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Efficacy of satellite-based monitoring of dry matter yield per hectare in grassland: A case study in the Upper Rhine Region

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6 funded partners

10 associated partners



1. Background

- Climate change increases drought frequency in Central Europe.
- Grassland-based livestock farming depends on a stable forage supply.
- Copernicus Sentinel-2 provides open-access, high-resolution satellite data.
- Normalized Difference Vegetation Index (NDVI) tracks vegetation greenness



2. Aim



Build a reproducible QGIS workflow for cloud-masked Sentinel-2 NDVI time series (2025).

Describe and develop seasonal patterns and spatial variability across the Upper Rhine Region.

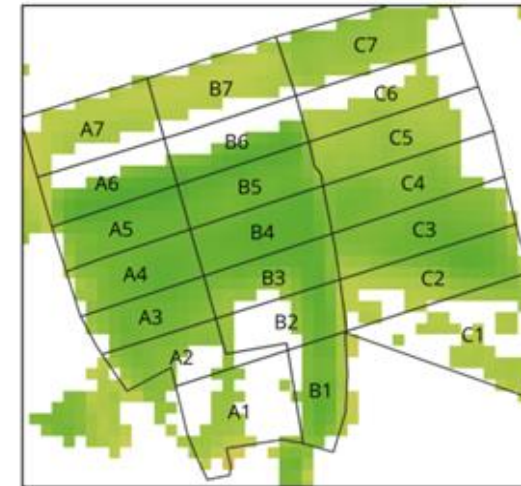
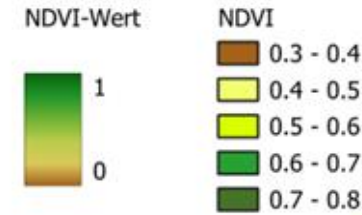
Compare NDVI with weekly dry matter yield/ha from a test farm and evaluate correlations

3. Material & Method

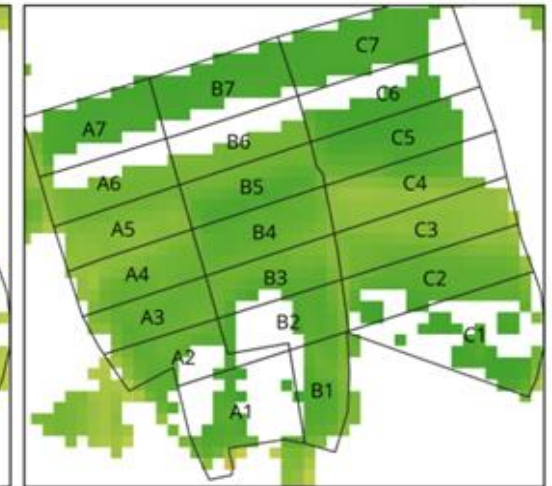
3.1. Data

- Copernicus Sentinel-2 Level-2A (surface reflectance), 2025 growing season
- Copernicus High Resolution Layer
Grassland (mask, 1= grasslands; 0= no grasslands)
- Test farm Anwil: weekly DMY/ha +
paddock polygons + management notes

