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Agroscope

Monitoring pasture vegetation using satellite remote sensing: which images and workflow?

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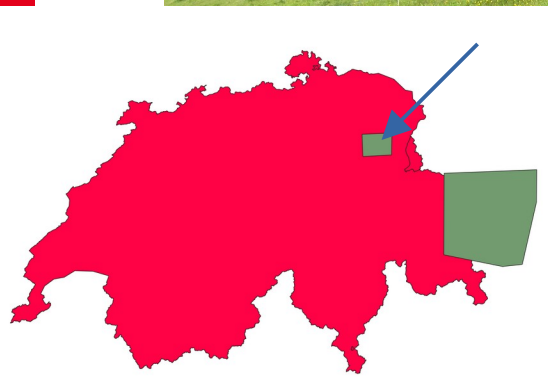
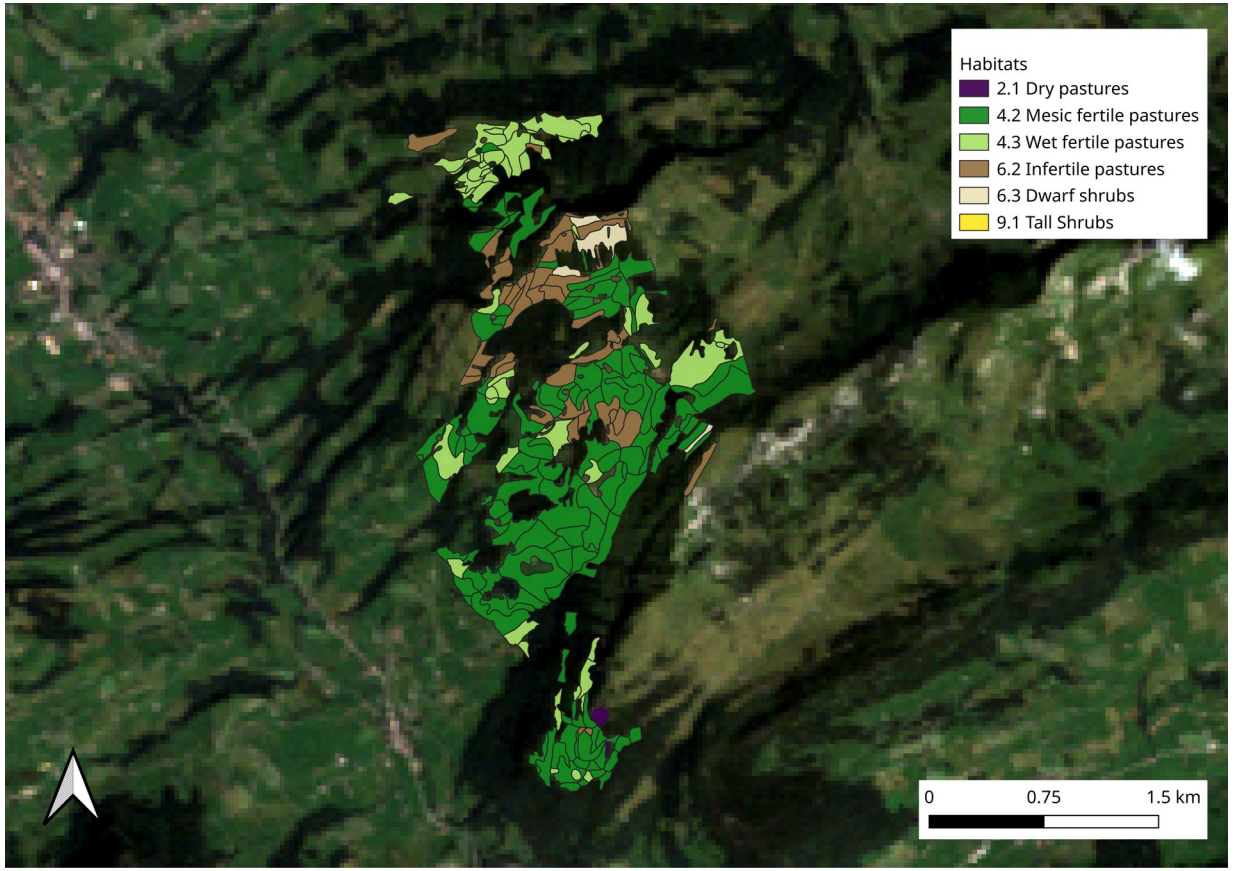
Introduction

- Alpine pastures are composed by different habitats
- Different exploitability and management
- Different phenology
- The **goal** is to develop a monitoring strategy based on Satellite Remote Sensing to:
  - Map different habitat units over time
  - Track the seasonal cycle
  - Use this information to improve pasture management

