ESA 9th Advanced Training in Land Remote Sensing - UCLouvain 2019

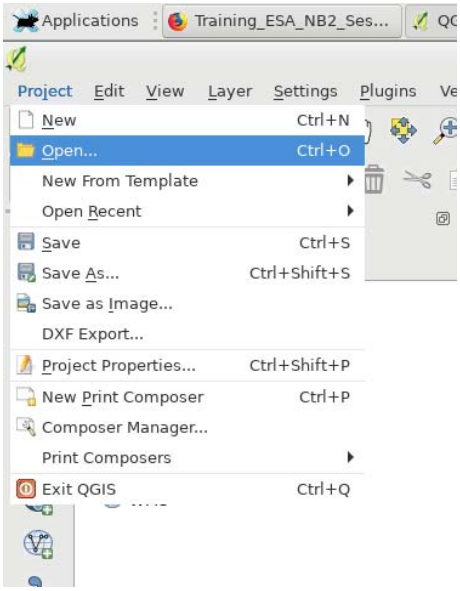
Session 7 - Crop specific time series analysis for growth monitoring

Thanks to the spatial and temporal resolution of Sentinel-1 and Sentinel-2 the crop monitoring can target specific fiels in most agricultural landscapes around the world and therefore can assess the vegetation growth conditions of a specific crop type at parcel level or for the whole national territory.
Three case studies are proposed as possible operational applications:

- the detection of crop growth anomaly using the LAI time series, between parcels belonging to the same administrative unit on one side and within the parcel for precision farming on the other side,
- the crop nitrogen status assessment using the Nitrogen Nutrition Index to support the farmers,and
- the crop emergence date for maize in South-Africa for insurance companies.

Introduction

Using QGIS display different cloud flagged LAI raster maps while overlaying the maize parcel boundaries and the administrative boundaries of the area of interest.



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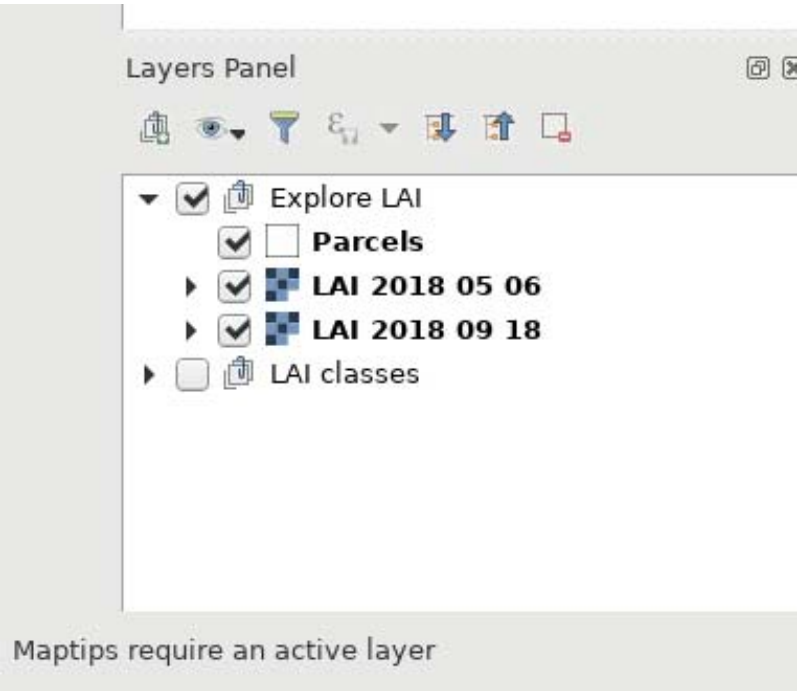

Assess visually for one or several parcels the change of the LAI spatial distribution according to the date and the development stage between the maize planting date in May and its harvest usually in September.

Part 1: Crop growth variability/anomaly detection from LAI time-series

Objectives:

- Inter-field variability assessment: comparison of LAI temporal profile spatially averaged for each parcel with regards to the local average using the cumulative LAI interpolated as metric.
- Intra-field heterogeneity assessment: analysis of the spatial distribution of LAI pixel values at the peak of LAI average profile.

Input data:

- LAI cloud flagged raster images from Sen2Agri with 10 m resolution for all dates in 2018.
- Shapefile containing the extent of maize parcels in Belgium (derived from a crop type classification.

Method:

- Extract spatially averaged LAI time-series for each parcel. - Plot the mean LAI temporal profile averaged over all the parcels.
- Compute as crop growth conditions metric the integration of LAI curve interpolated over the whole season for each parcel.
- Plot a histogram of the integrated LAI profiles and label the detected outlying parcels at admin level.

- Display the map of the LAI pixel values at the maximum of green vegetation to detect spatial patterns within each parcel.

Before running the program, it is necessary to install all the packages that contain the functions that will be used.

