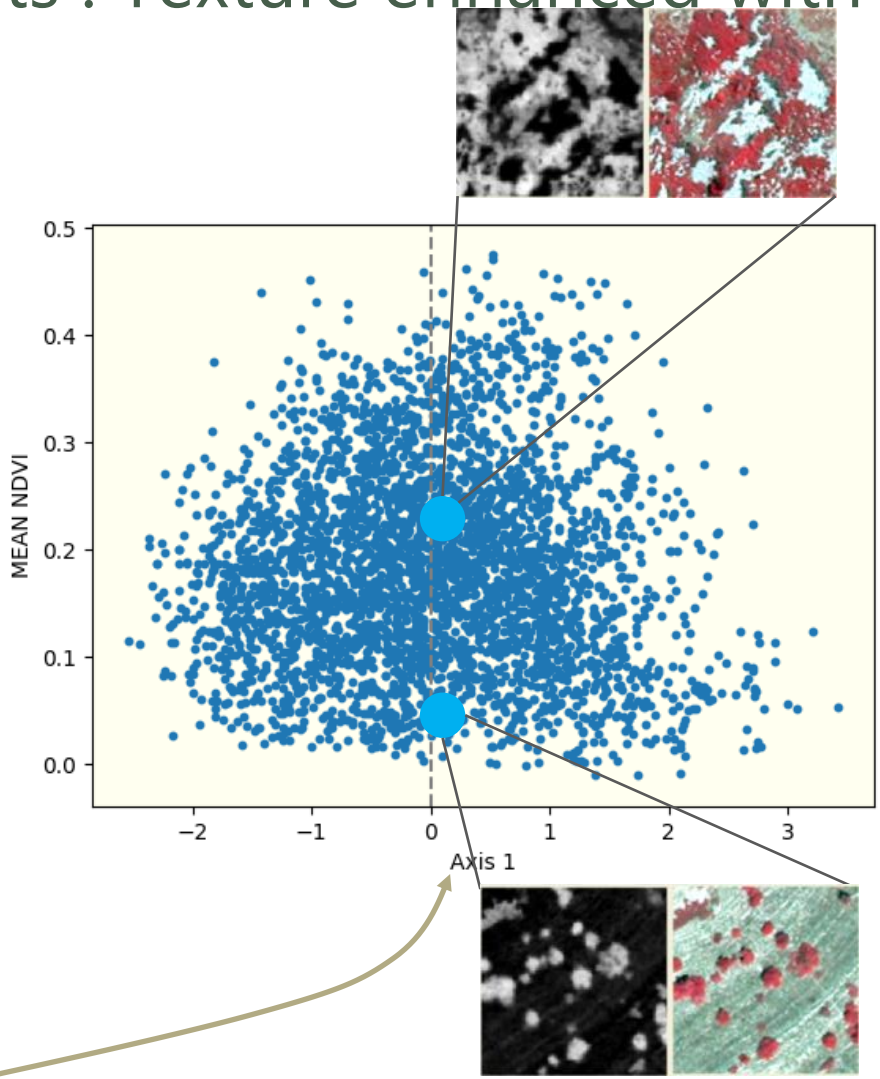

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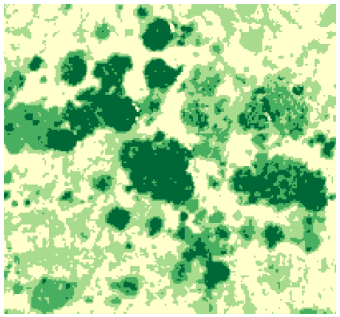
Landscape Metrics from discret maps

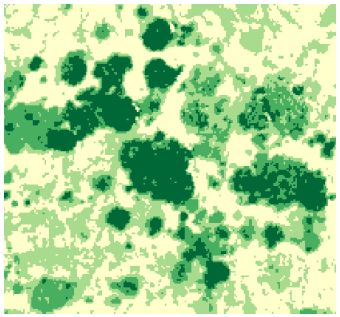


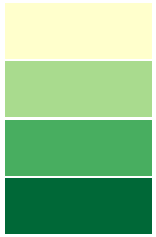
Bare Soil (BS)
Herbs (H)
Low ligneous (LL)
High ligneous (HL)

Fragstat

Group	Acronym	Metric Name	Description
Area			
	PLAND	Percentage of Landscape	Percentage of area occupied by a certain land cover class
Shape			
	PAFRAC	Perimeter-Area Fractal Dimension	Patch shape complexity measure from 1 for shapes with simple perimeters to 2 for complex shapes
	SHAPE_MN	Shape Index Mean	Mean of patch shape irregularity. From 1 for square patches, increasing without limit with irregularity
	SHAPE_AM	Shape Index Area-Weighted Mean	Area-weighted mean of patch shape irregularity
Aggregation			
	SPLIT	Splitting Index	Equal to the number of patches of a landscape divided into equal sizes, keeping landscape division constant
	IJI	Interspersion Juxtaposition Index	Measure of evenness of patch adjacencies, equals 100 for even and approaches 0 for uneven adjacencies
	AI	Aggregation Index	Measure of aggregation of a class: the percentage of neighbouring pixels being the same land cover class based on single-count method
	LSI	Landscape Shape Index	Ratio of the total edge to the minimum total edge
	COHESION	Patch Cohesion Index	Measure of the physical connectedness of the focal land cover class

Landscape Metrics from discret maps





Bare Soil (BS)
Herbs (H)
Low ligneous (LL)
High ligneous (HL)