Introduction: Study zones

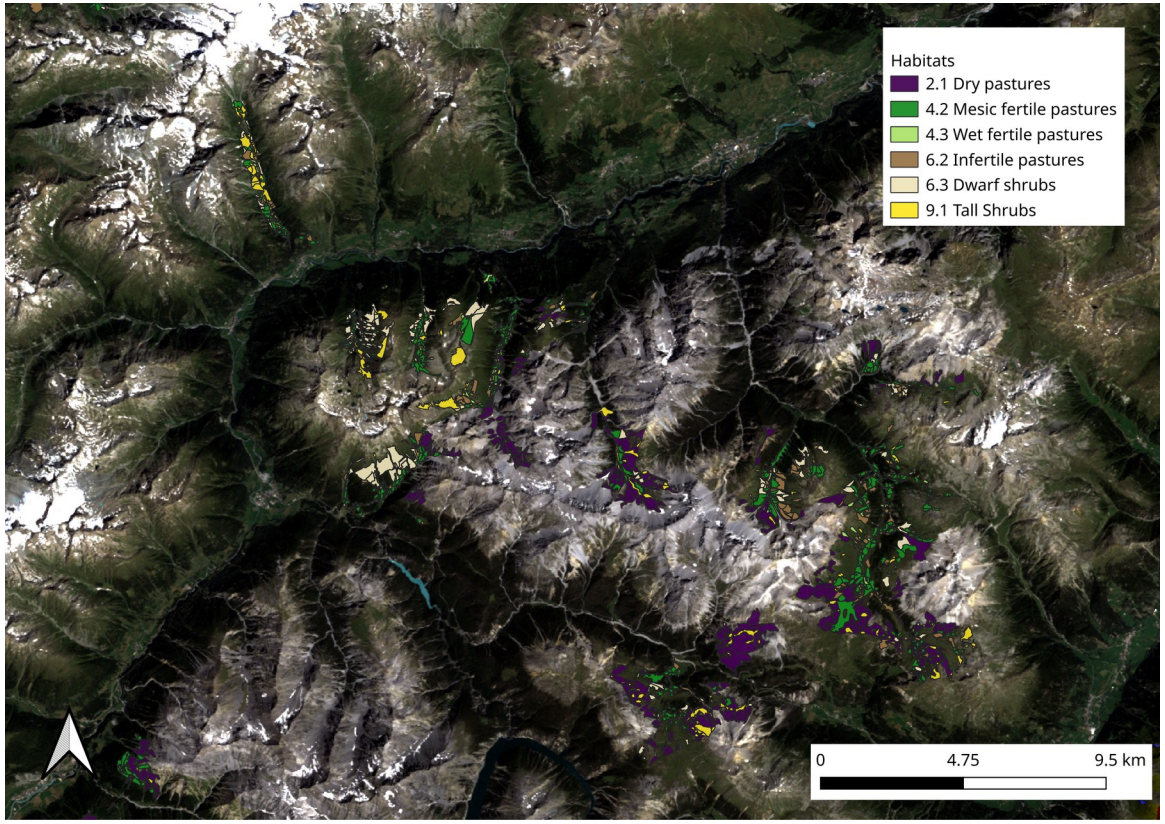
1) **Toggenburg district** (St. Gallen): mid-mountain pastoral environment in the Northern Swiss Pre-Alps. Approx. 10 sq. Km, up to 1500 m a.s.l.

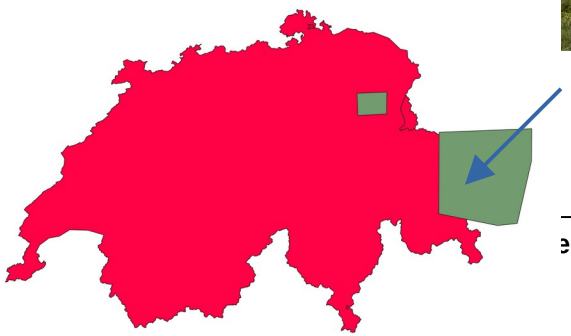




Introduction: Study zones

2) **Swiss National Park** (Grisons): mid-to-high elevation mountain pastures surrounding the park. Approx. 200 sq. Km up to 2500 m a.s.l.





