

Within-field Spatial Heterogeneity of Crop Growth from Multi-year Green Area Index Time Series Analysis

Tom Kenda¹, Céline Champagne¹, Xavier Draye¹, Pierre Defourny¹

¹. Earth and Life Institute, UCLouvain, Belgium – tom.kenda@uclouvain.be

Context

- This study is part of the **PHENET** project, led by INRAE, which aims to **improve plant phenotyping** services.
- Phenotyping capabilities range from small handheld devices to satellite imagery, and the challenge is to **scale up and down** these capabilities.
- Scaling up means moving from controlled microplots and greenhouses to larger fields with **less control over variability** in environmental conditions.

Objective

Characterising the **within-field** spatial and temporal **variability** of environmental conditions affecting **crop growth** to provide a tool to enhance :

- **Phenotyping** in farmer fields
- Precision agriculture

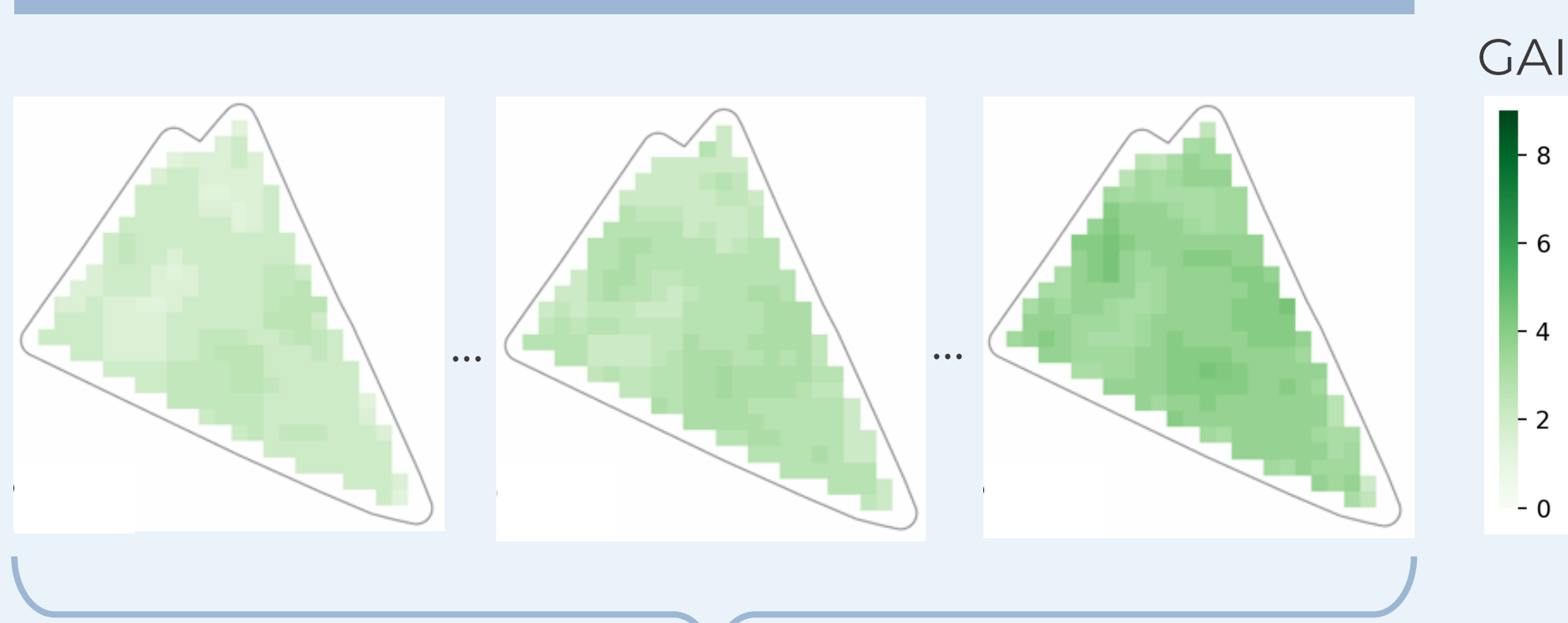
Pixel based synthesis of in-season GAI



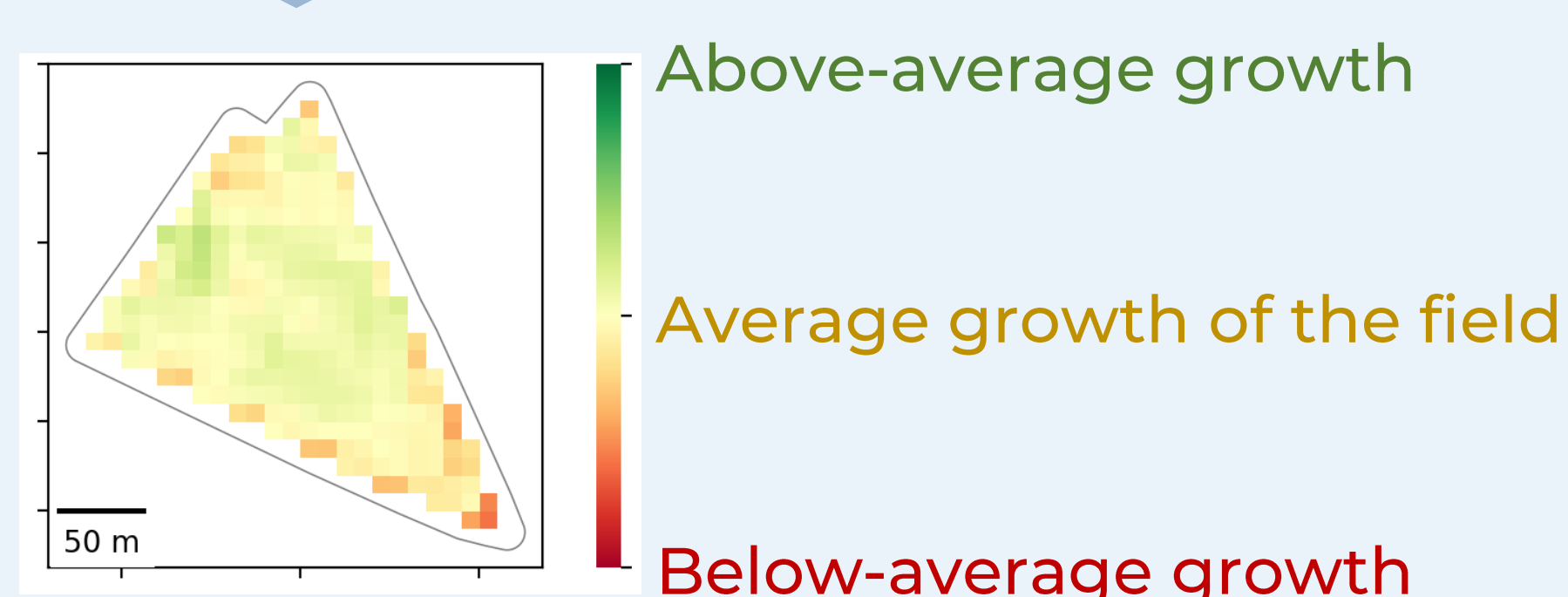
Sentinel-2 MSI time series (10-m res.)

Green Area Index (GAI) retrieval using Sen4Stat open-source system (UCLouvain *et al.* 2021)

Time series smoothing and vegetation growth detection (main crop)