Fragstat

Group	Acronym	Metric Name	Description
Area			
	PLAND	Percentage of Landscape	Percentage of area occupied by a certain land cover class
Shape			
	PAFRAC	Perimeter-Area Fractal Dimension	Patch shape complexity measure from 1 for shapes with simple perimeters to 2 for complex shapes
	SHAPE_MN	Shape Index Mean	Mean of patch shape irregularity. From 1 for square patches, increasing without limit with irregularity
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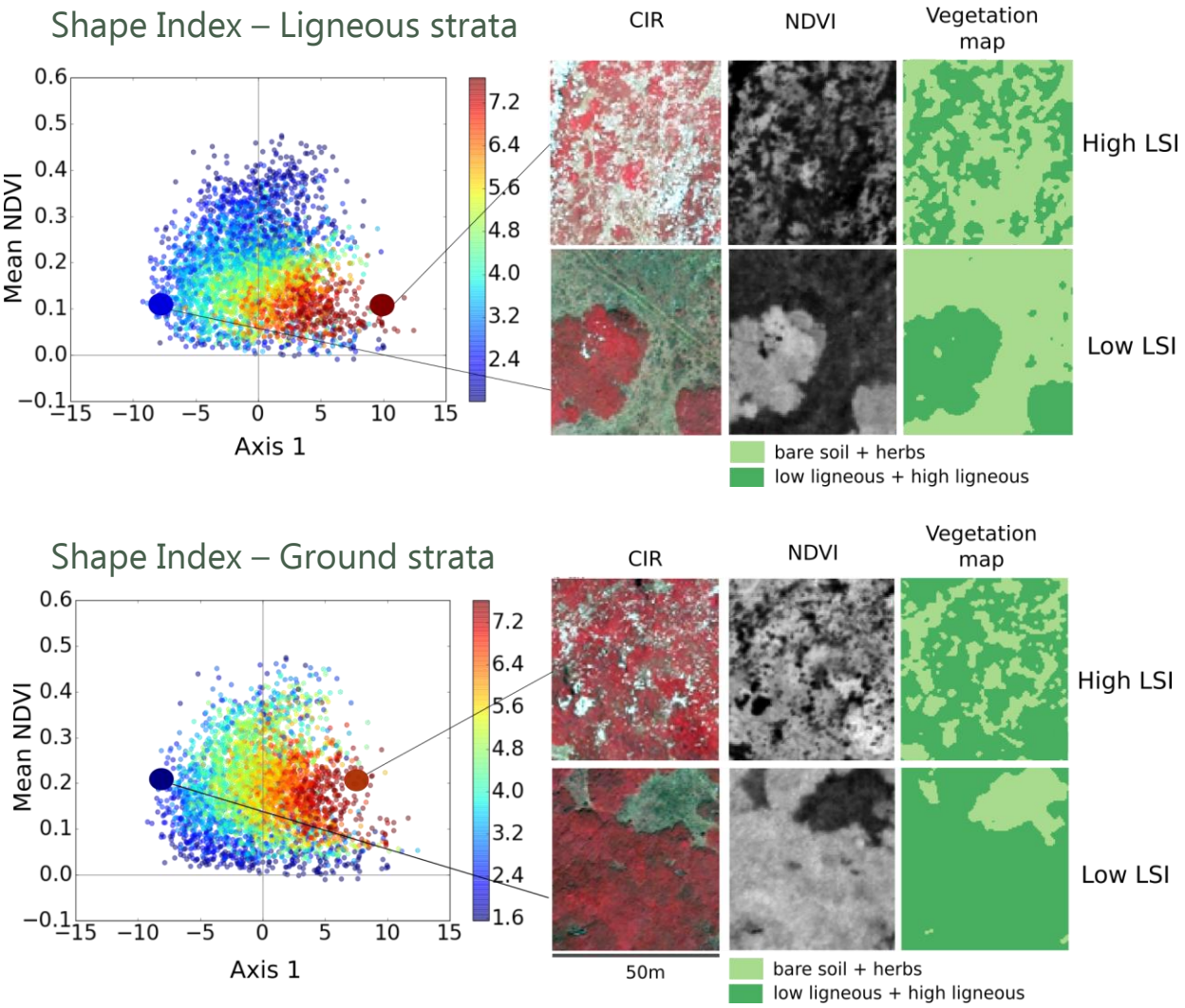
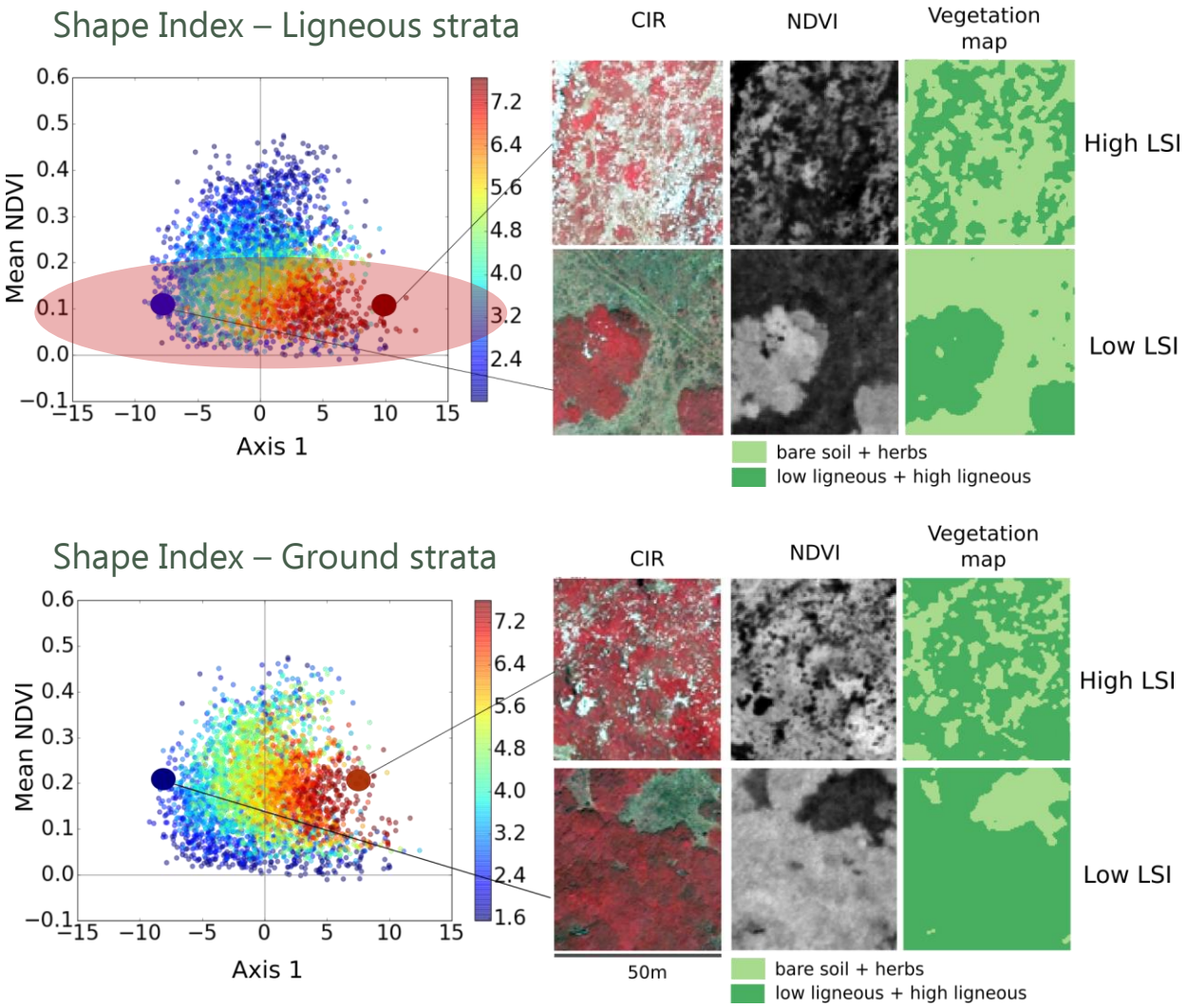
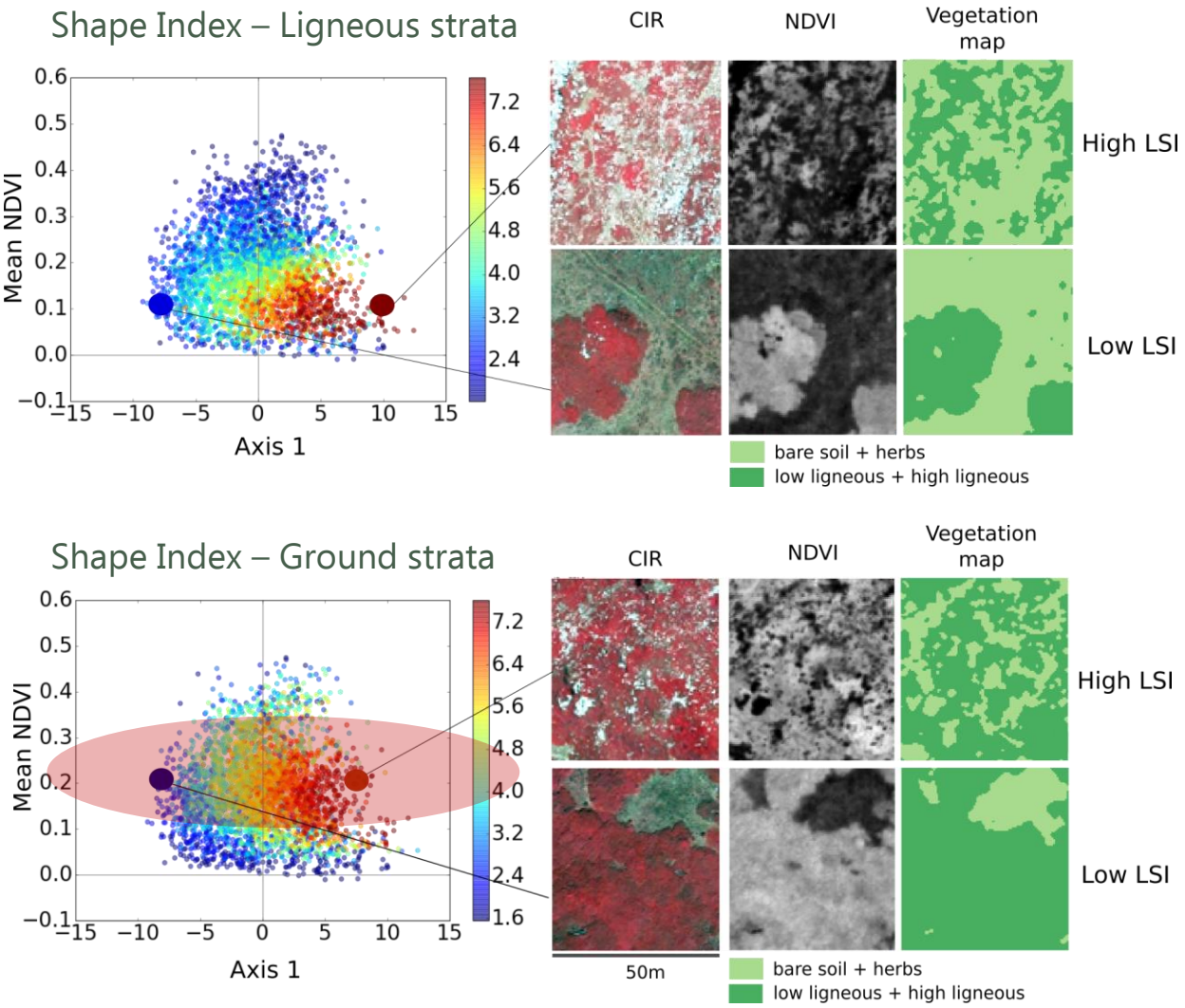
Continuous indices and configuration