Introduction: Habitats

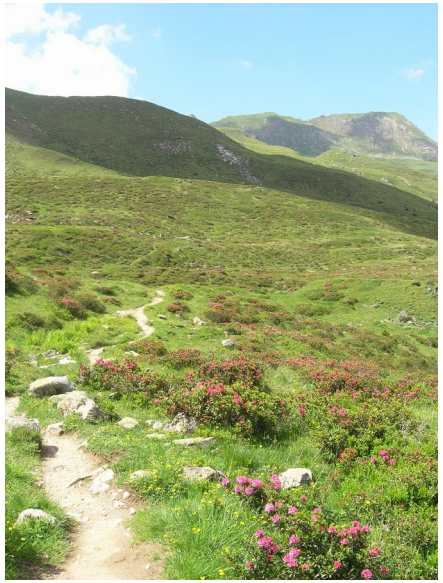
Dry pastures

Mesic fertile pastures

Wet fertile pastures

Introduction: Habitats

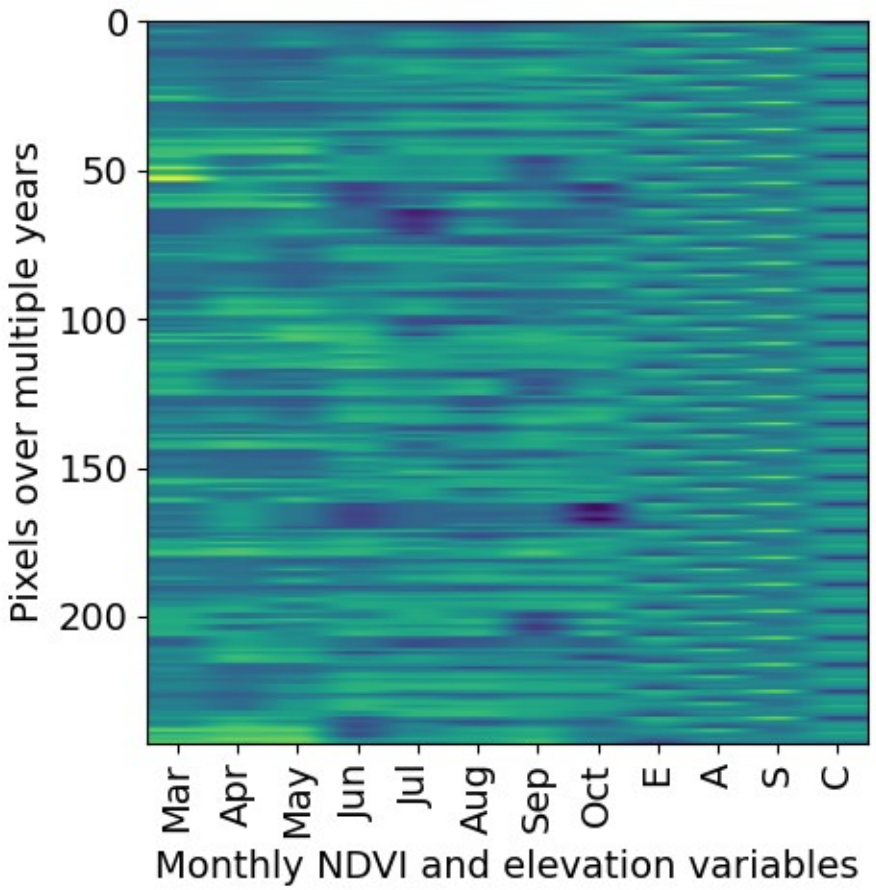
Infertile pastures



Dwarf shrubs

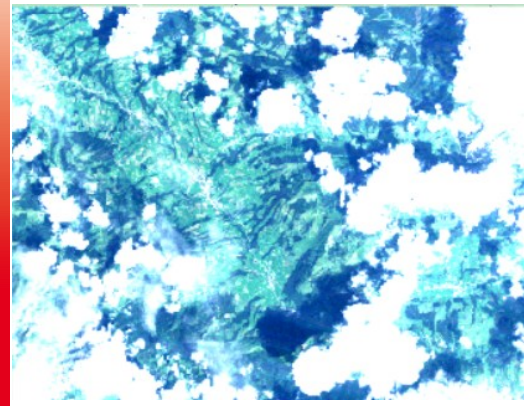
Tall shrubs

A spatiotemporal dataset



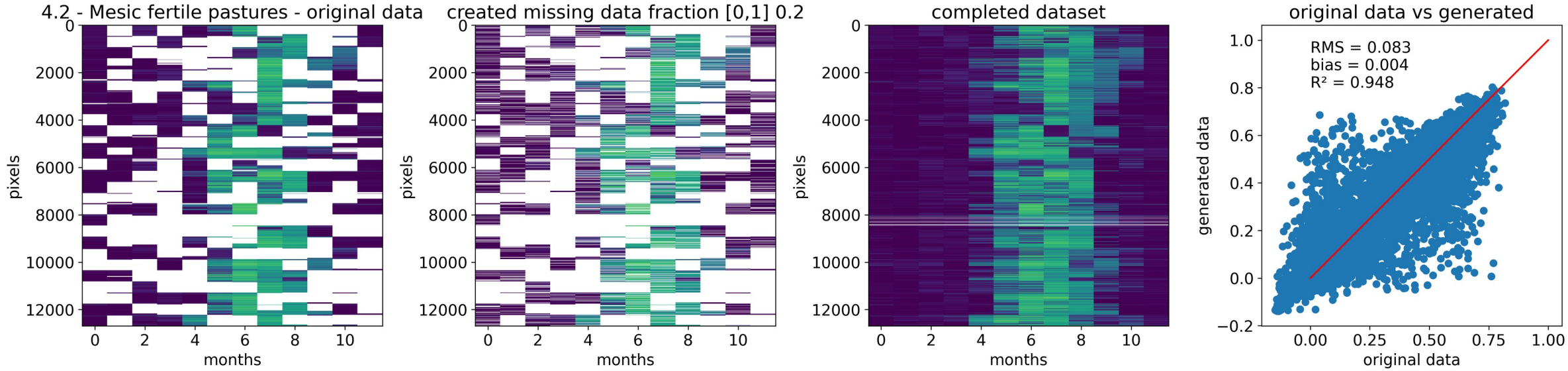
- **Monthly NDVI** from Landsat5 (1984-2013):
  - NDVI = (NIR - Red) / (NIR + Red) → proxy for photosintetic activity
  - 30-m space resolution
  - Best monthly image over 15-day revisit time
- Other satellite options:
  - Sentinel-2 (res. 10-60m 10-day),