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A_Data/"
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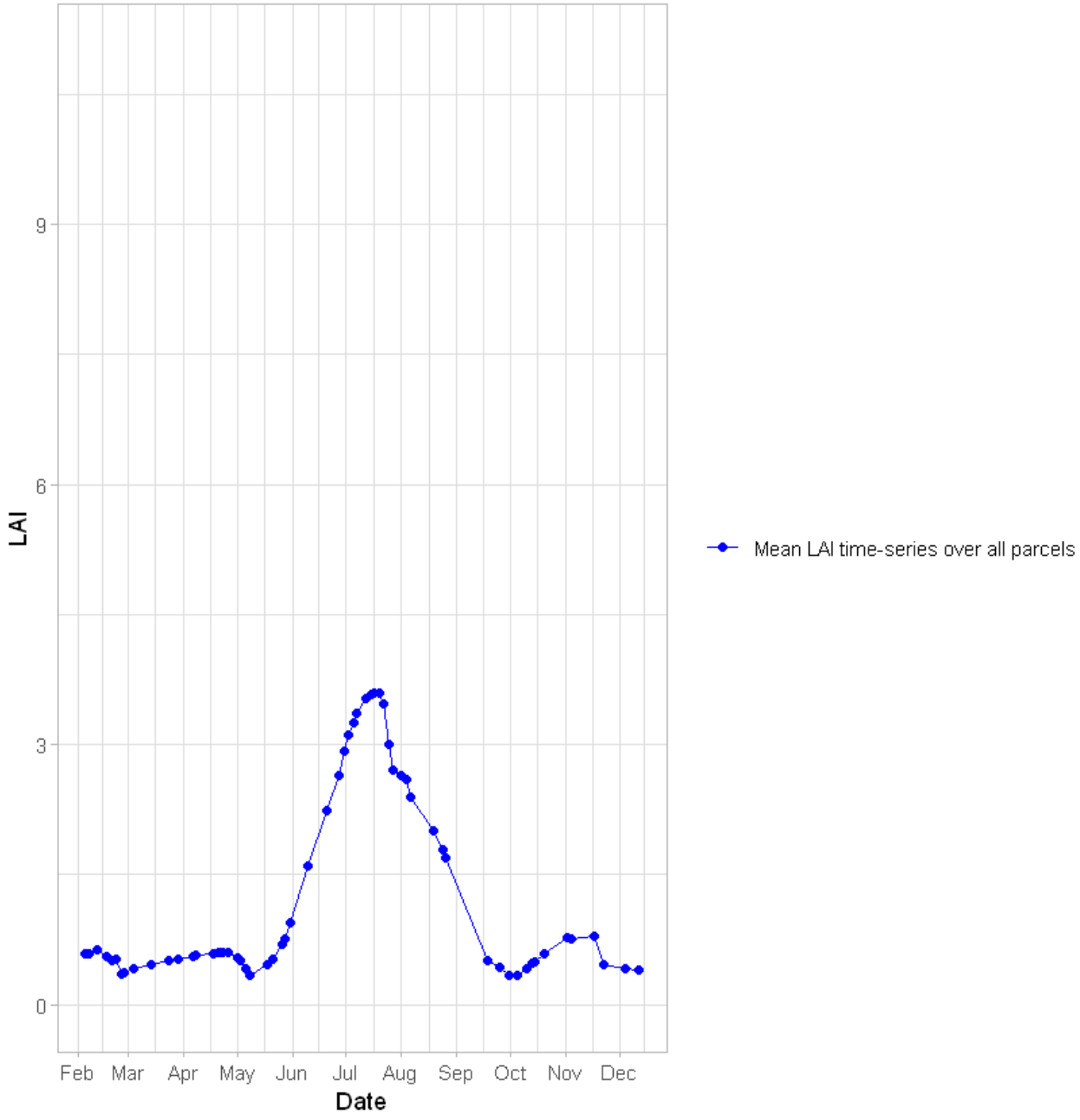
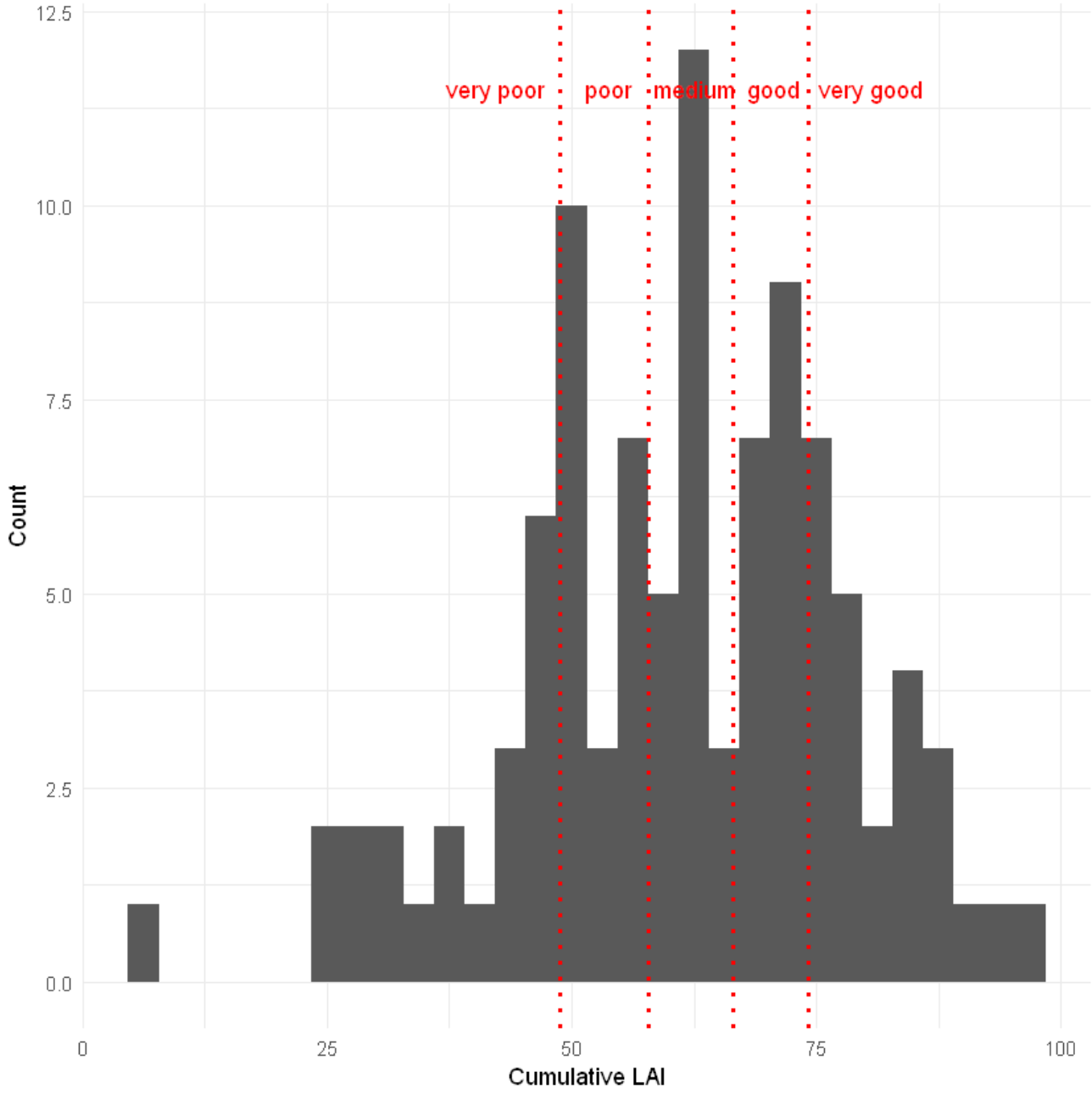
1.1 Creation of LAI time-series averaged at the parcel level



1.2 LAI average profile for all maize fields in the administrative unit and crop growth condition metric

The average maize profile corresponds here to the normal crop growth condition and the growing season extents from May 15th (i.e. the planting date) to Septembre 31st (i.e. the harvest).

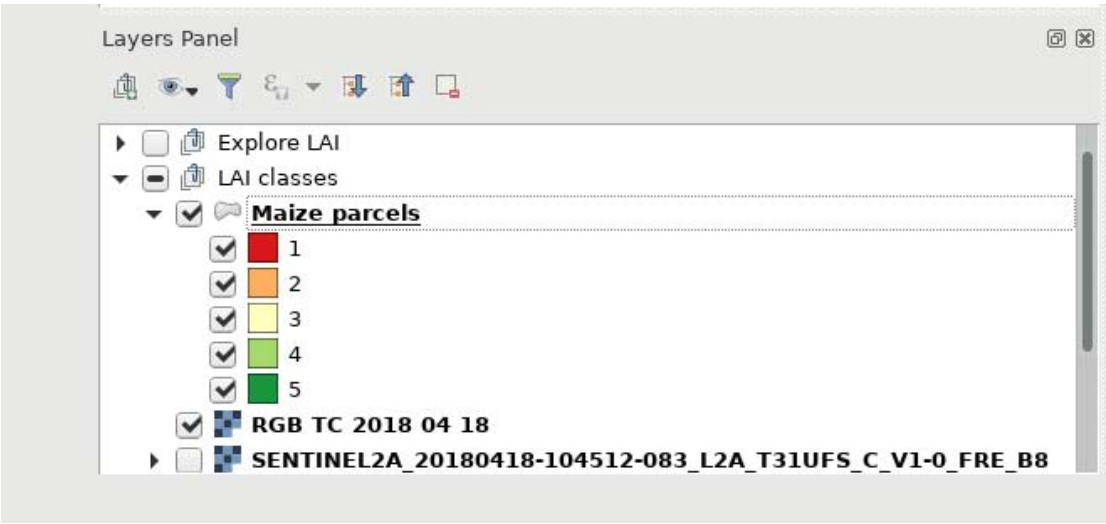
First, the integration of the interpolated LAI values from 15 May (planting date) to 31 September (harvest) is computed for the whole season to quantify the crop growth condition in one single number (metric).



Each parcel polygon is attributed a category corresponding to the portion of the distribution in which it falls (e.g. "very poor" is when integrated LAI value for the parcel is between 0 and the integrated LAI value corresponding to percentile 20).