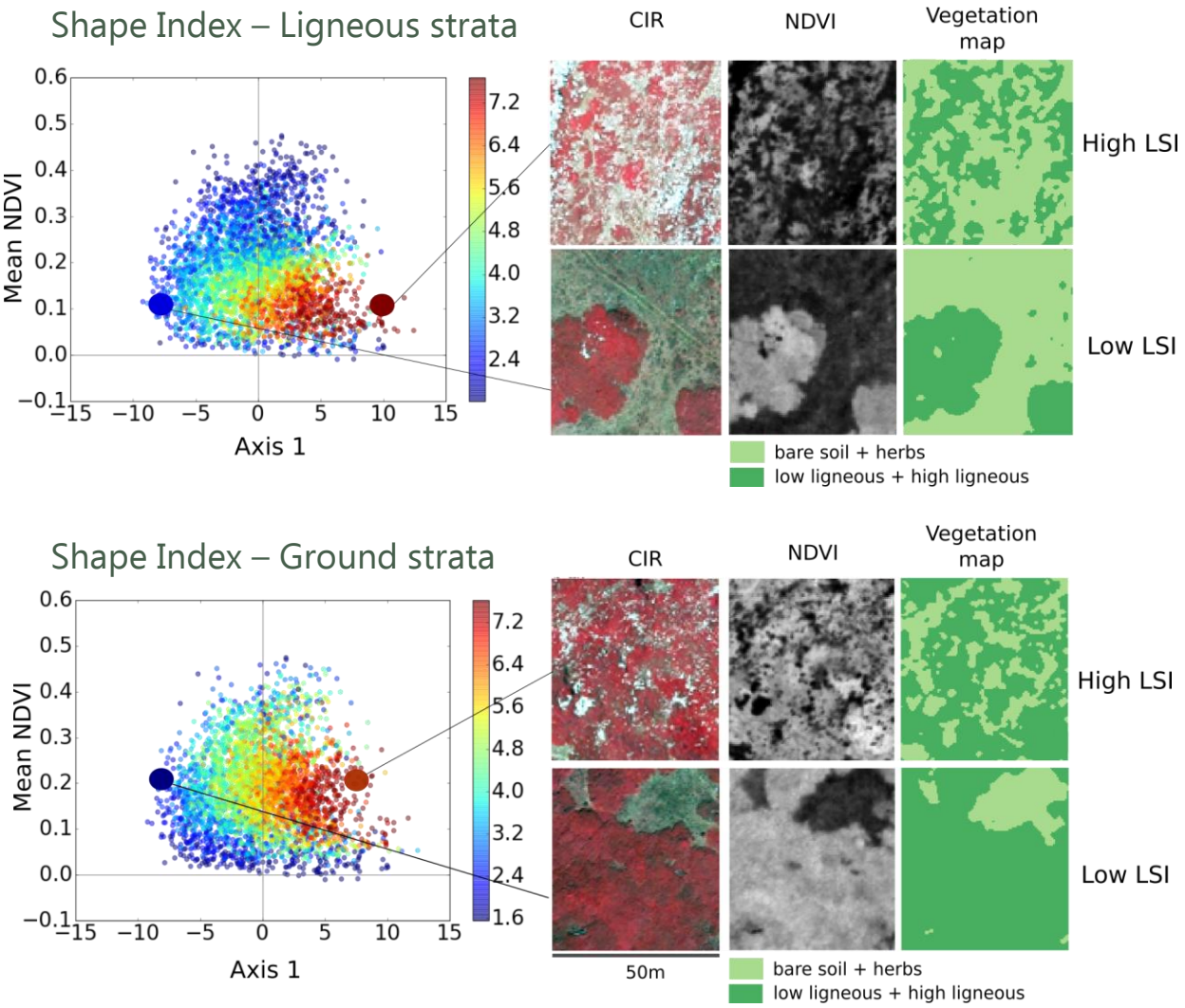
Continuous indices and configuration



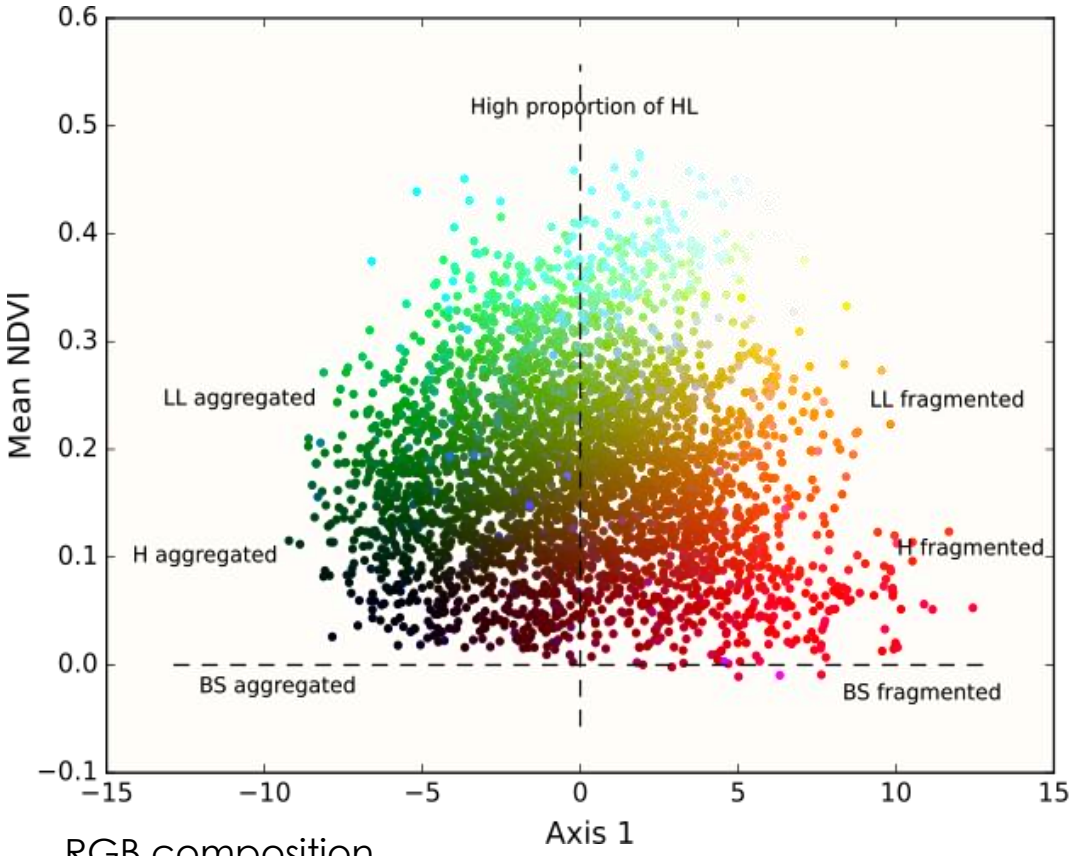
Continuous indices and configuration



Continuous indices and configuration



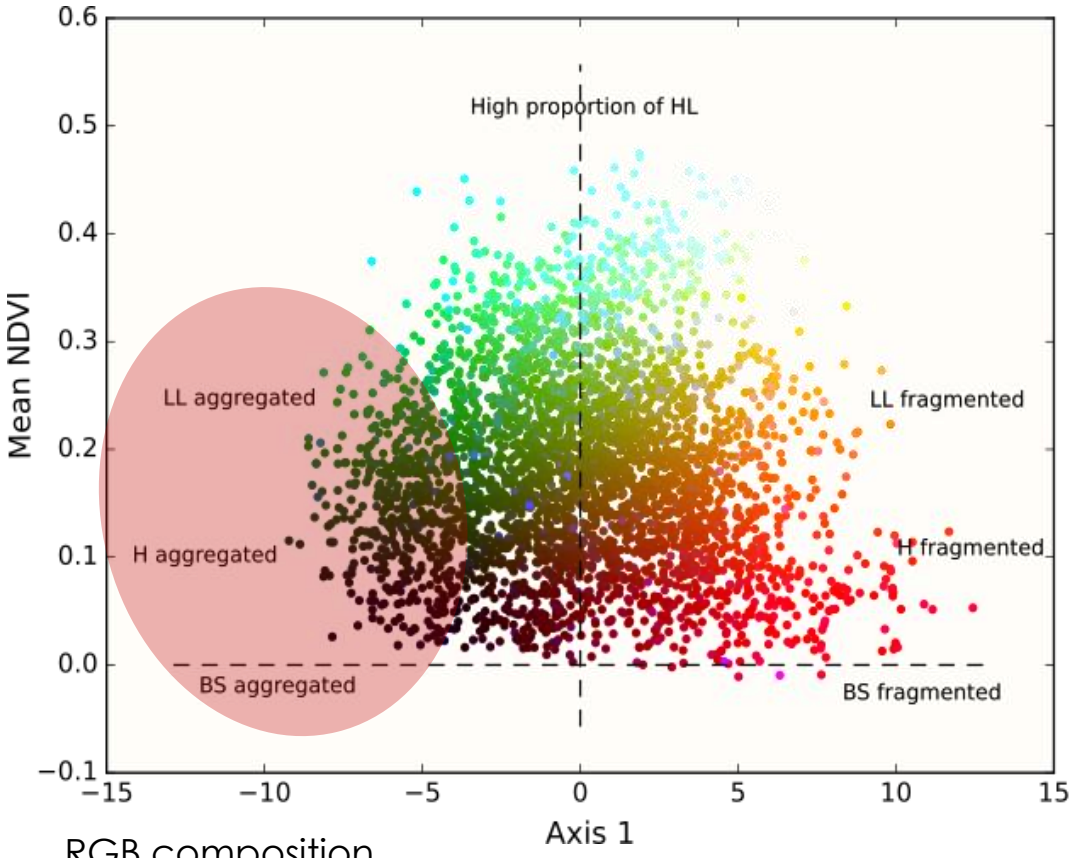
Structure from the three continuous indices



RGB composition

Axis 1 | NDVI | Axis 2

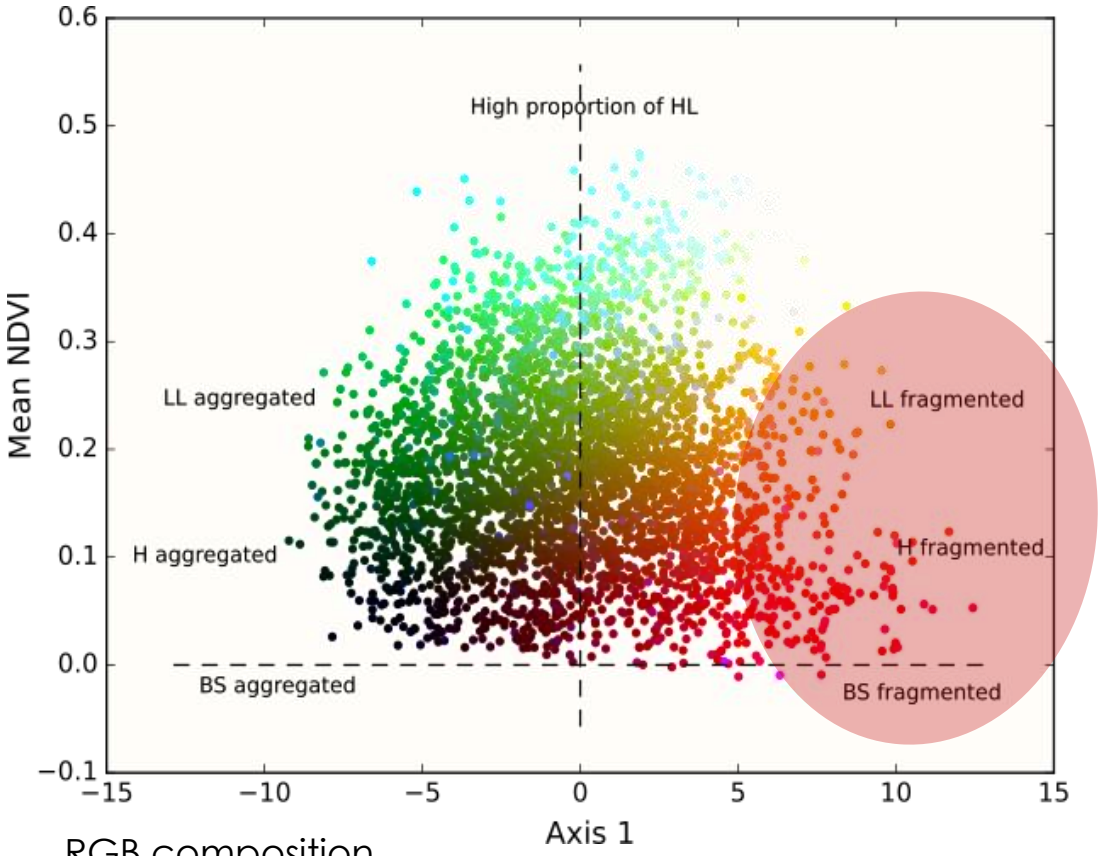
Structure from the three continuous indices



RGB composition

Axis 1 | NDVI | Axis 2

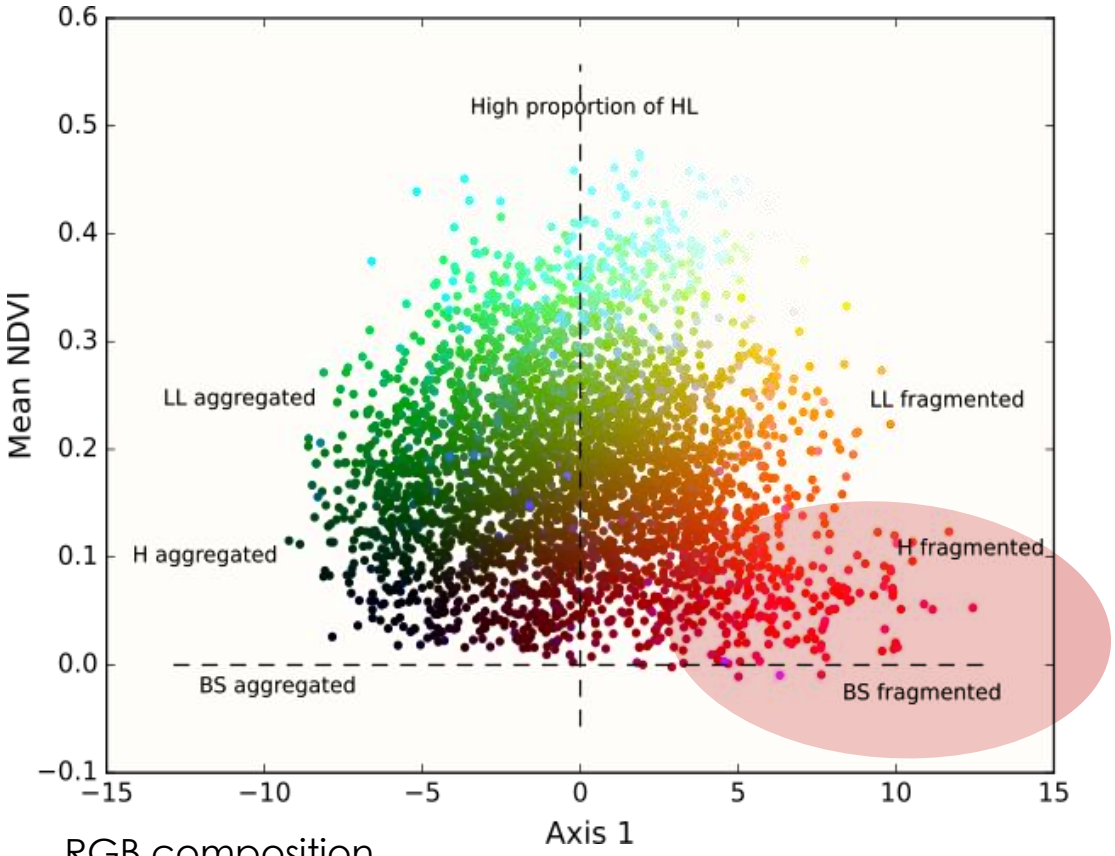
Structure from the three continuous indices