  - Planet Labs (commercial res 3-5m subweekly),
- **DEM derived variables** from Swissalti3D:
  - Elevation (E), Aspect (A), Slope (S), Curvature (C)

Challenges of the mountain environment



- Shadow cast by mountains → computation of cast shadow and selection of never-shadowed pixels
- Extensive snow coverage → removal of winter months
- Frequent cloudy days → many data gaps in the satellite images

- **Gapfilling** of the NDVI time series necessary to keep a monthly dataset



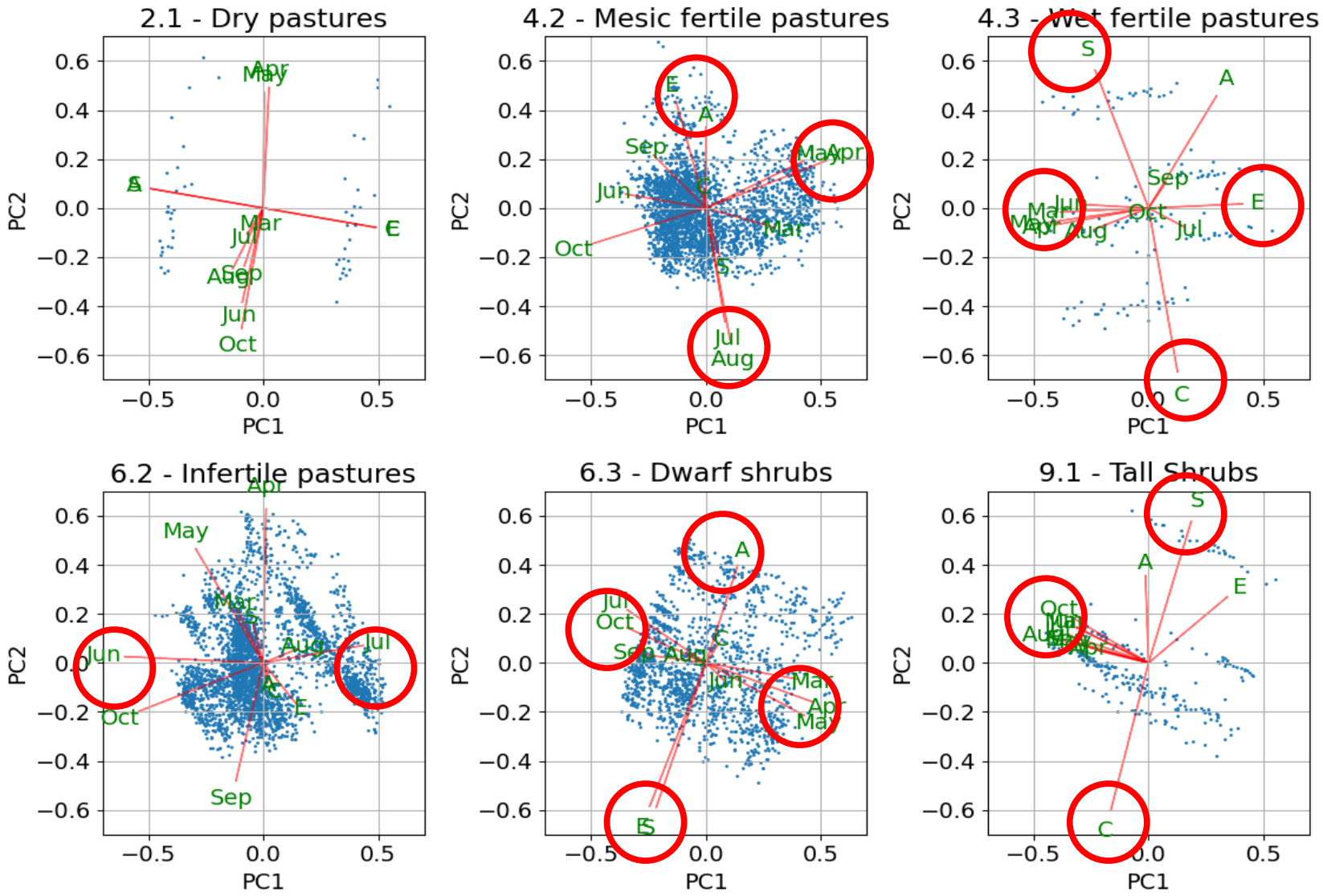
Pattern-based Vector Sampling technique, Oriani et al. 2020 https://doi.org/10.1175/JHM-D-19-0220.1