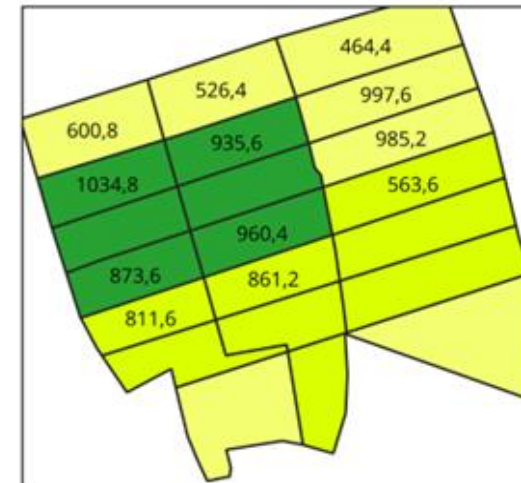
Legend



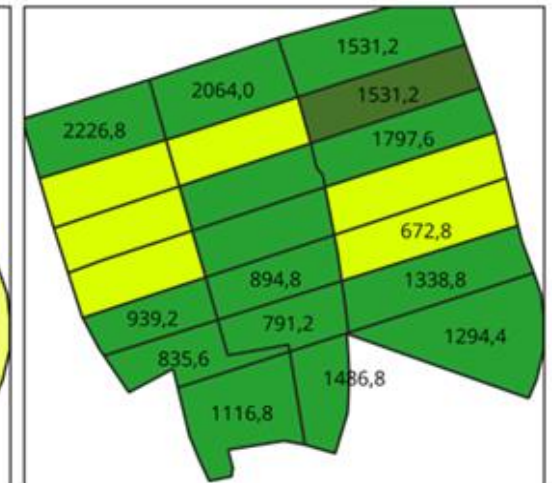
NDVI 02.07.2025



NDVI 20.09.2025



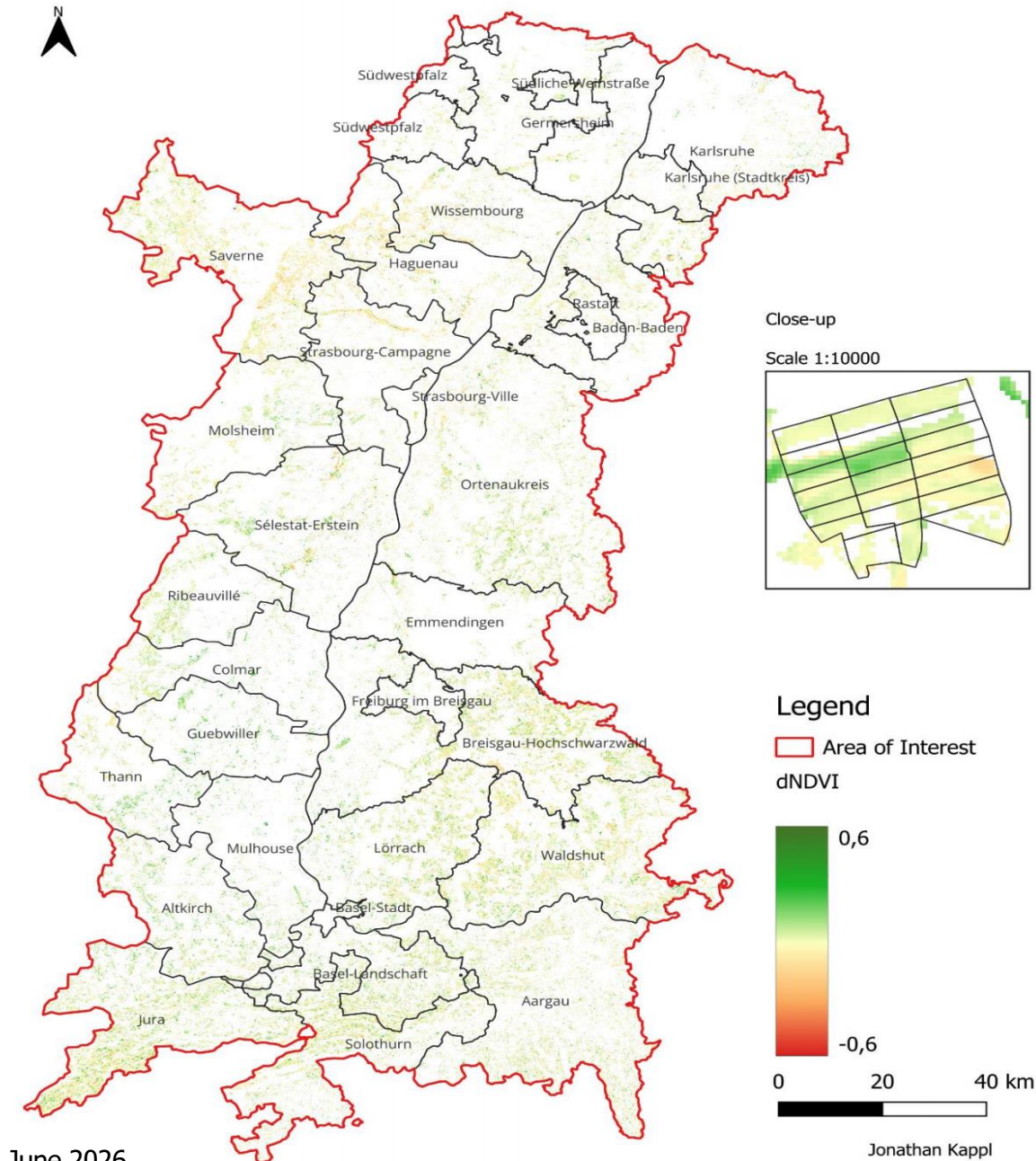
DMY/ha 02.07.2025



DMY/ha 20.09.2025

3.2. Processing (QGIS)

- Cloud and cloud-shadow masking (Scene Classification Layer)
- NDVI calculation; $NDVI = (NIR - RED) / (NIR + RED)$ (near-infrared band, red band; 0=dry, 1=high vegetation density and vitality)
- Mosaic and align tiles; clip to area of interest and grassland mask