RGB composition

Axis 1 | NDVI | Axis 2

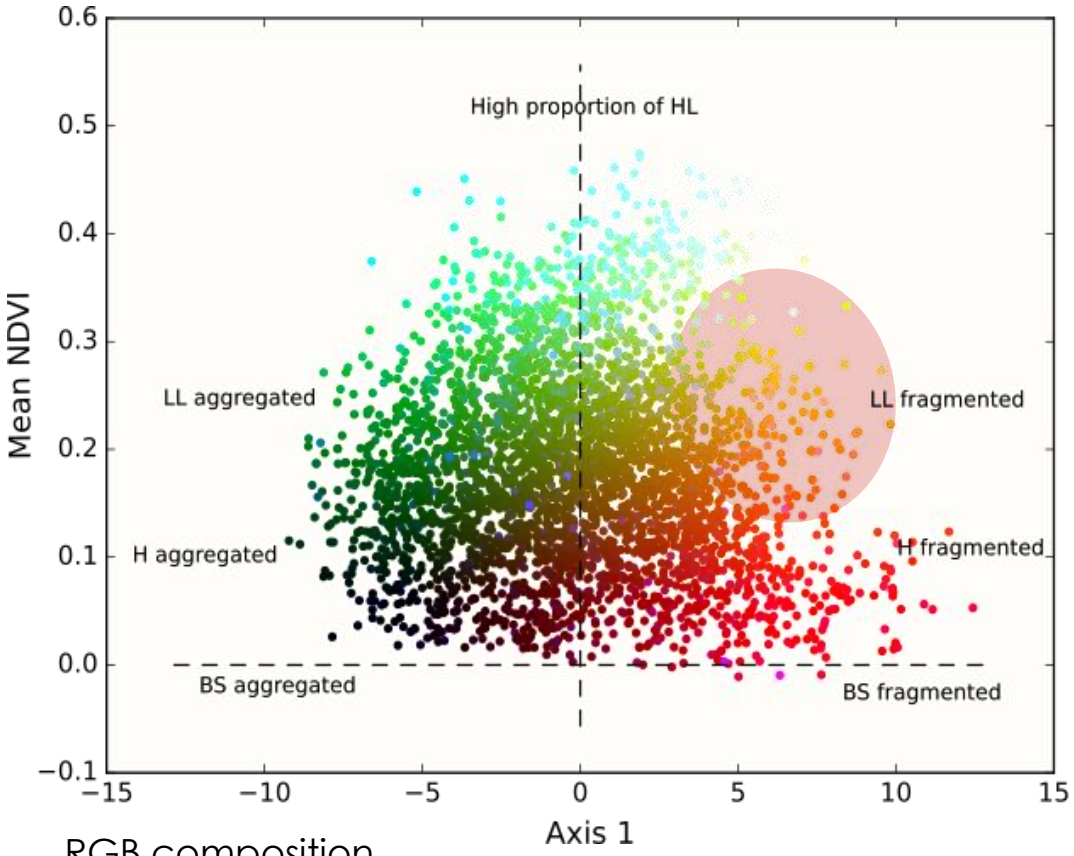
Structure from the three continuous indices



RGB composition

Axis 1 | NDVI | Axis 2

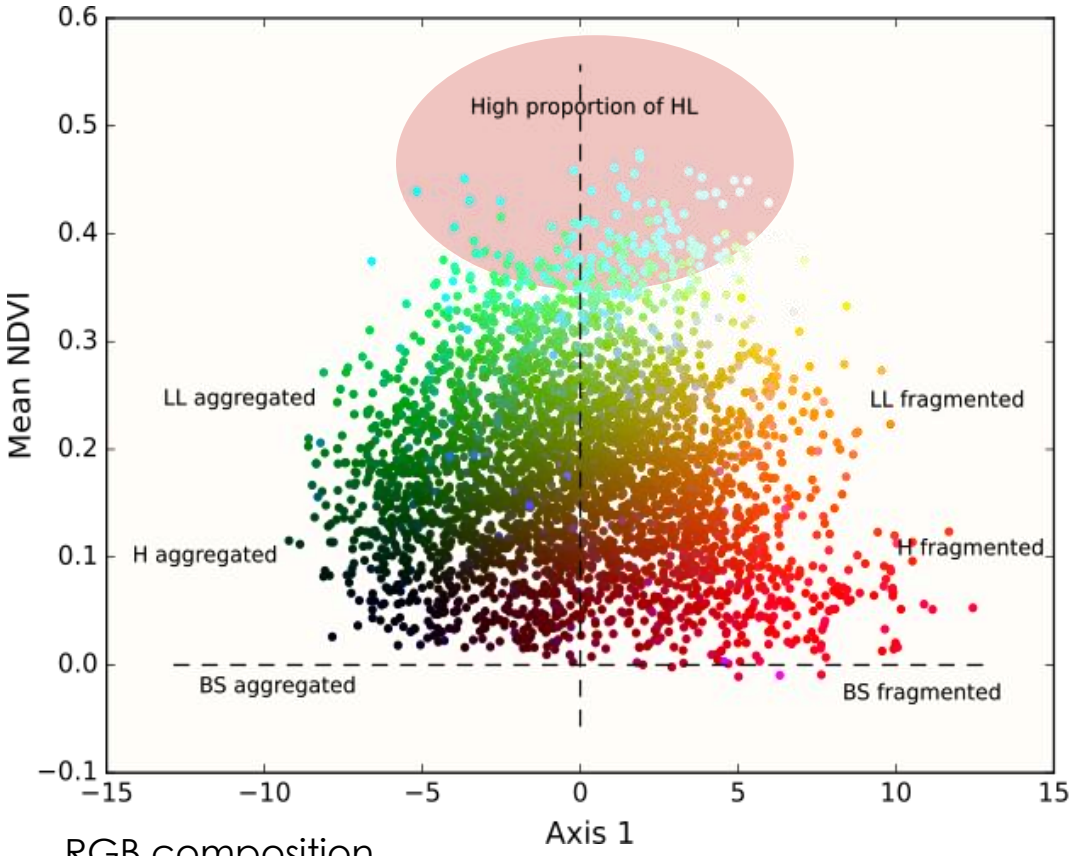
Structure from the three continuous indices



RGB composition

Axis 1 | NDVI | Axis 2

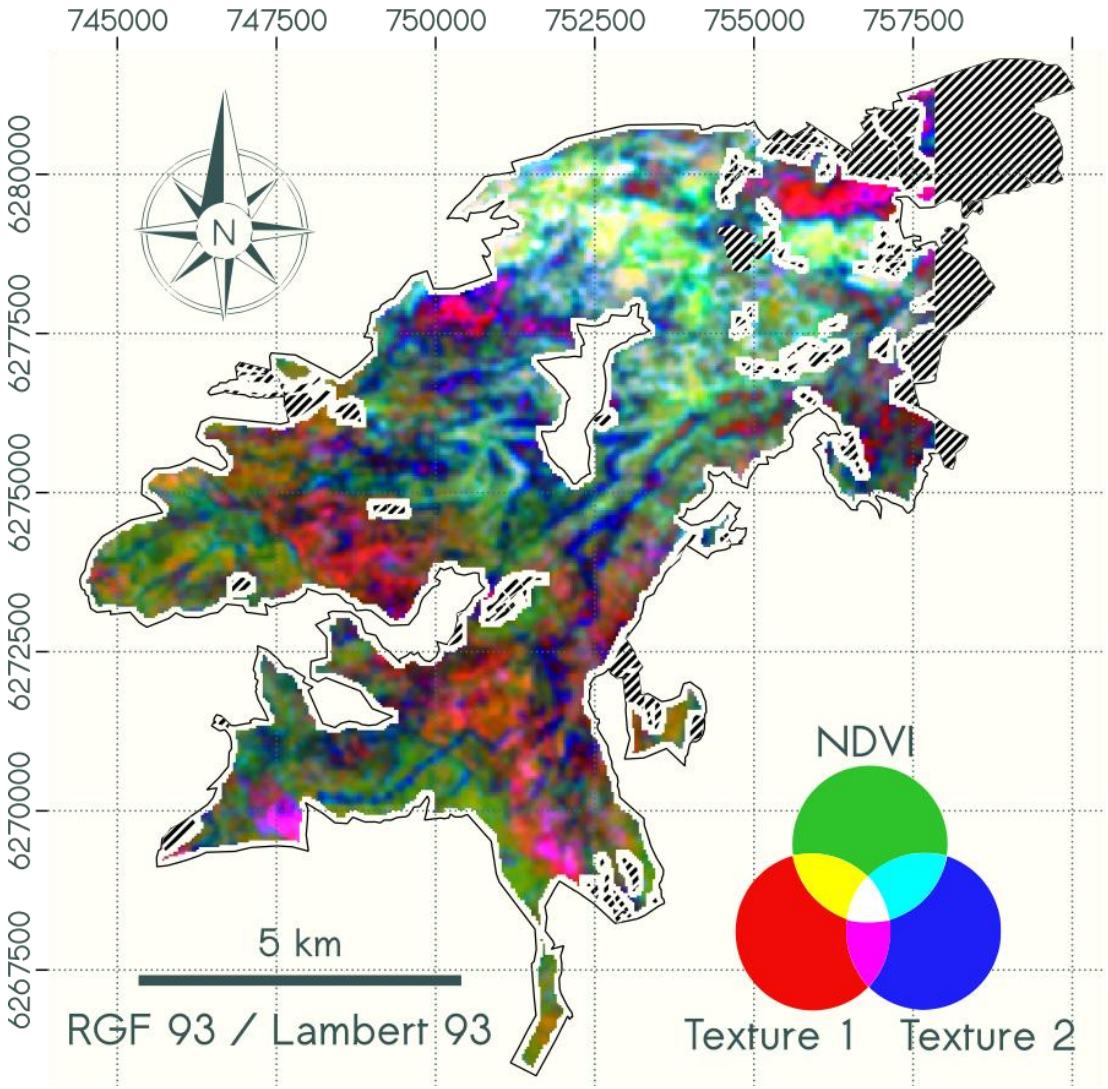
Structure from the three continuous indices