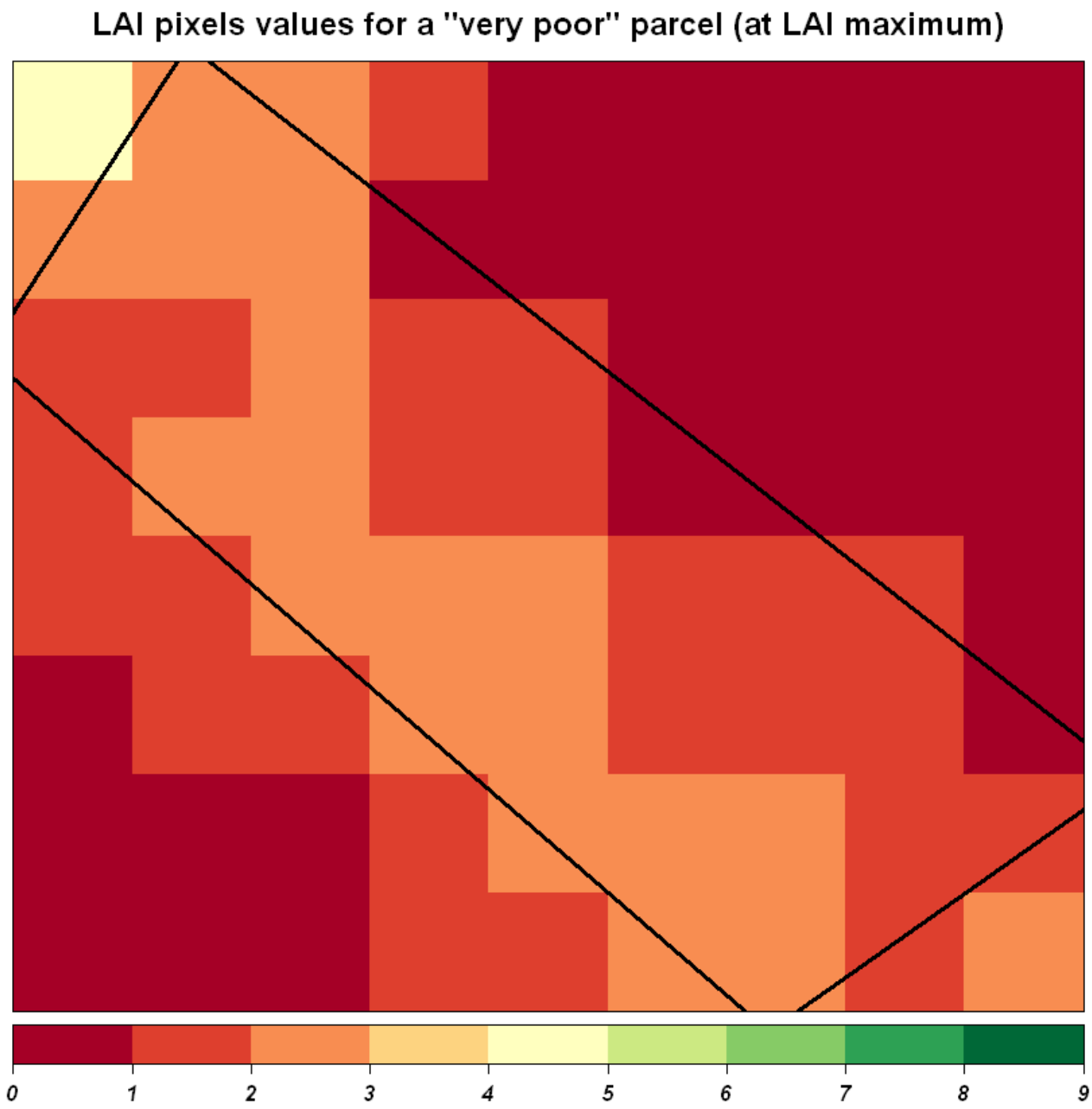
Exploration of the results

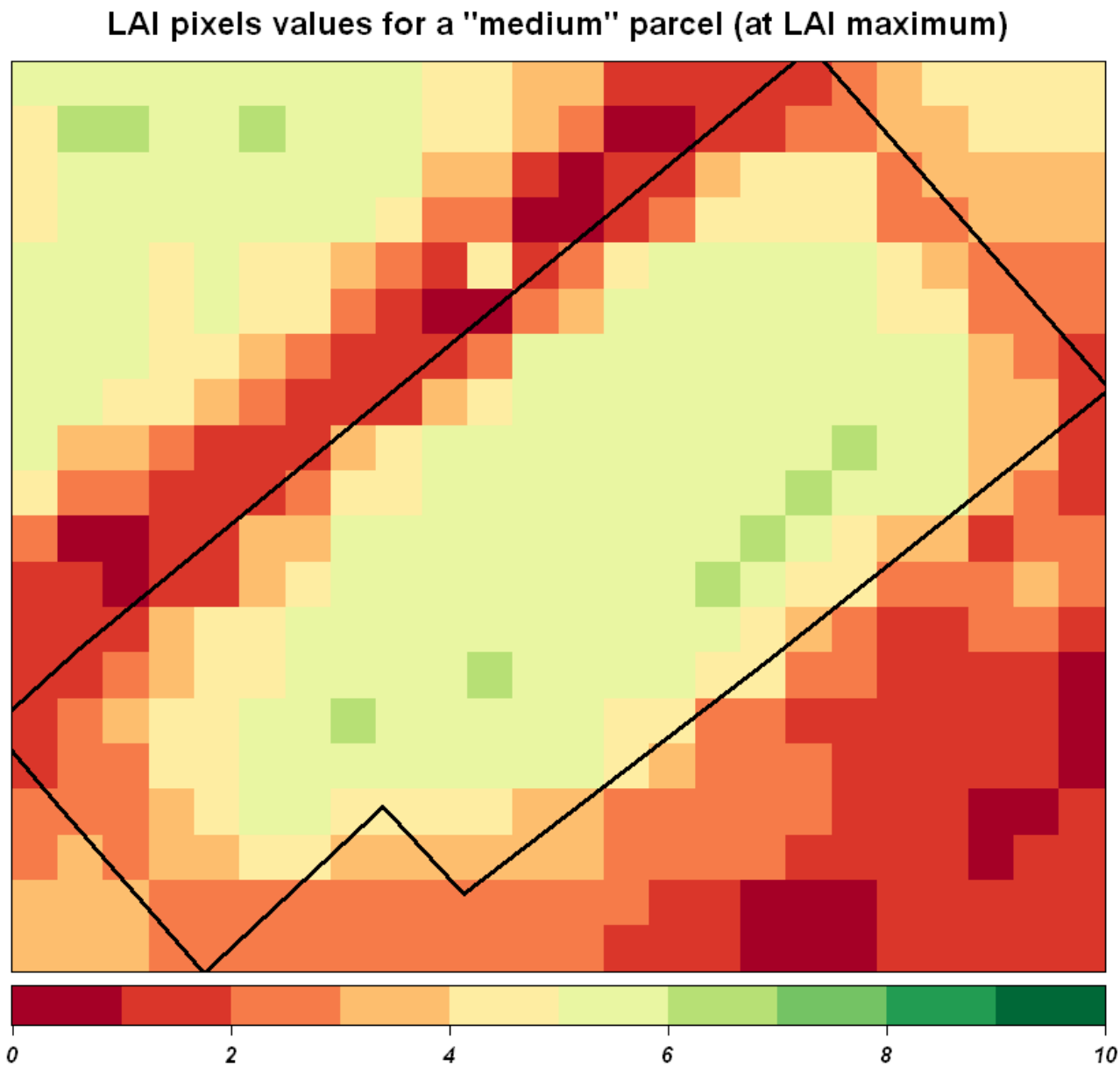
Open QGIS to analyze the shapefiles that were created.
Visualize a Sentinel-2 surface reflectance colour composite image and observe the spatial structure of the parcels of the different categories.