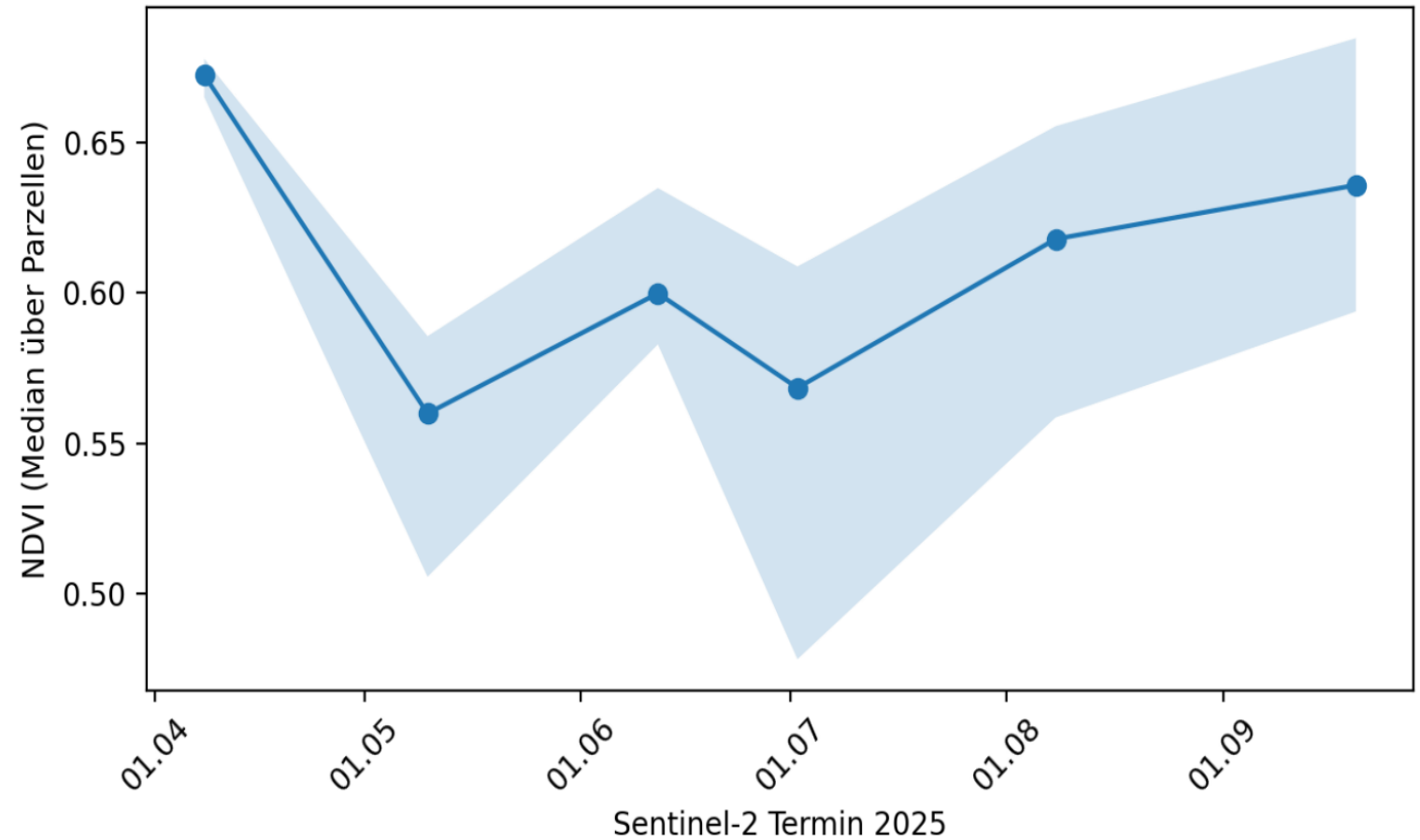
3.3. Zonal statistics & correlation analysis

Sentinel-2 date	Spearman ρ (NDVI vs. dry matter yield)	p-value	n (yield)	Spearman ρ (NDVI vs. grass growth rate)	p-value	n (growth)
08.04.2025	0,20	0,412	19	0,31	0,203	19
10.05.2025	0,53	0,027	17	0,07	0,867	8
12.06.2025	0,40	0,152	14	0,29	0,385	11
02.07.2025	0,47	0,124	12	0,02	0,955	8
08.08.2025	0,74	0,002	14	0,33	0,318	11
20.09.2025	0,81	0,000	14	-0,54	0,057	13

Table 1: Spearman correlations: NDVI DMY and NDVI grass growth rate by date (management cases excluded)