RGB composition

Axis 1 | NDVI | Axis 2

Map of heterogeneity



Texture 1

Vegetation fragmentation

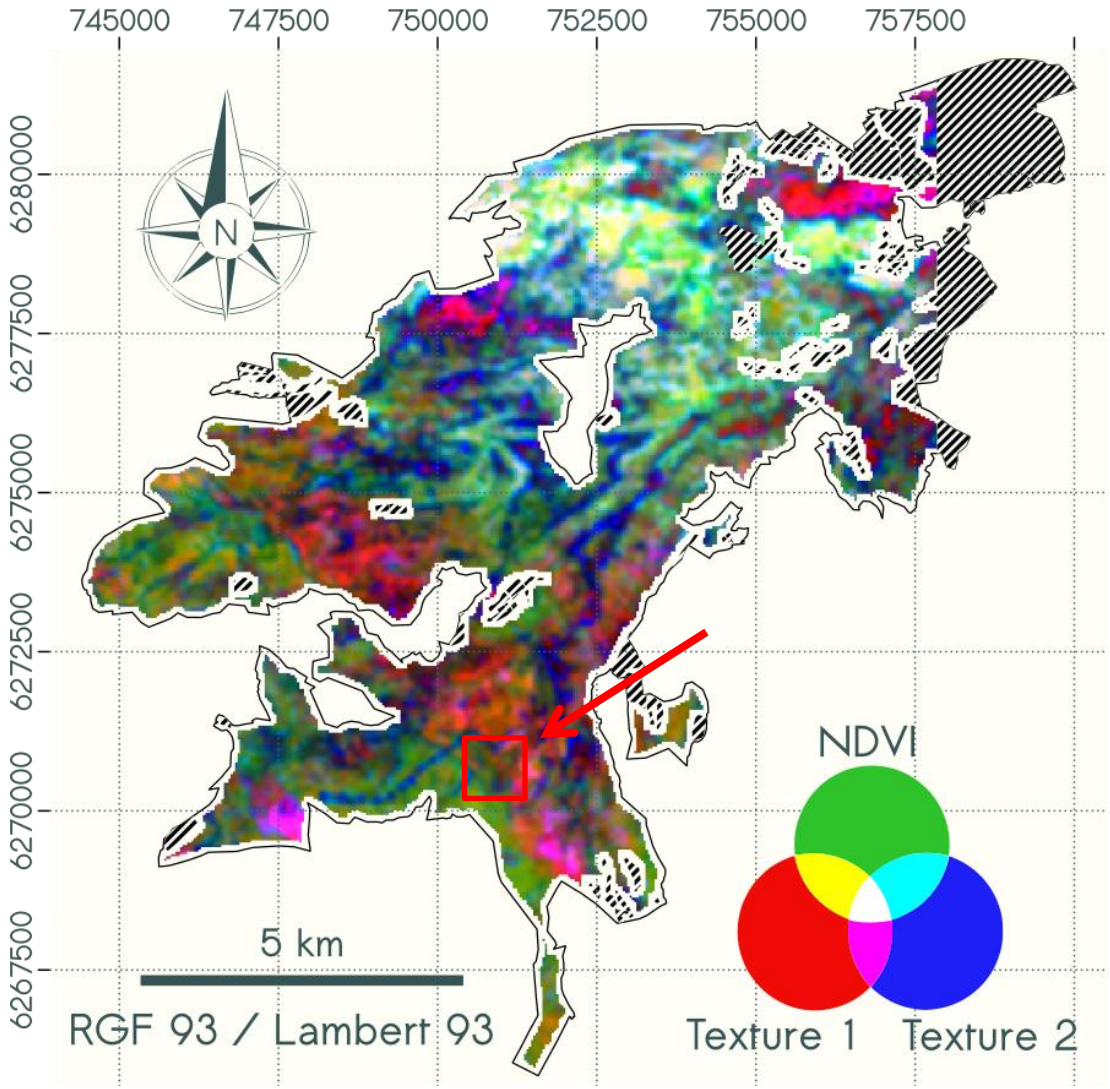
Texture 2

High ligneous dominance

NDVI

Proxy of strata composition

Map of heterogeneity



Texture 1

Vegetation fragmentation

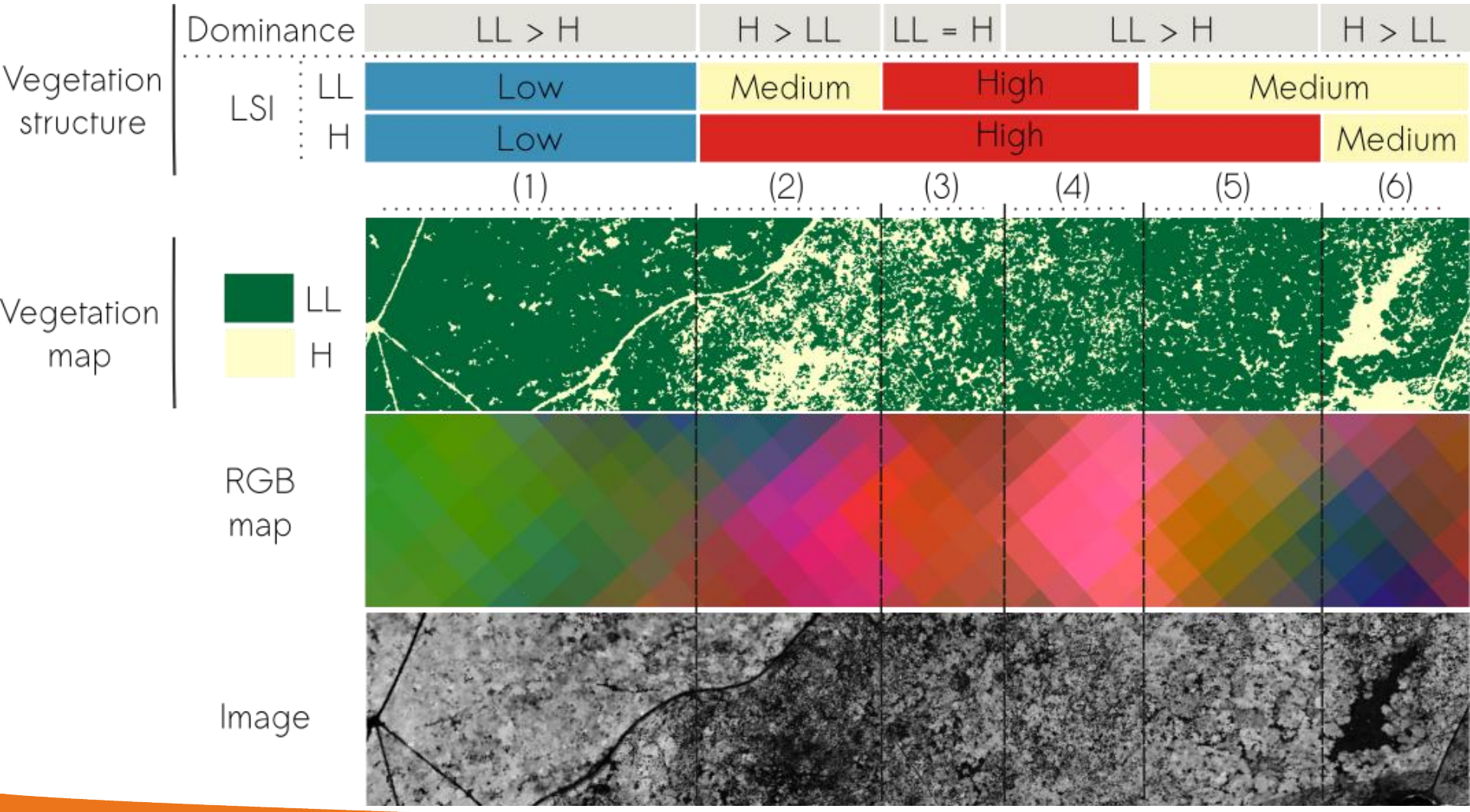
Texture 2

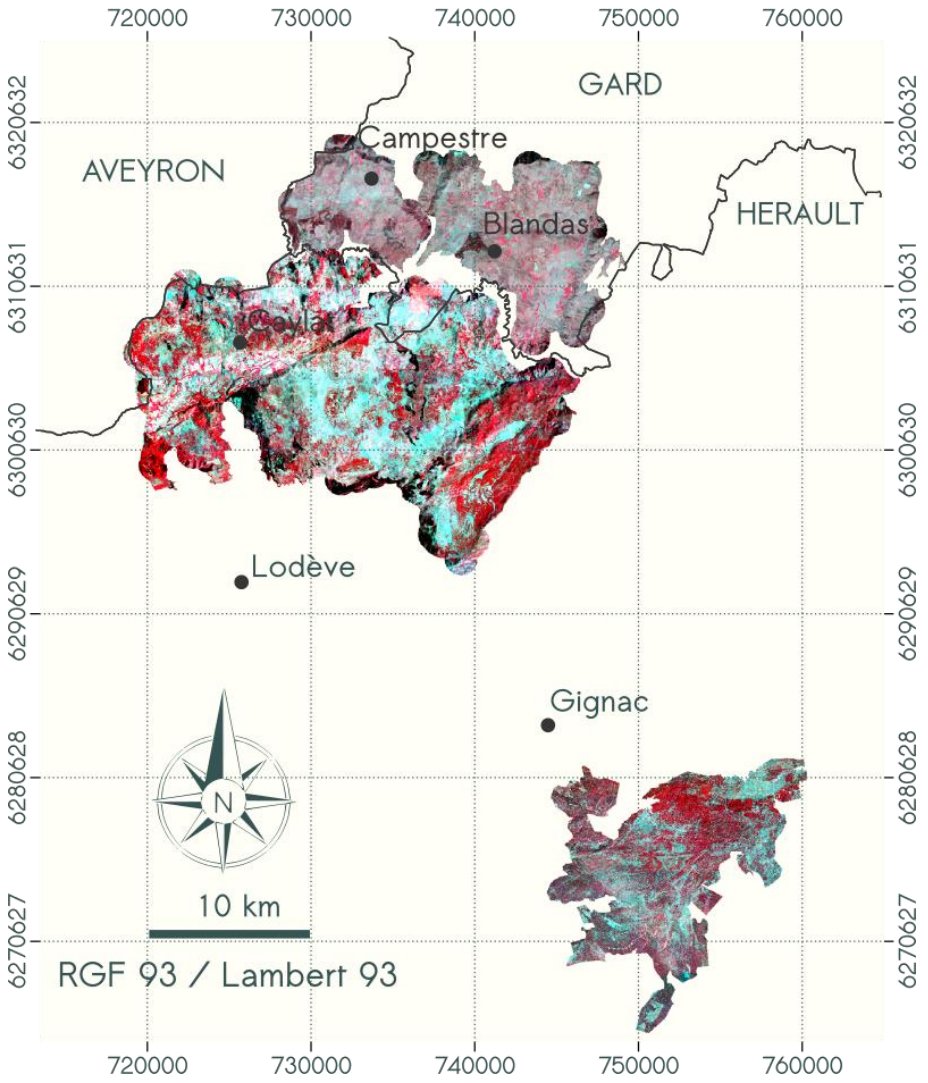
High ligneous dominance

NDVI

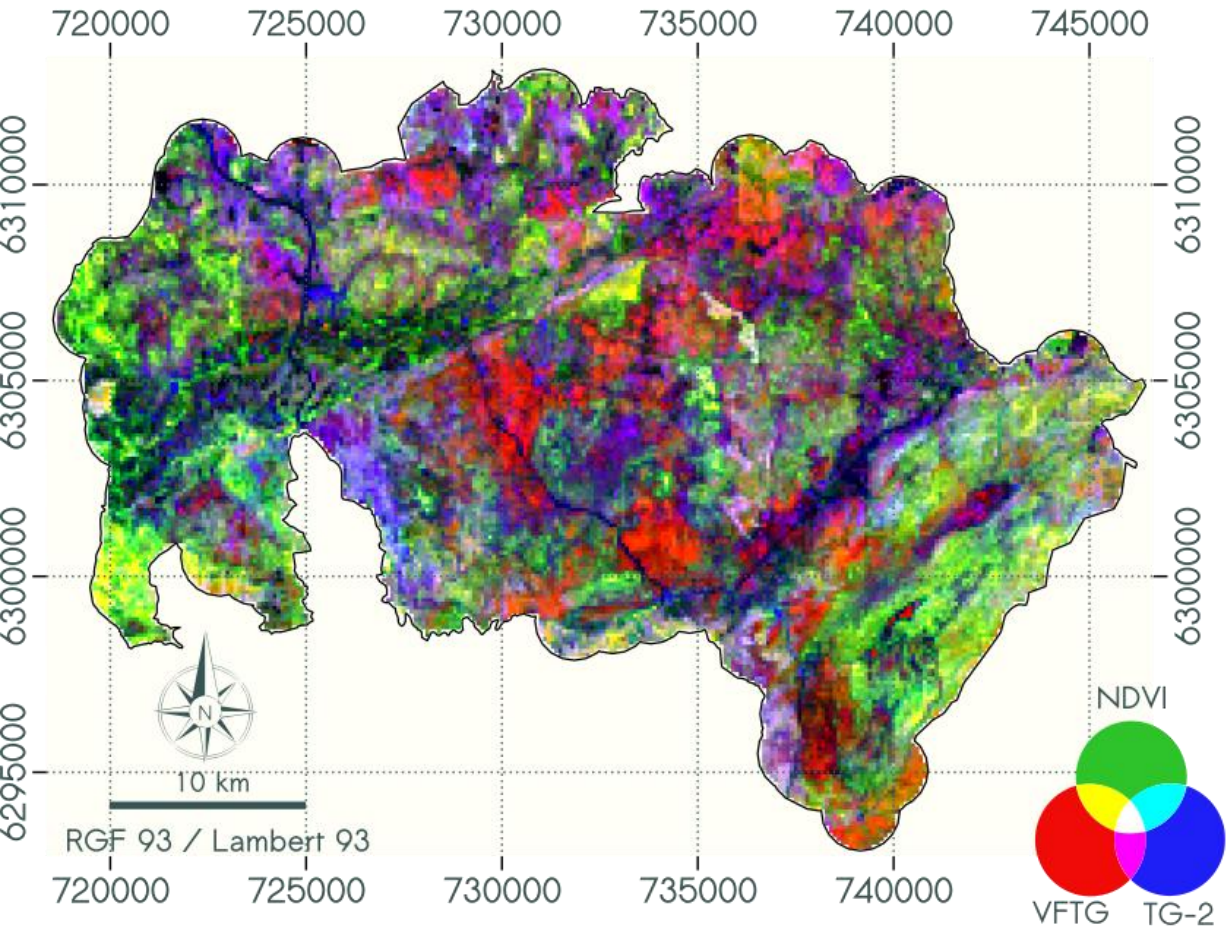
Proxy of strata composition

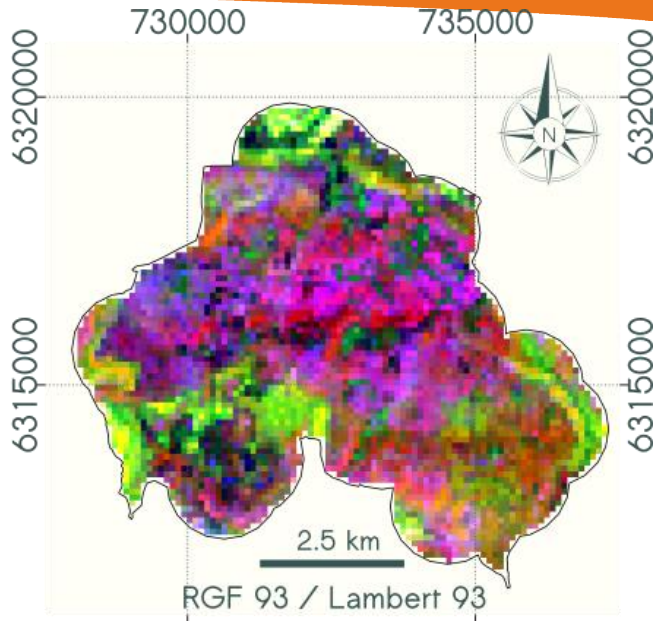
Depicting gradient of heterogeneity

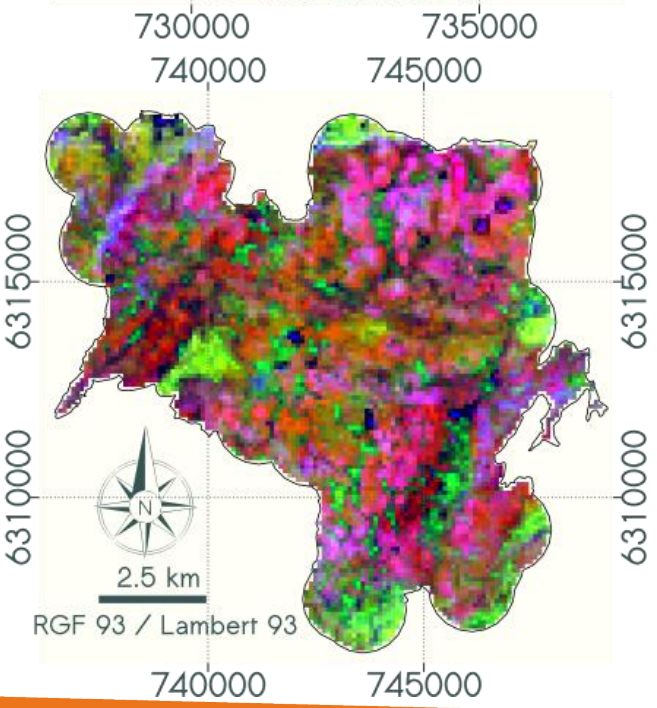



720000
730000
740000
750000
760000
6320632
6310631
6300630
6290629
6280628
6270627
GARD
AVEYRON
HERAULT
Campestre
Blandas
Lodève
Gignac
N
10 km
RGF 93 / Lambert 93