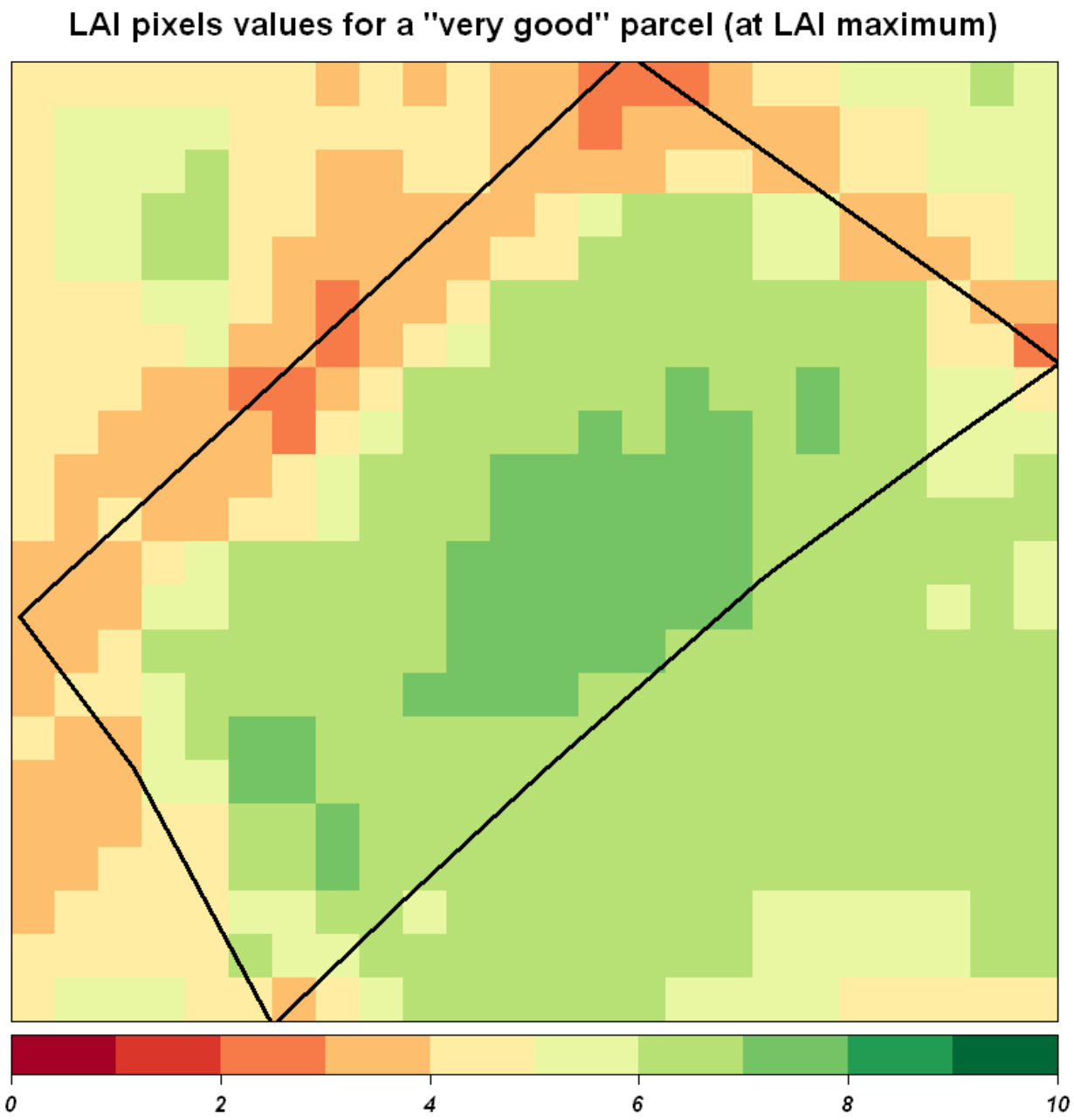


1.3 Intra-field variability analysis at the peak of the LAI

The analysis of the spatial patterns within a field is a key information for precision agriculture or for field zoning allowing the farmer to manage more precisely the crop by taking into account the field spatial heterogeneity.


LAI pixels values for a "very poor" parcel (at LAI maximum)
0
1
2
3
4
5
6
7
8
9


LAI pixels values for a "medium" parcel (at LAI maximum)
0
2
4
6
8
10


LAI pixels values for a "very good" parcel (at LAI maximum)
0
2
4
6
8
10

Part 2 : Anomalies detection from NNI time-series

Objectives:

- Creation of NNI time-series spatially averaged at the parcel level.
- Graphic representation of averaged time-series over all the parcels.
- Comparison of integrated NNI profiles of the different parcels.

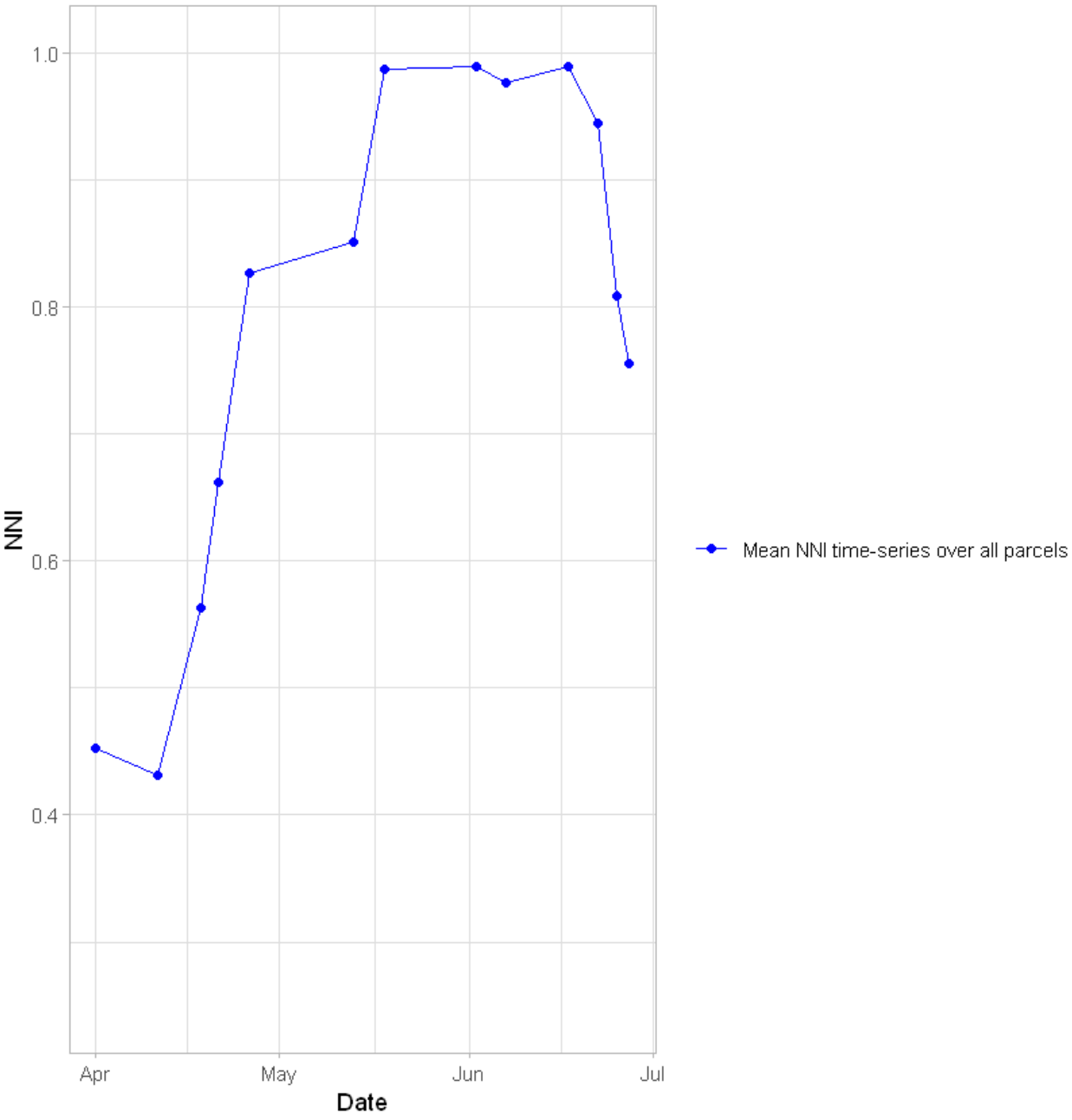
Input data:

- BELCAM 10 m resolution NNI cloud flagged raster images for all available dates in 2019.
- Shapefile containing the extent of wheat parcels in Wallonia.