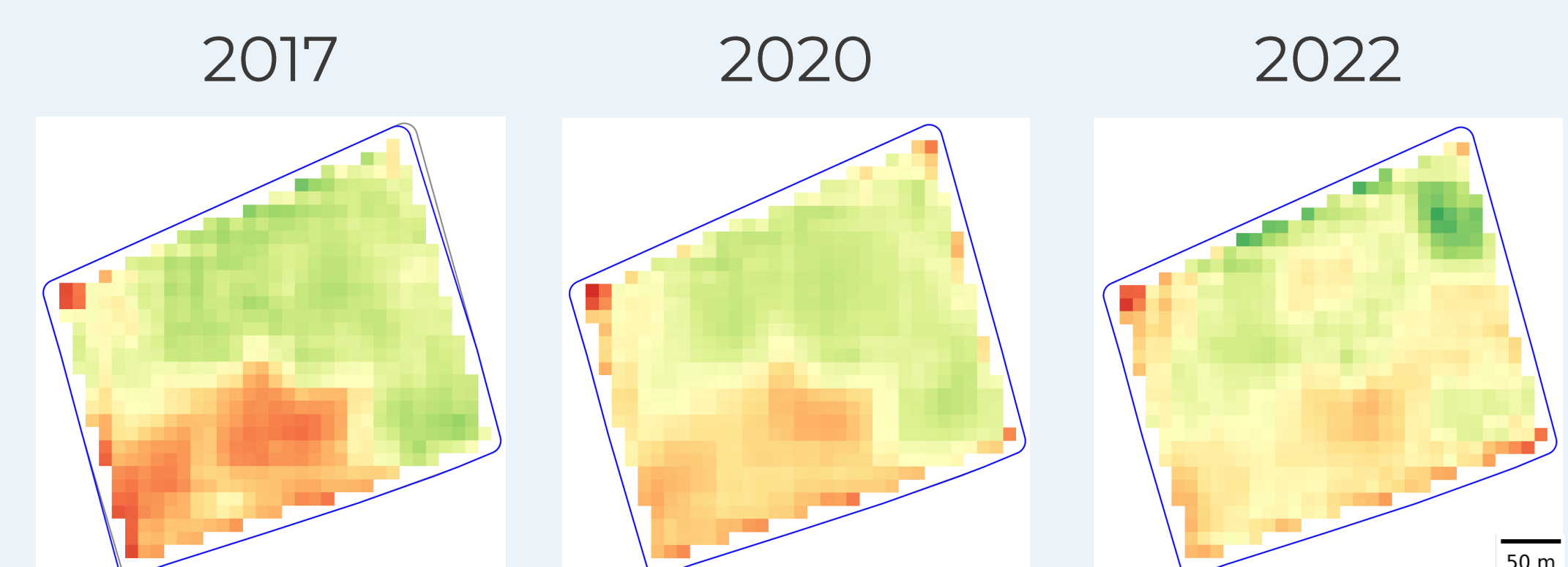


Comparing each pixel to the field average over the vegetation growth



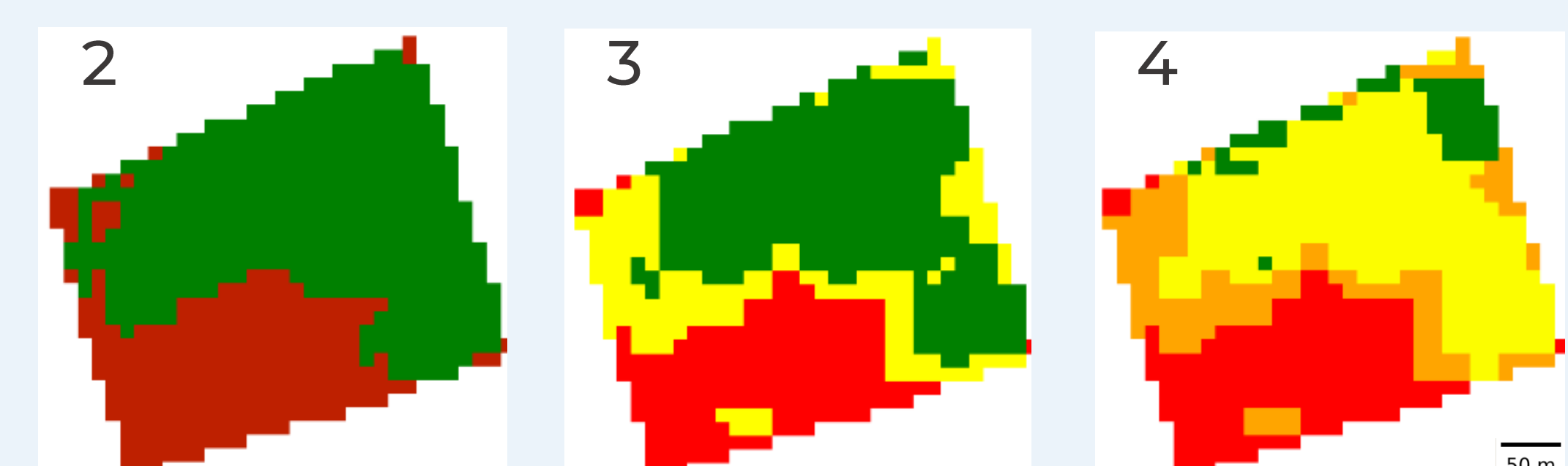
Clustering over several seasons with the same crop reveals structural heterogeneity

Walloon **winter wheat** field over 3 years on a sandy-loam soil (8ha) :



The **number of cluster** can be customized depending on :

- The needs (smart farming, soil sampling, ...)
- The size of the field
- Complexity of environmental conditions



An expert based qualitative validation

- Pixel based heterogeneity maps were evaluated by experienced farmers on their own parcels
- The maps effectively captures both seasonal and structural spatial heterogeneity

Conclusions

- **Promising results** were obtained **to captures the within-field spatial heterogeneity** using a 10m resolution GAI time series
- Heterogeneity patterns can be caused by a large range of **environmental factors**.
- Subdivisions within-field provide opportunities for **soil sampling**, target **in-field phenotyping**, and **precision agriculture**.

References

- UCLouvain, CS GROUP - Romania, CLS, & UPM. (2021). *ESA SEN4STAT SENTINELS FOR AGRICULTURAL STATISTICS* (1.0) [Computer software]. <https://www.esa-sen4stat.org/>