Upscaling

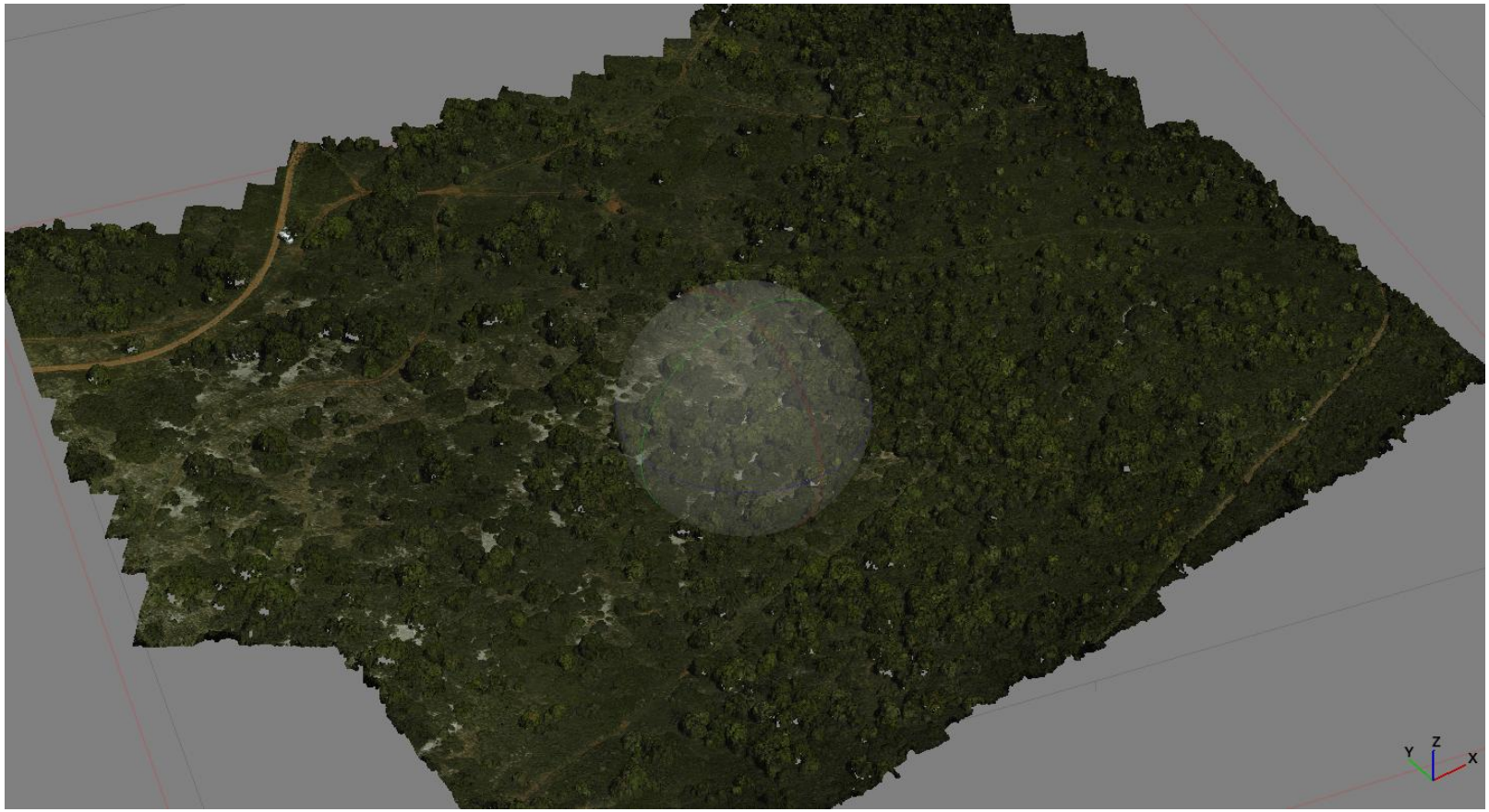

720000
725000
730000
735000
740000
745000
6310000
6305000
6300000
6295000
N
10 km
RGF 93 / Lambert 93
NDVI
VFTG
TG-2