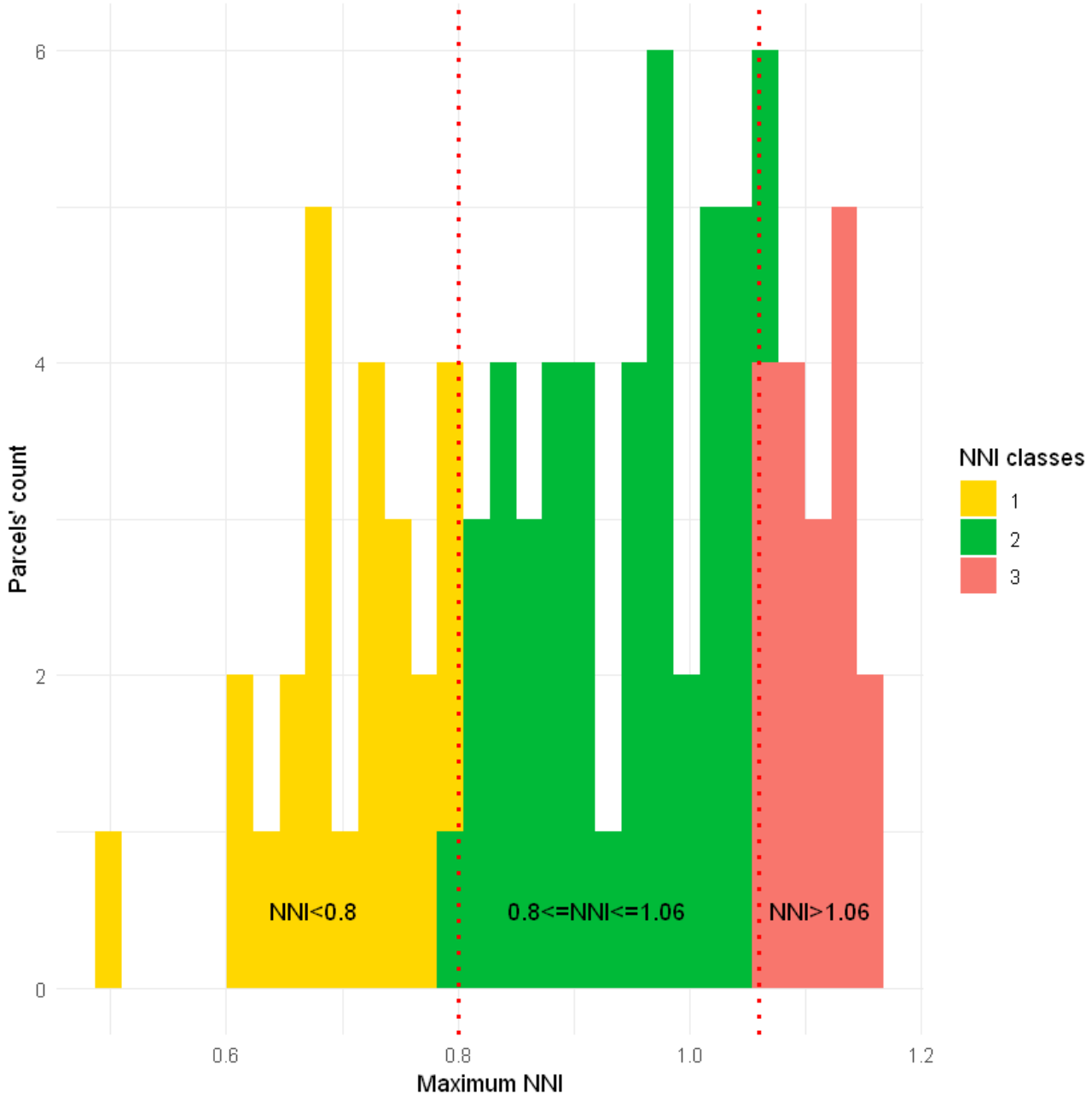
Method:

- Extract spatially averaged NNI time-series from each parcel.
- Plot NNI temporal profile average over all the parcels.
- Compute the integration of NNI over the whole season for each of the parcel.
- Plot a histogram of the integrated NNI profiles and visual detection of outlying parcels.

2.1 Creation of NNI time-series averaged at the parcel level


1.0
0.8
0.6
0.4
NNI
Apr
May
Jun
Jul
Date
Mean NNI time-series over all parcels

2.2 Maximum NNI distribution for all wheat fields in the administrative units and crop nutrition metrics



Explore the results

Open QGIS to analyse the shapefiles that were created.