- **ANALYSIS**: PCA to detect which variables explain the linear variability inside the multivariate dataset:

Site 1: Toggenburg

Input variables for the PCA:

- montly NDVI
- DEM variables

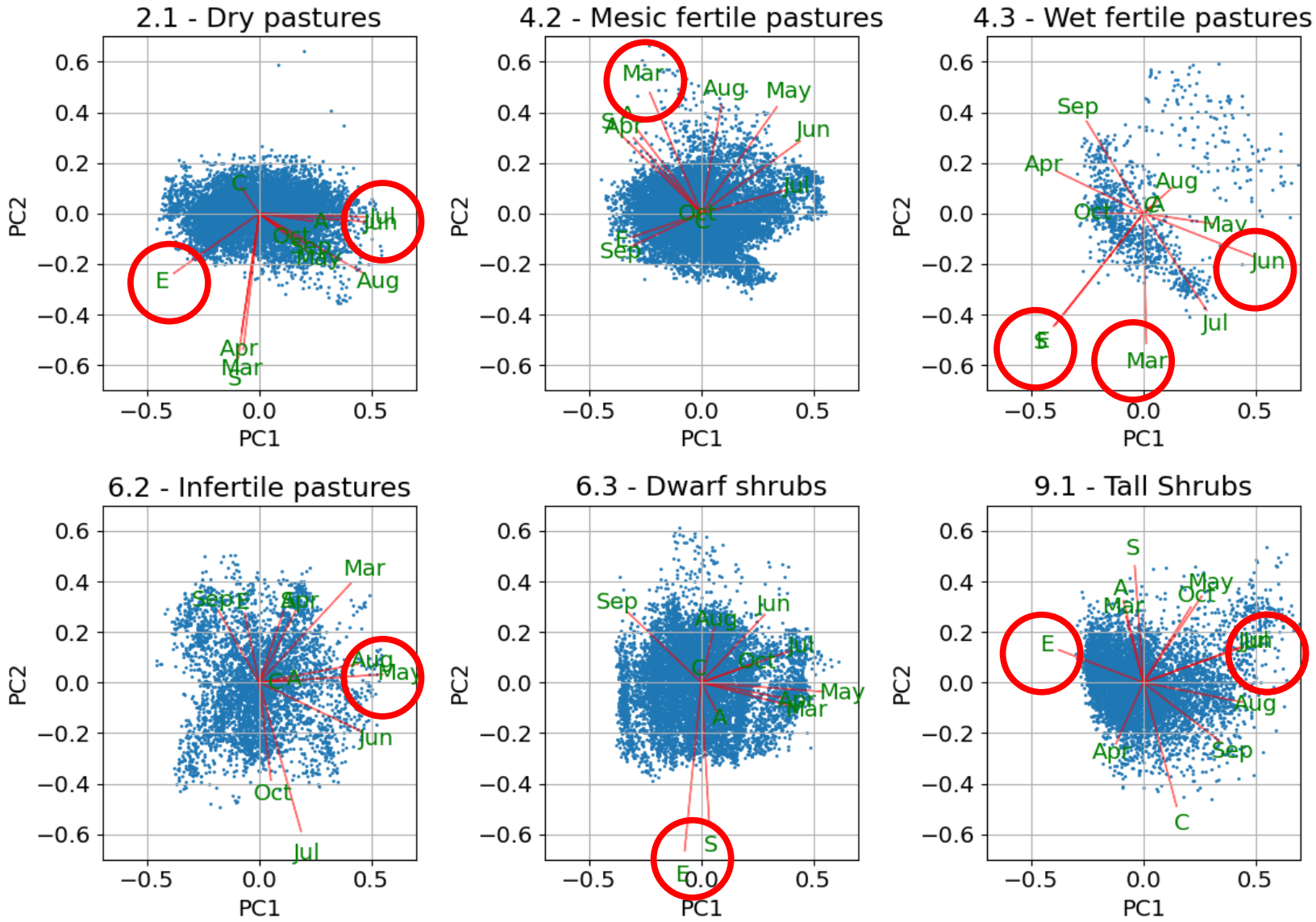


- **ANALYSIS**: PCA to detect which variables explain the linear variability inside the multivariate dataset:

Site 1: National Park

Input variables for the PCA:

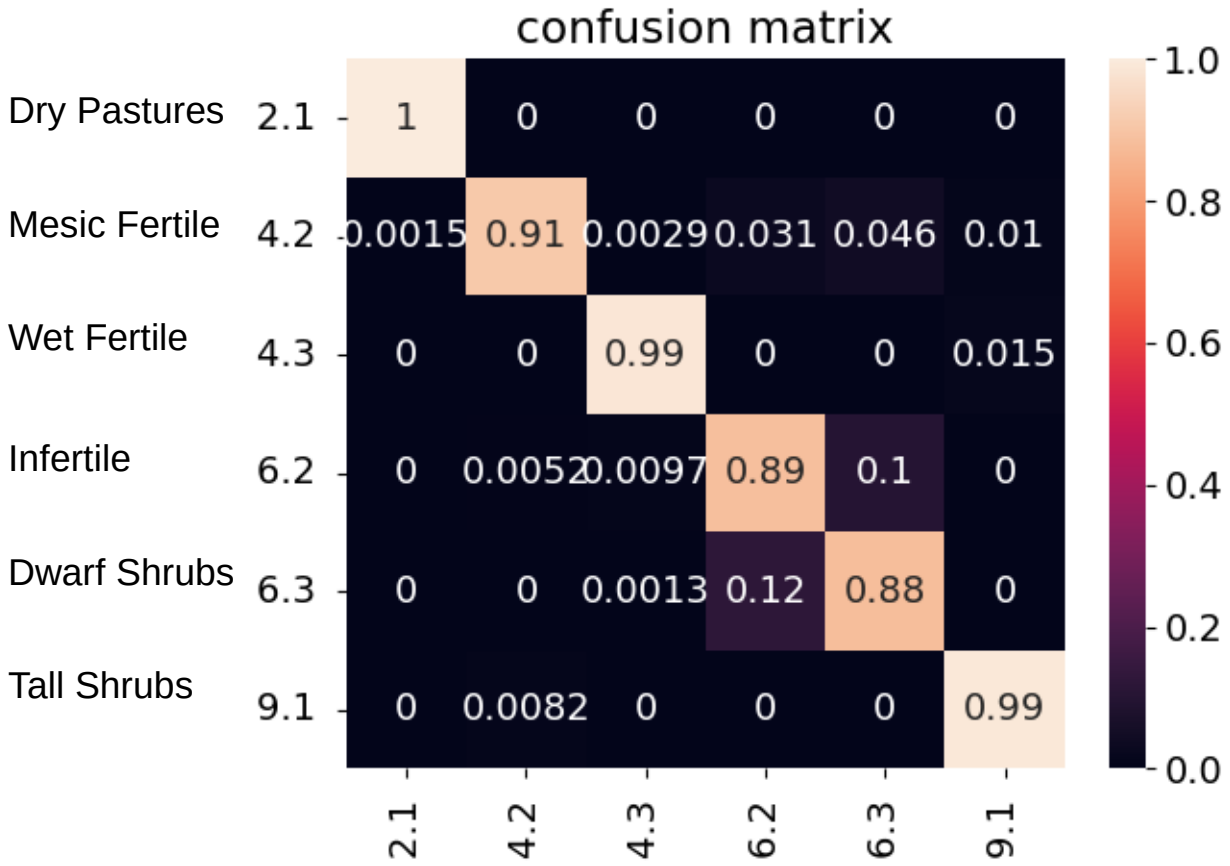
- montly NDVI
- DEM variables

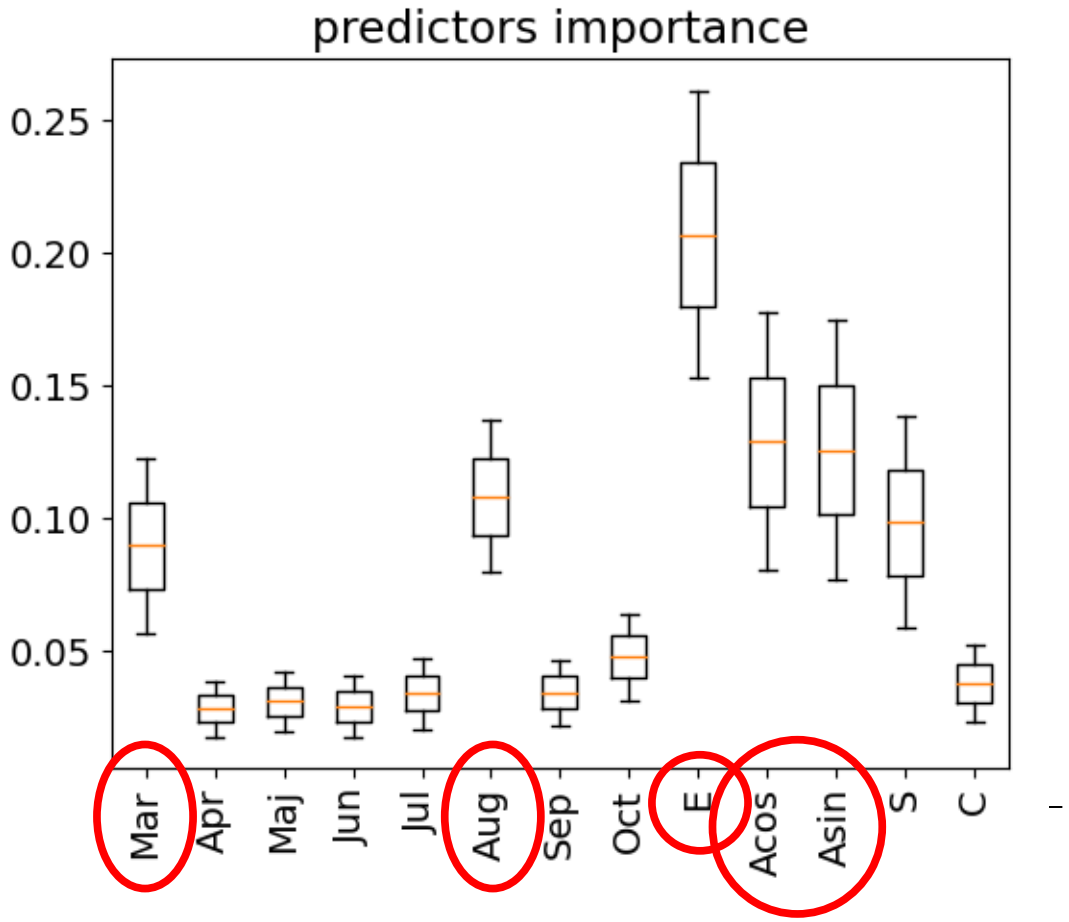


Analysis

- Random Forest classification to