730000
735000
6320000
6315000
N
2.5 km
RGF 93 / Lambert 93


730000
735000
740000
745000
6315000
6310000
N
2.5 km
RGF 93 / Lambert 93

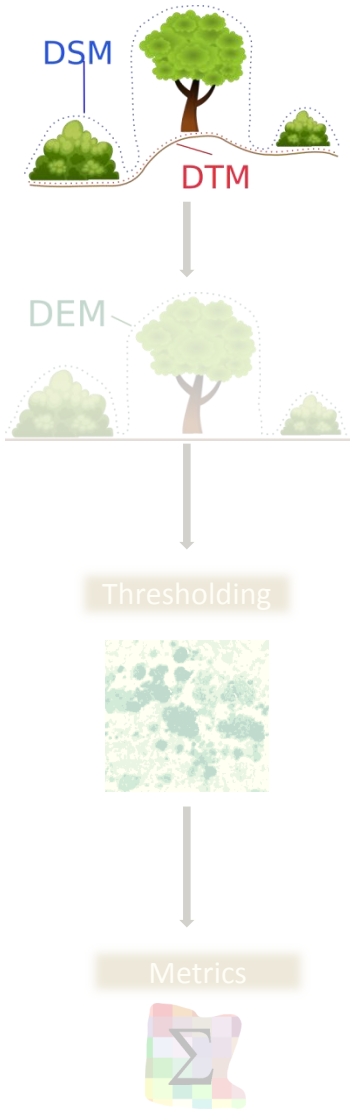
Heterogeneity from UAV data

- UAV acquisition on the Causse d'Aumelas

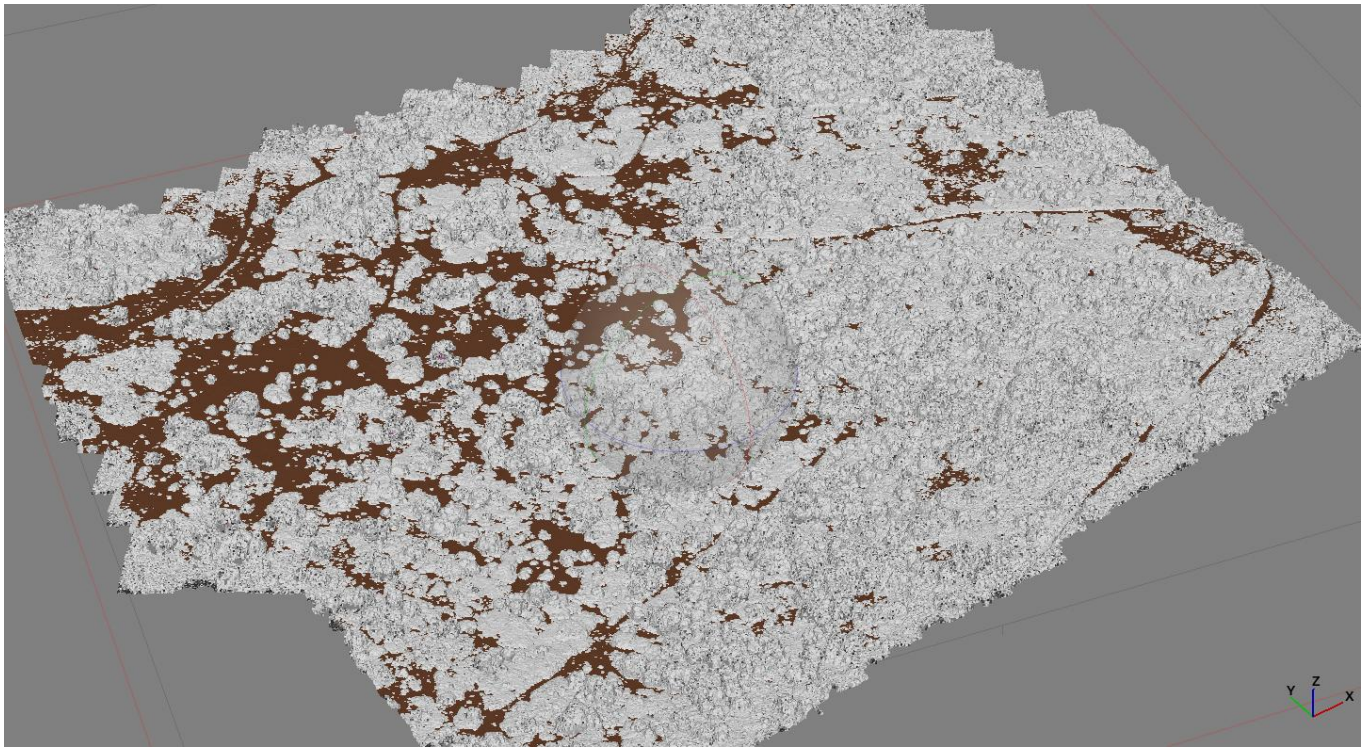



DSM
DTM
DSM- DTM
DEM

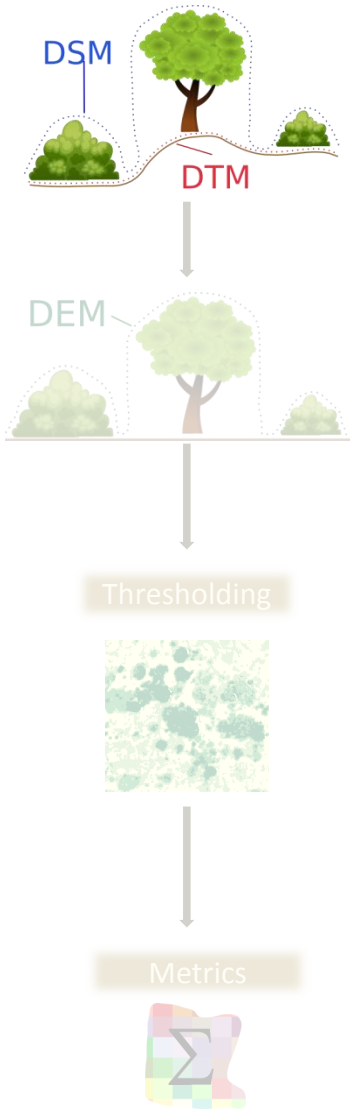
DTM computation



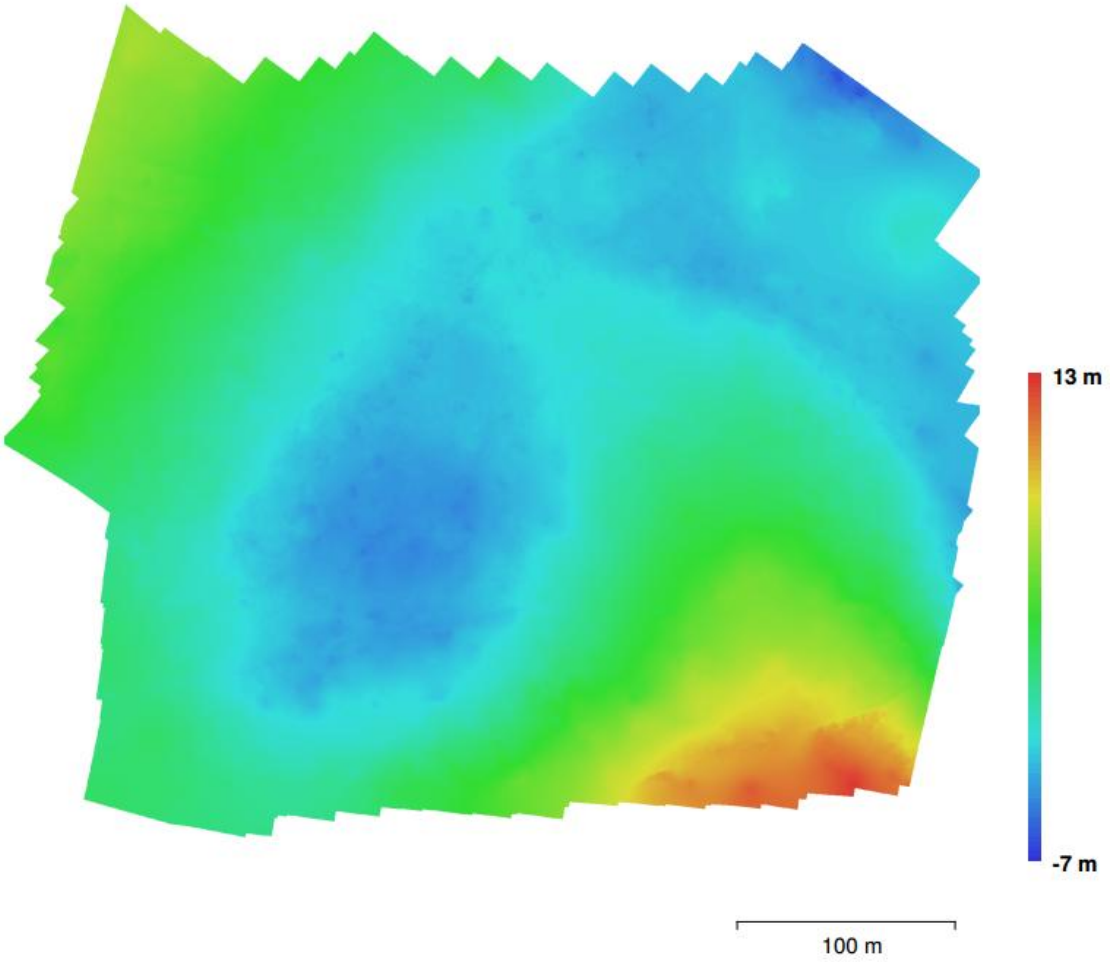
- Ground points classification



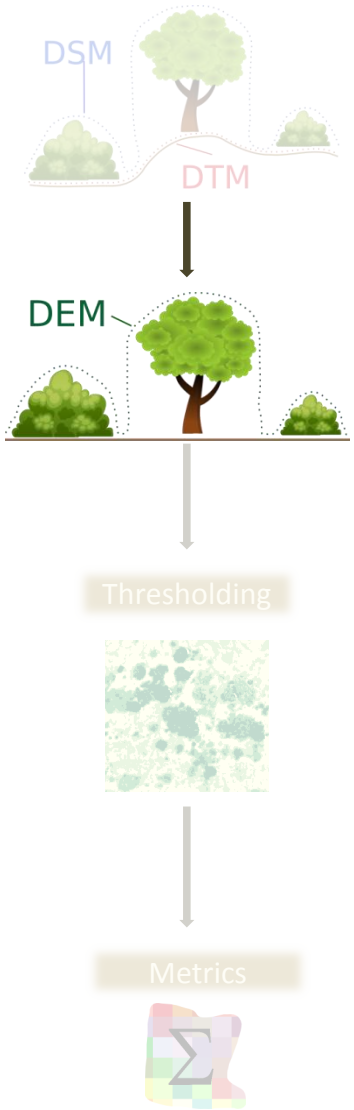
DTM computation



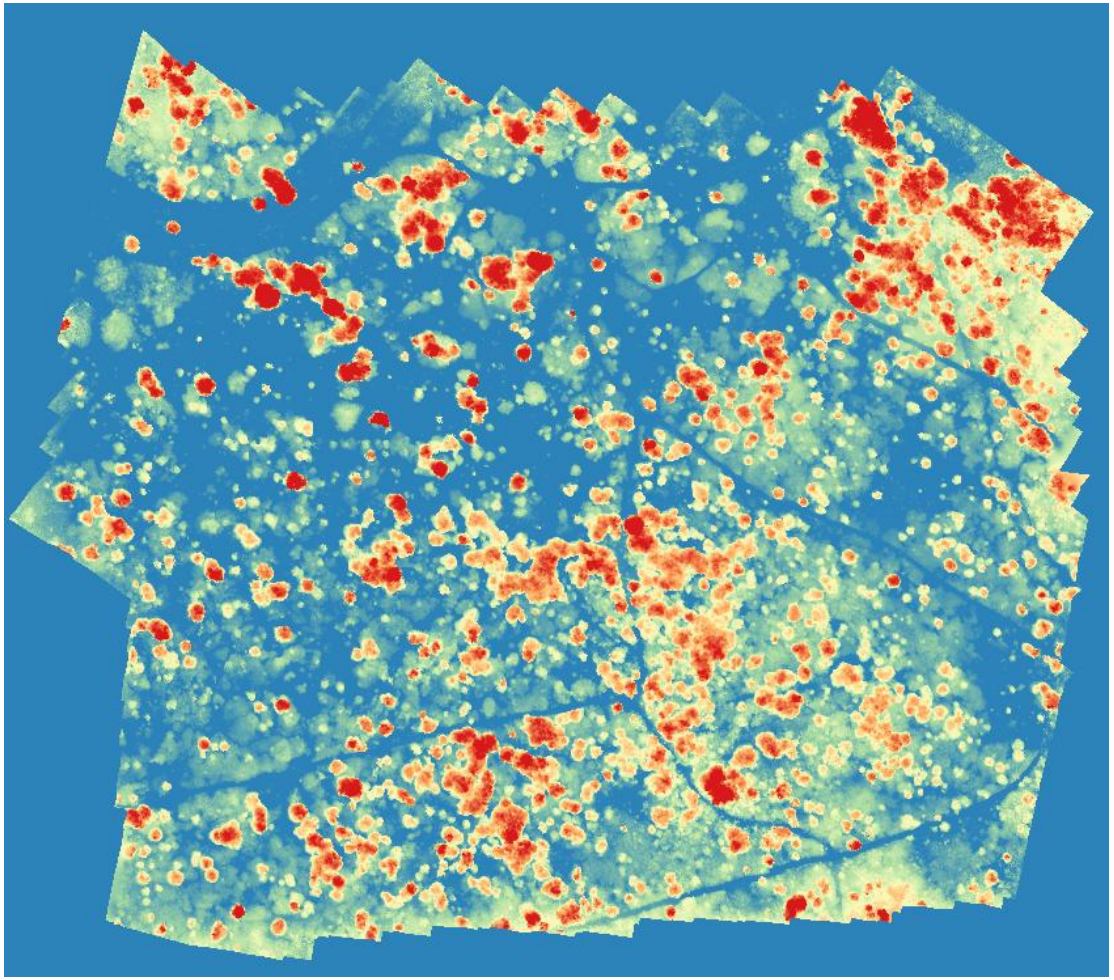
- Interpolation from ground points