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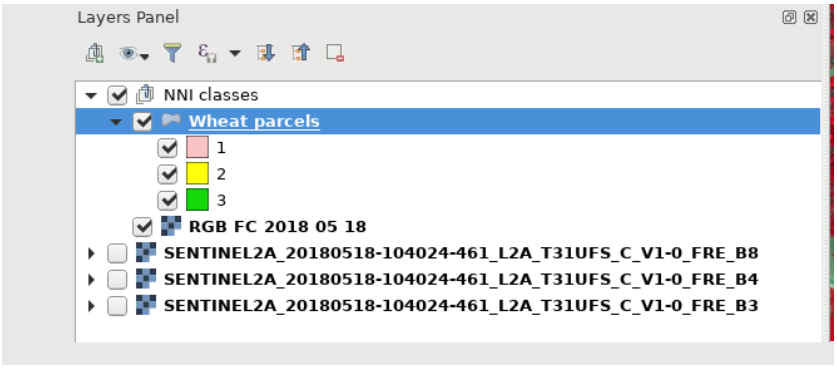
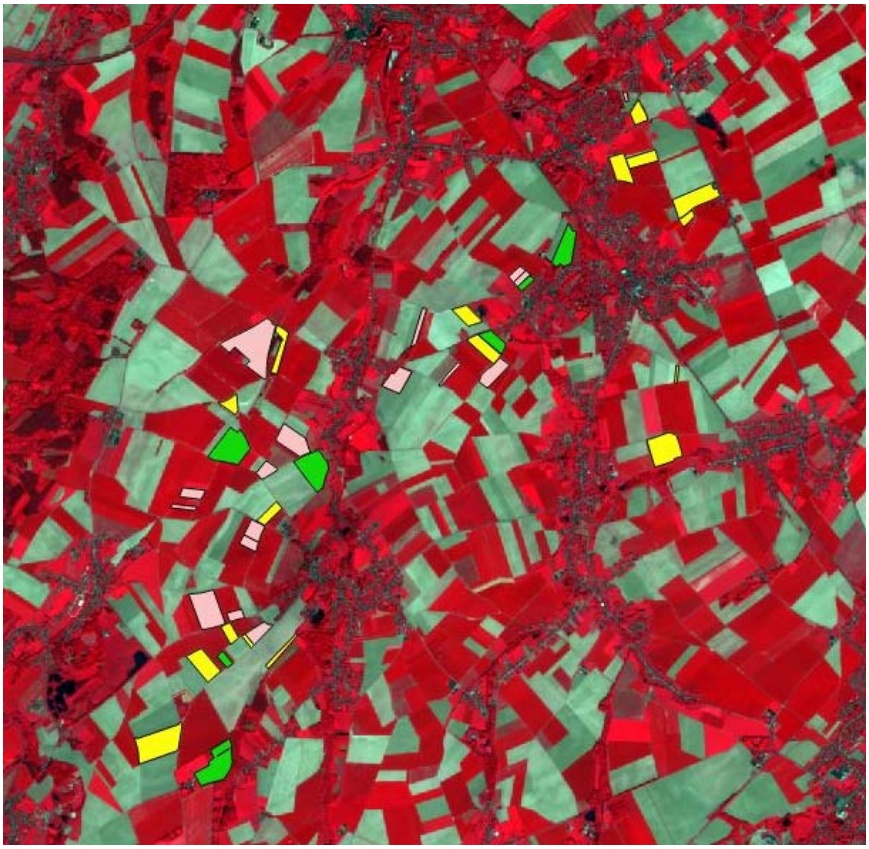
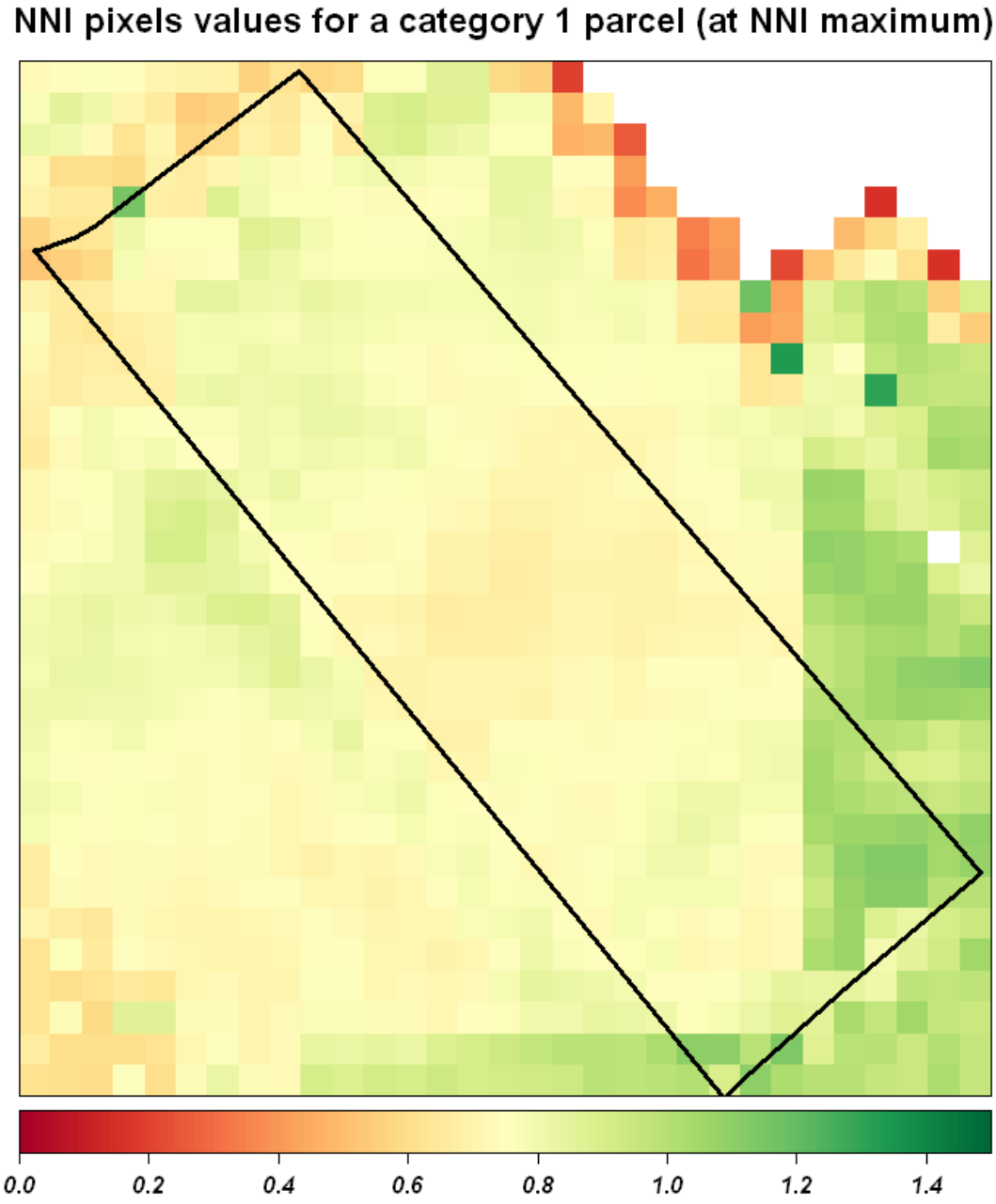
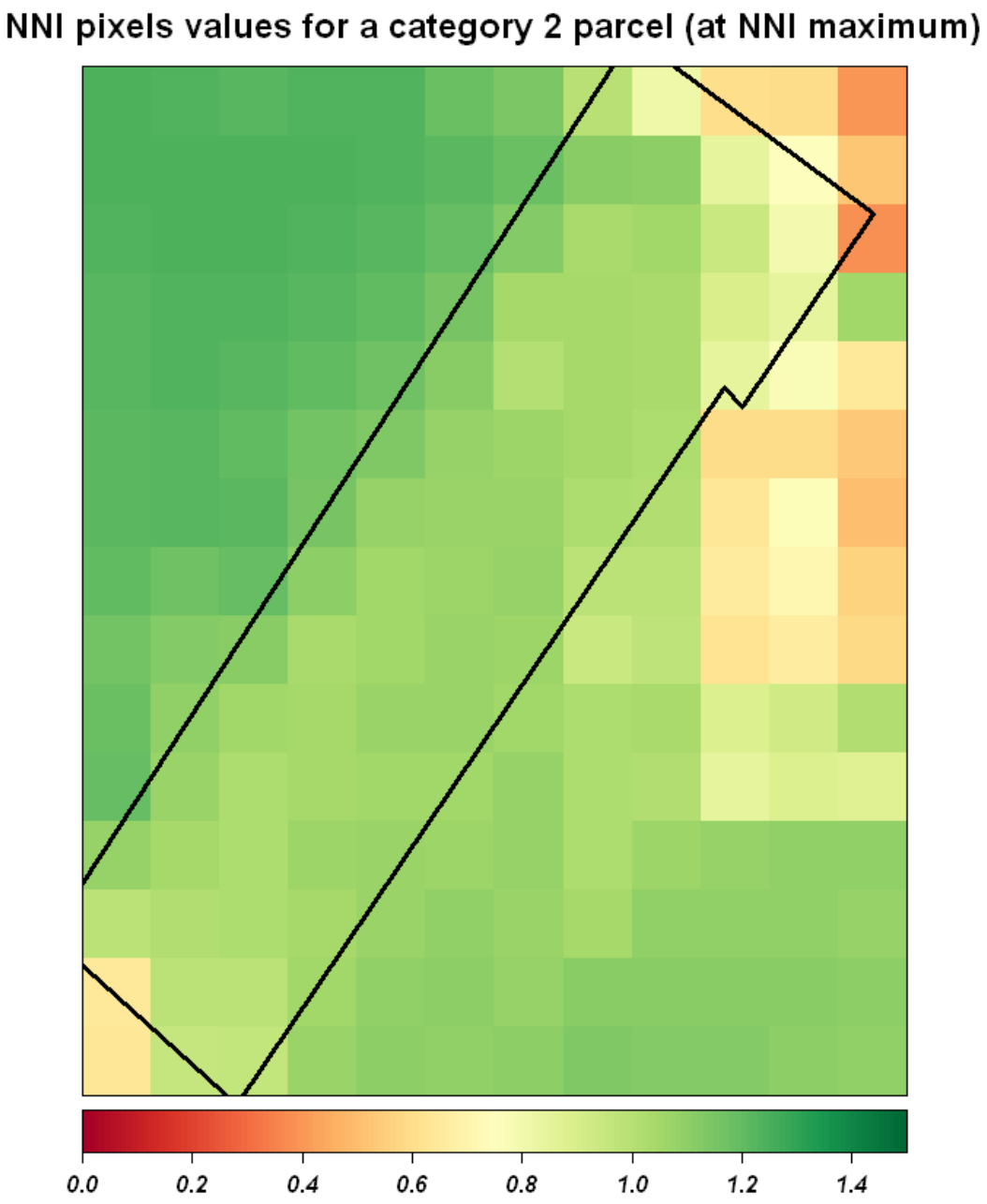
How are the fields belonging to the different categories spatially distributed ?