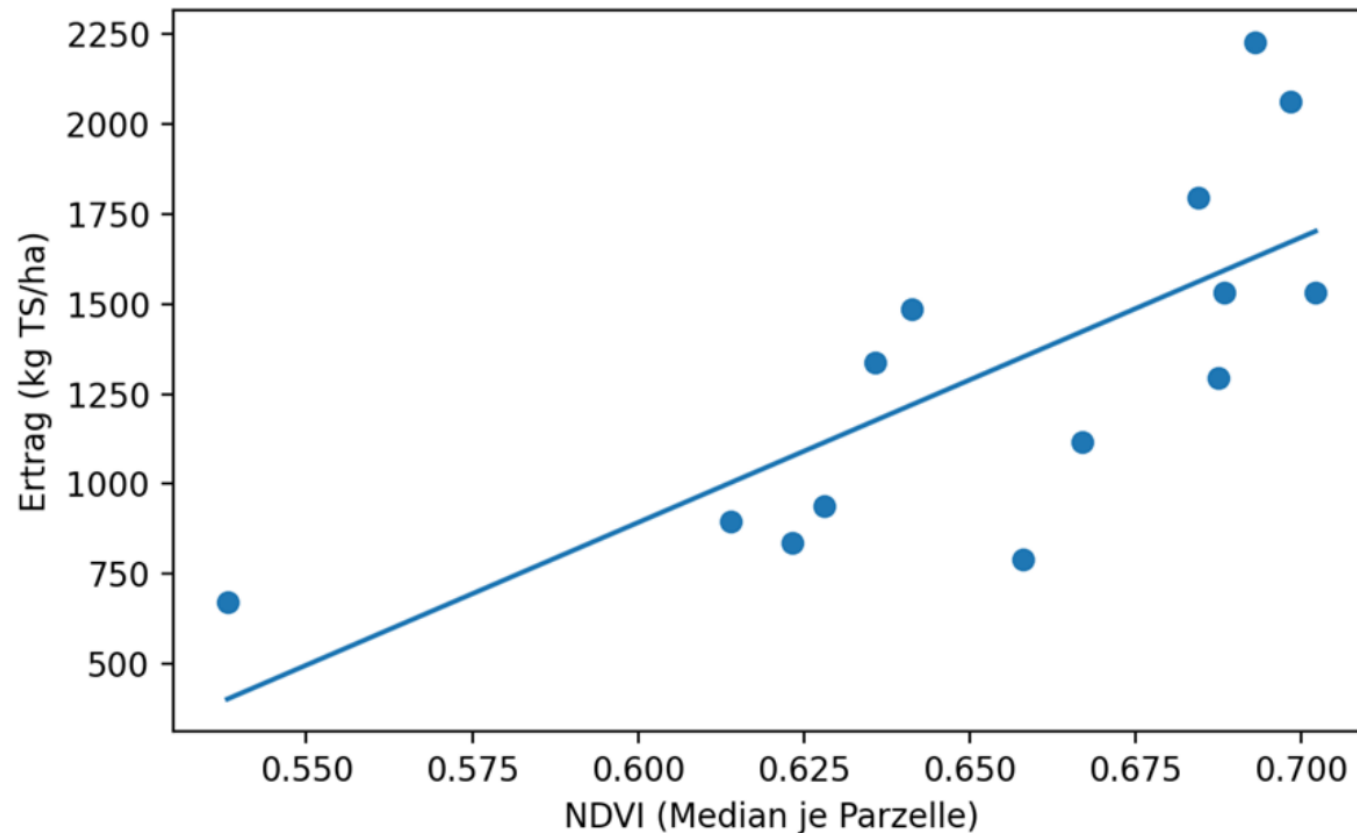
4. Key Findings

- NDVI time series show clear seasonal dynamics; strongest contrasts in summer.
- Cloud cover and small field sizes limit precision in fragmented landscapes.



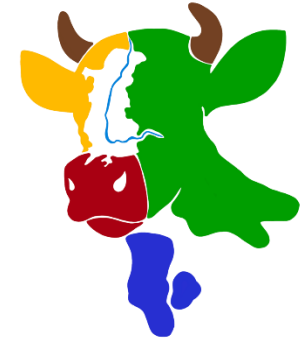
4. Key Findings

20.09.2025 (n=14, r=0.74)



- Cutting/silage changes NDVI and yield relationship → management events must be recorded.
- After filtering/quality correction, NDVI and DMY/ha showed a positive association in the case study (Spearman $r_s \approx 0.74$).
- NDVI supports monitoring, hotspot detection and decision support for grassland management

5. Discussion



- NDVI serves as an indicator for vegetation status, not a direct yield measurement.
- Management (grazing/cutting) and mixed pixels should be accounted for in the statistical framework.
- Combining multi-year satellite records with consistent farm data can strengthen monitoring and early warning

6. Conclusion

- ➡ A QGIS-based workflow can generate robust, cloud-masked NDVI time series for regional grassland monitoring.
- ➡ In the case study, NDVI correlated with DMY/ha when management effects were considered.
- ➡ Next steps: multi-year analysis, improved management-event logging, and integration of additional indicators, e.g. the vegetation condition index (VCI), red and red-edge normalized difference vegetation index (NDVI_{red&RE})

Thank you for your attention!

| Acknowledgements

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