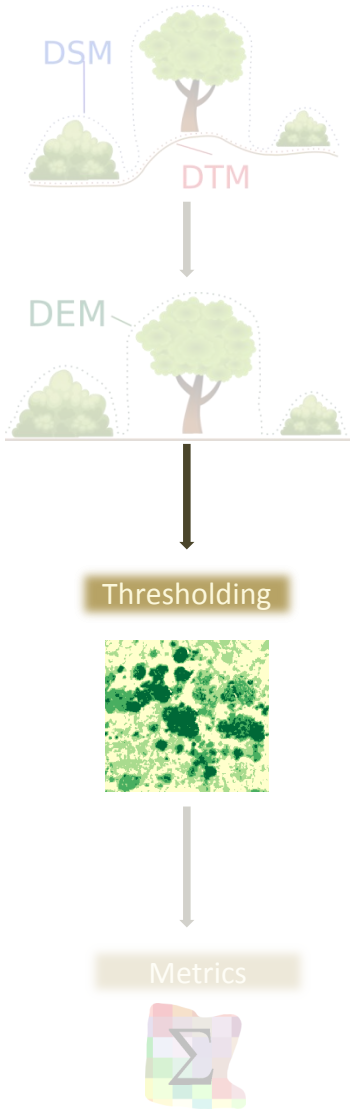
DEM computation



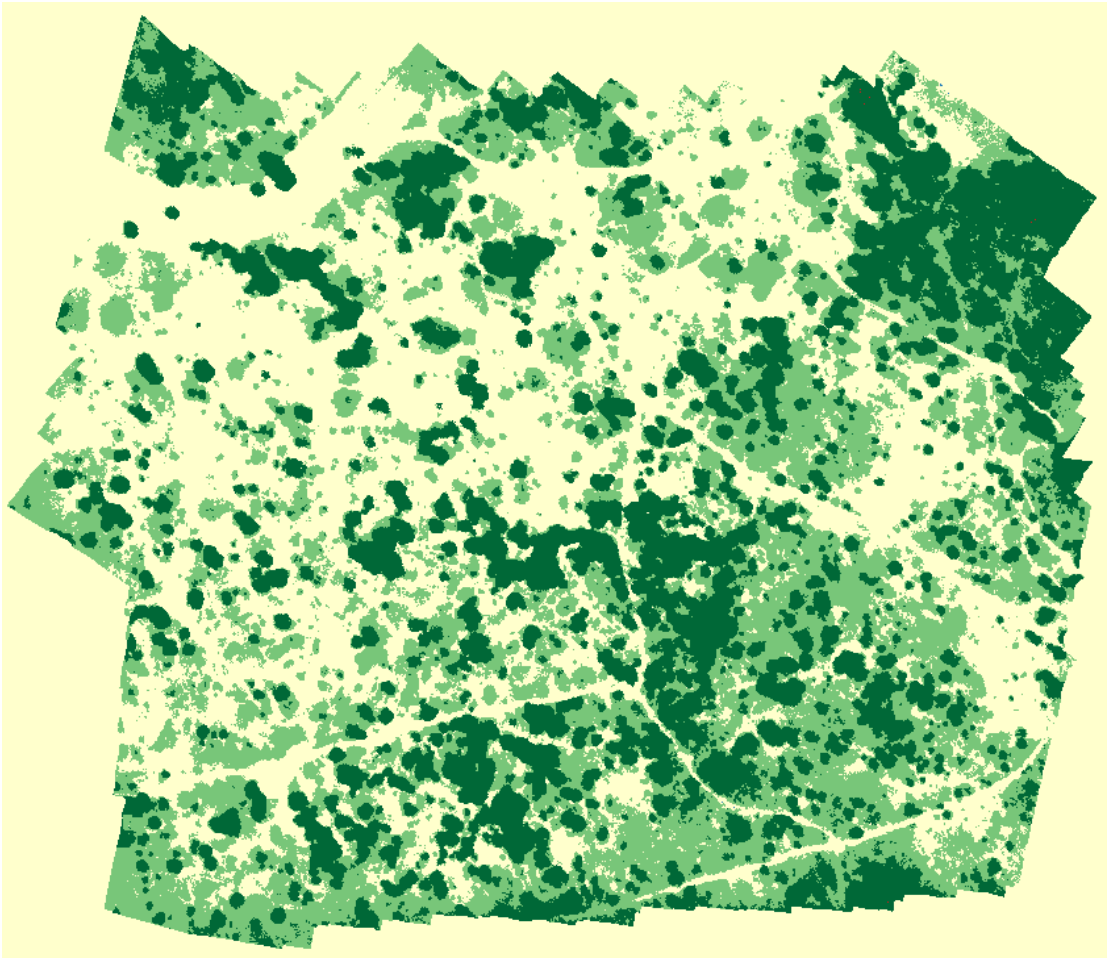
- DSM – DTM :



Classification



- Thresholding



Ground

Low ligneous

High ligneous

Take home message

- Textural indices from FOTO combined with NDVI can efficiently characterize vegetation structure of complex landscape

- The method is unsupervised
  - is unsupervised
  - With no parametrization

- Only three indices summarize information about :
  - composition and organisation
  - on four vertical strata

- Maps of heterogeneity can be used for monitoring biodiversity, natural hazards, crop pratices …