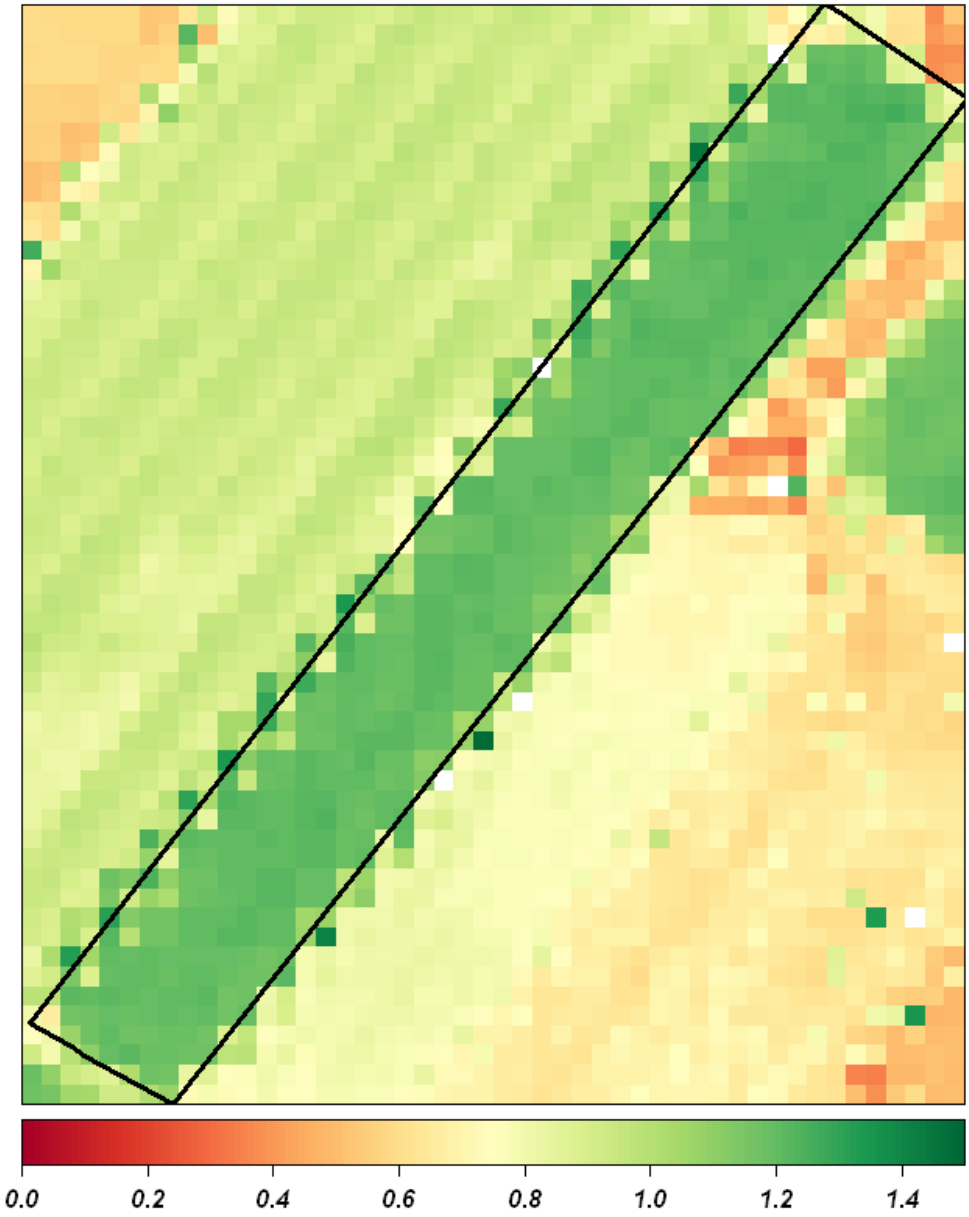


2.3 Intra-field variability analysis at the NNI peak




NNI pixels values for a category 2 parcel (at NNI maximum)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

NNI pixels values for a category 3 parcel (at NNI maximum)



Part 3 : Detection of emergence

Objectives:

- Creation of MSAVI time-series spatially averaged at the parcel level for several districts in South Africa.
- Graphic representation of MSAVI time-series over a subset of parcels.
- Computation of the MSAVI value at emergence.
- Computation of the emergence date for all parcels.
- Attribute the emergence date to the parcels' shapefile.

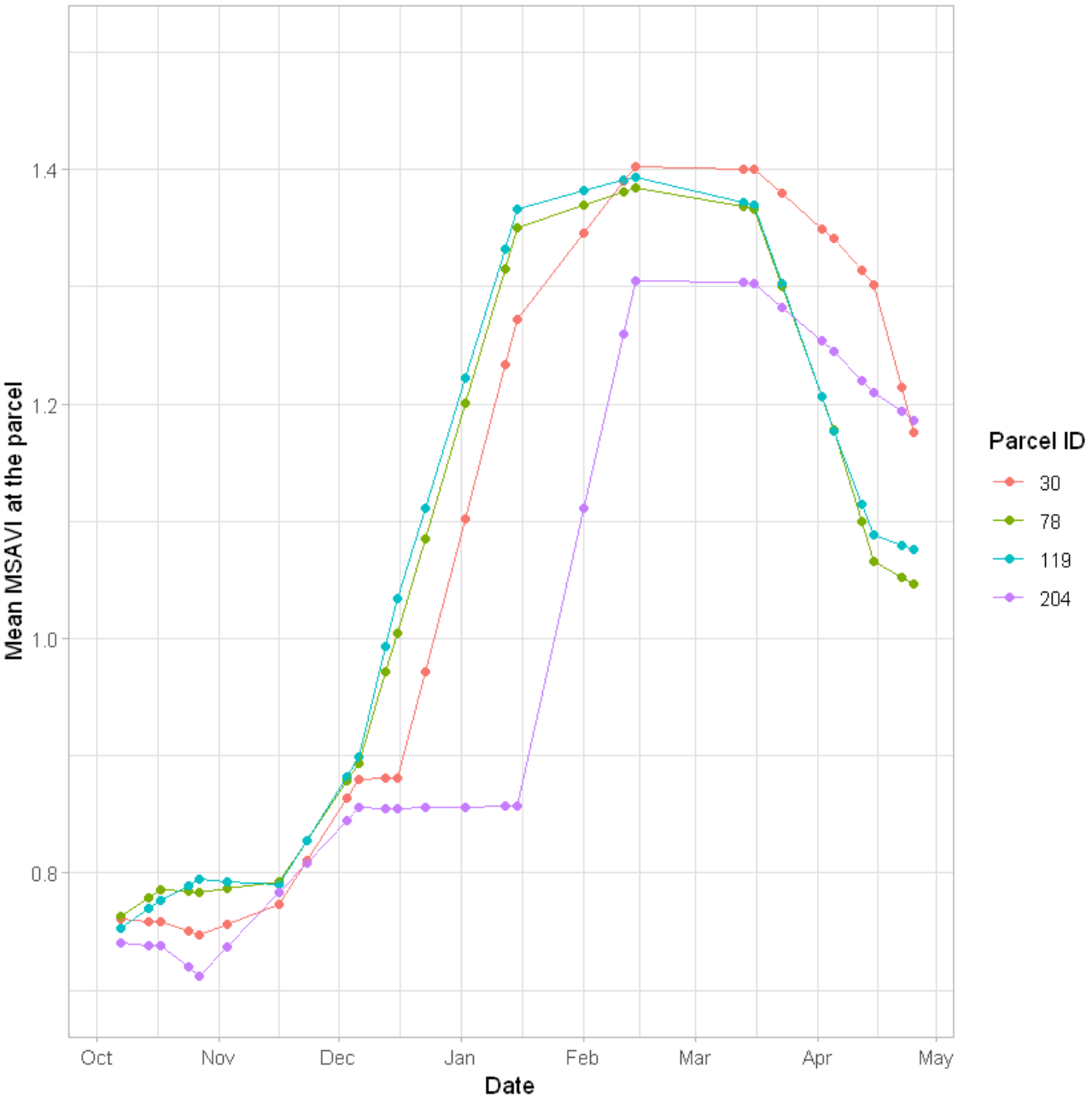
Input data:

- Mean MSAVI data durin the growing season 2016-2017.
- Shapefile containing the extent of maize parcels in several districts in South-Africa.