test the detectability of the units and the importance of the different predictive variables:

Site 1: Toggenburg





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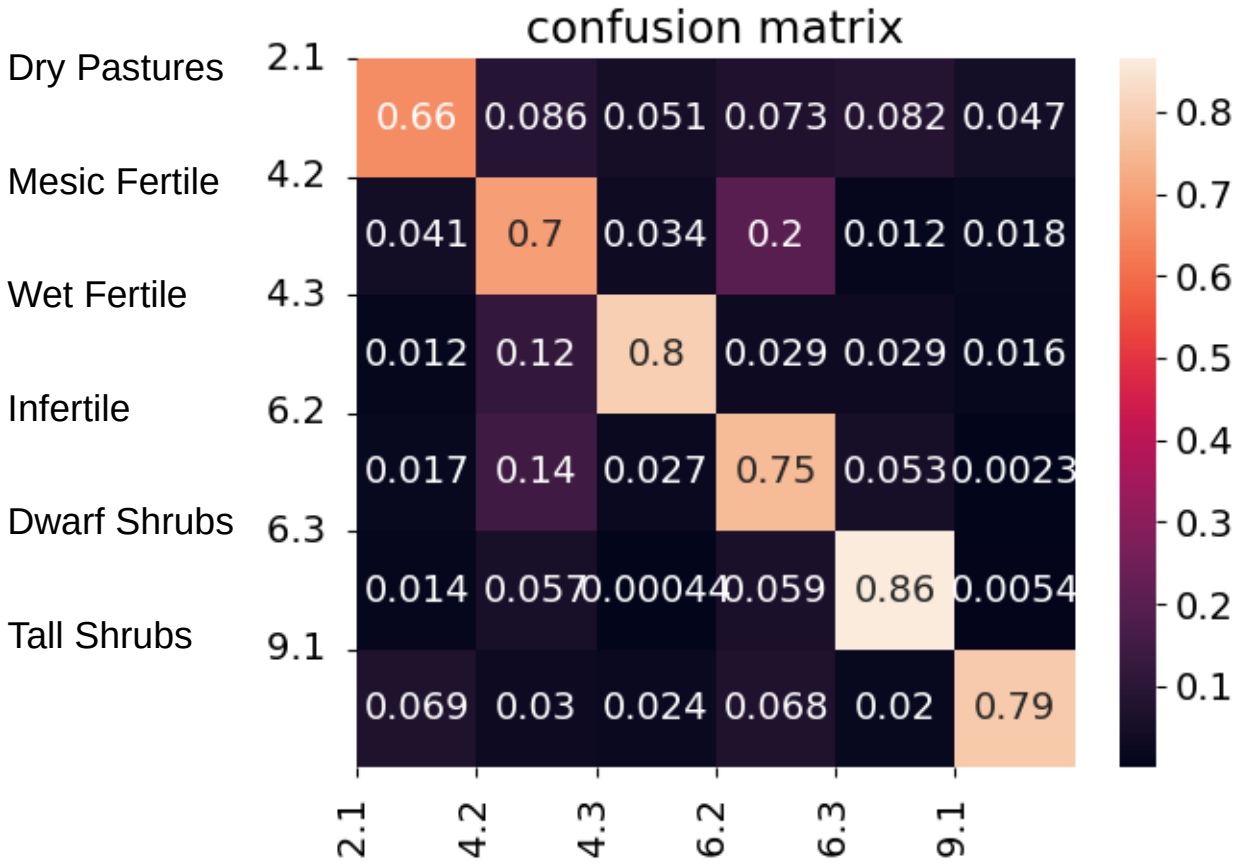