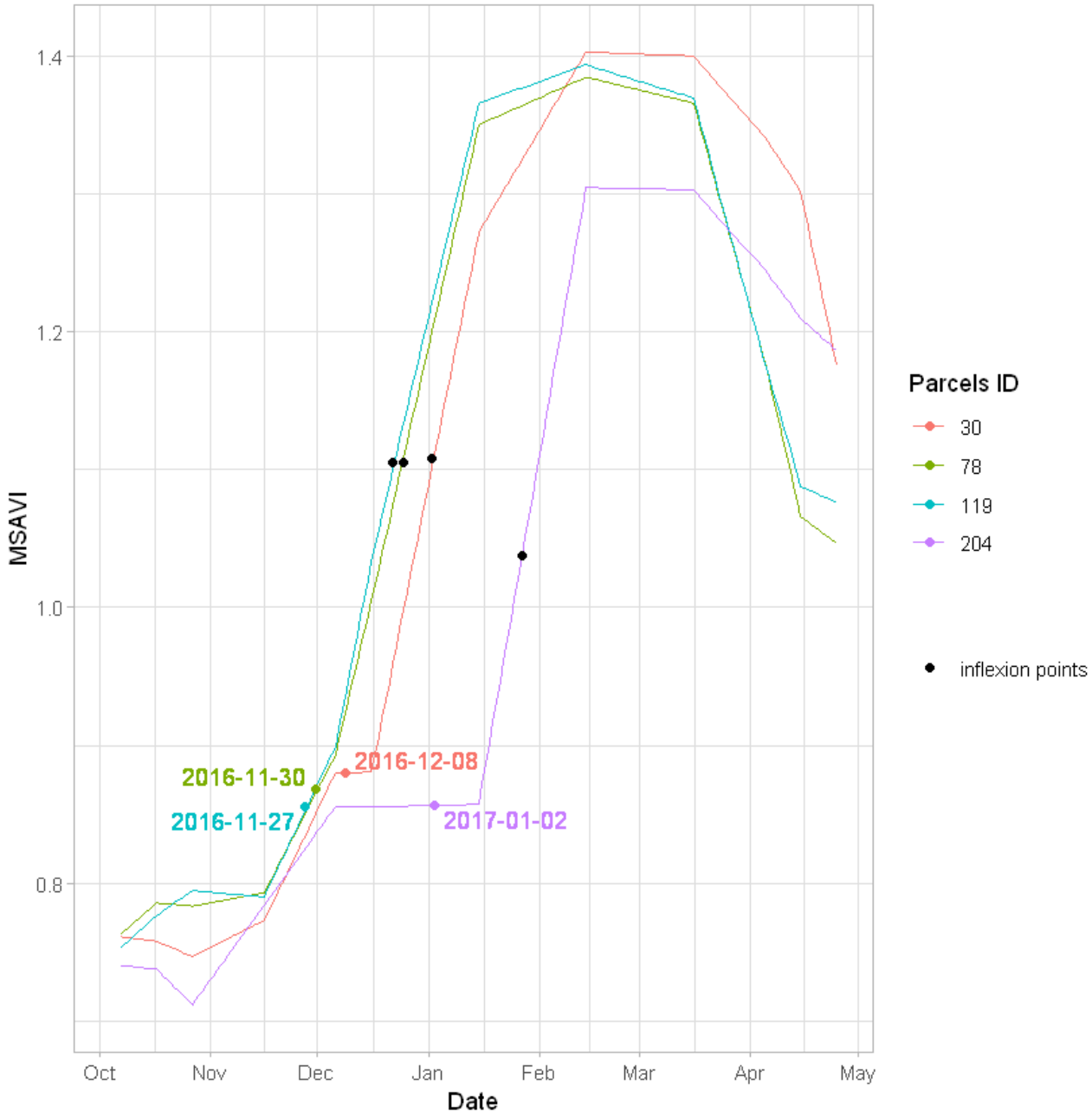
Method:

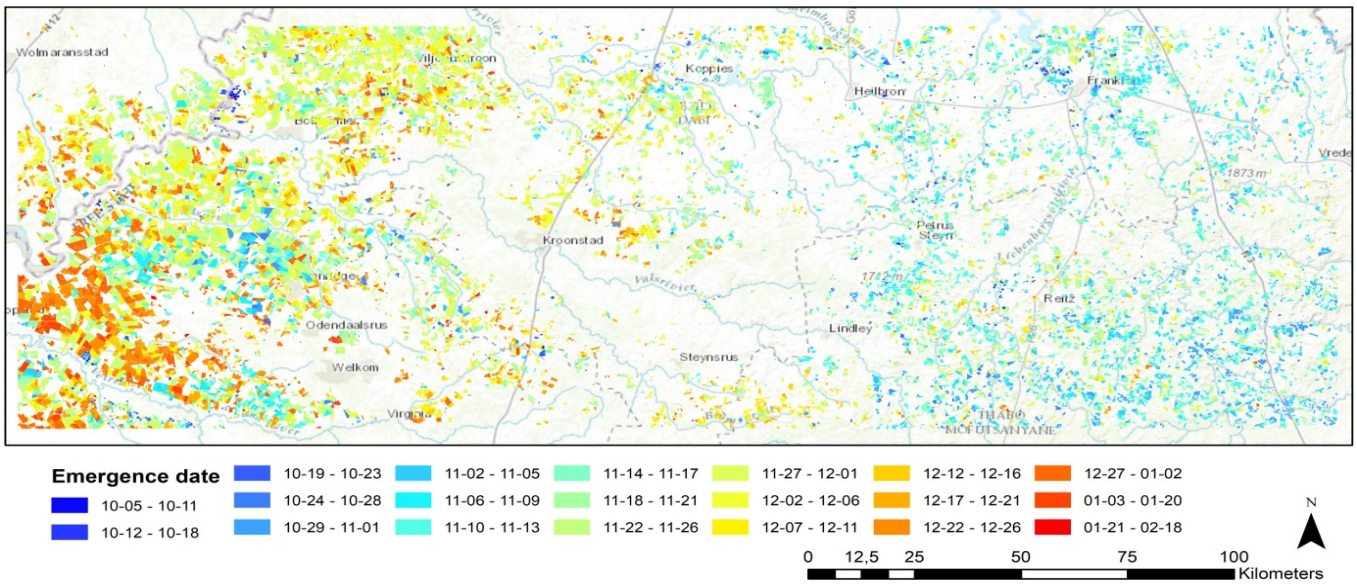
- Fill the missing values in MSAVI time-series for each parcel using linear interpolation.
- Plot the MSAVI time-series for a subset of the parcels.
- Compute the MSAVI value at emergence using a threshold based method.
- Interpolate the time-series to reach the granulometry of one day.
- Infer the date of emergence based on the results of the previous interpolation for all parcels.
- Plot the interpolated time-series as well as the date of emergence for a subset of parcels.
- Append date of emergence to the parcel's shapefile.

3.1 Representation of MSAVI time-series


Mean MSAVI at the parcel
1.4
1.2
1.0
0.8
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Date
Parcel ID
30
78
119
204

3.2 Computation of inflexion point based on MSAVI profiles



Maize emergence date map at field level

Free State, South-Africa (by ARC and UCLouvain)