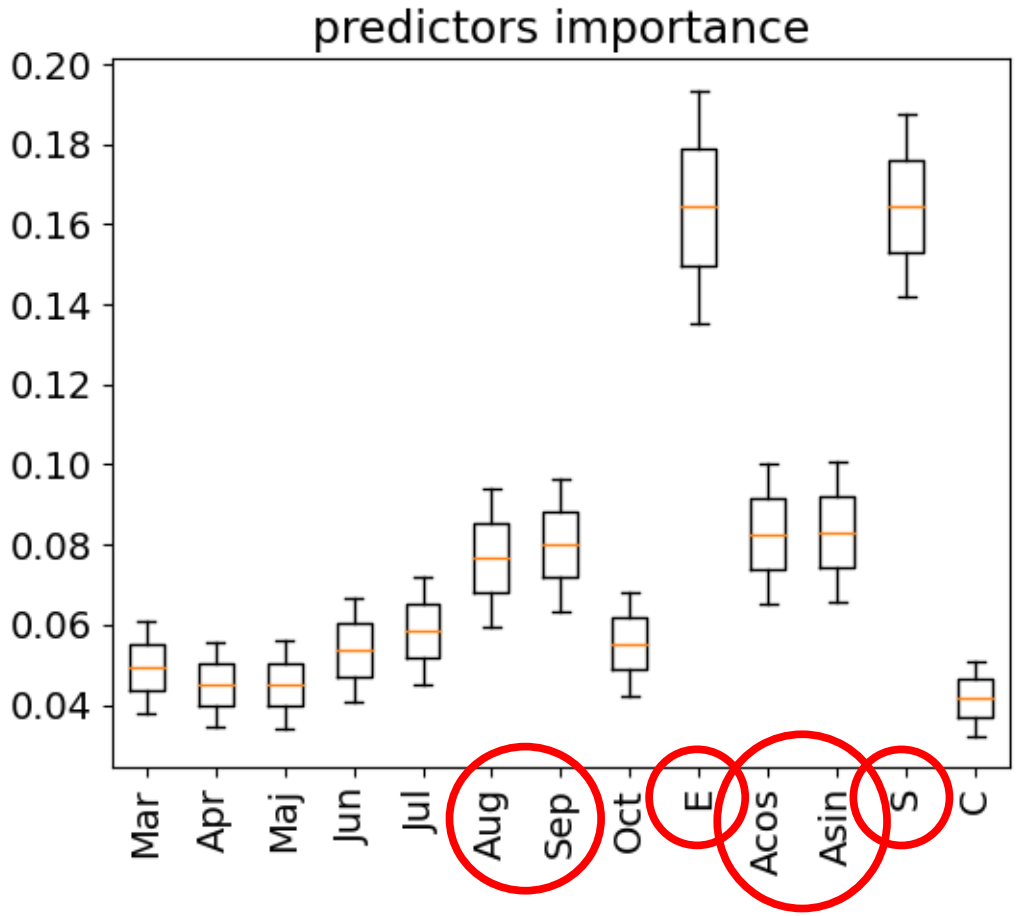

Conclusions

- Analysis based on public Landsat-5 and digital elevation imagery
- Monthly spatiotemporal dataset reconstructed by pattern-based gap filling
- Preliminary linear analysis based on PCA → variability **within habitat** mainly controlled by beginning spring/late summer NDVI and elevation/slope.
- Nonlinear analysis based on Random Forest classification → variability **among habitats** mainly controlled by elevantion/slope and late summer NDVI.

Future outlook:

- Random Forest as a potential approach to **map habitats**, but a robust calibration is needed to avoid overfitting to (topography-controlled) local conditions
- Possible integration with **climatic data**: temperature fields → detection of early greening. (limited spatial resolution)
- **Commercial images** for a higher spatiotemporal resolution

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Thank you for your attention

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