Optical responses on multiple spatial scales for assessing vegetation dynamics - a case study for alpine grasslands

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1. INTRODUCTION

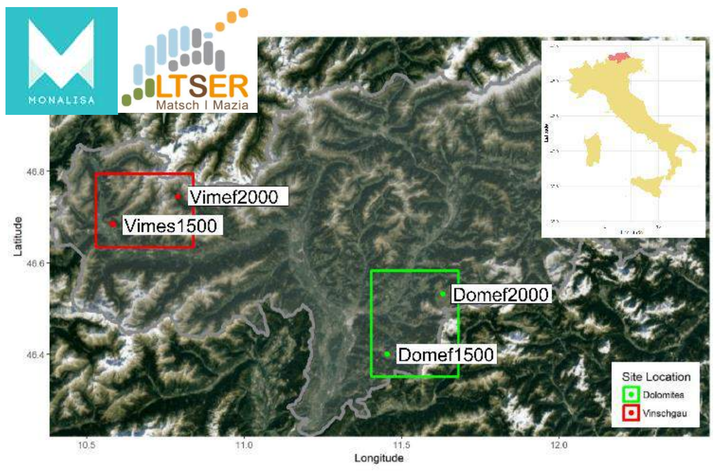
Alpine grasslands are essential for various ecosystem services, but are **heavily managed and exposed to climatic changes**. This results in a higher interest for **continuous and detailed monitoring** of their condition as well as the ongoing management activities throughout the year.

Currently, the **amount of sensors** suitable for continuous measurement of vegetation is constantly increasing. The **combined use of multiple optical sensors** offers huge possibilities stabilizing results by enriching databases or filling gaps.

In this study we aim to analyze **how the Normalized Difference Vegetation Index (NDVI) describes dynamic changes in alpine grasslands** by combining the spectral information from Earth observation with in-situ field sensors (Fig. 1).

Figure 1: NDVI from Sentinel 2 T32TPS Tile, Phenocam Image, Decagon SRS Sensor and Spectroradiometer

2. METHODS



Four different study sites (Fig. 2) are located along the Vinschgau valley and the Dolomites in **South Tyrol, Italy** in 1500 m respectively 2000 m a.s.l. and are part of two sensor networks:

- **MONALISA**
  http://monalisasos.eurac.edu/sos/
- **LTSER**
  http://lter.eurac.edu/

Figure 2: The study site in South Tyrol

Within these sites we collected data of 2017 from four different sensors:

- **Sentinel-2 Multi Spectral Imager (MSI)**
- **Repeated Digital Imagery (Phenocam)**
- **Spectral Reflectance Sensors (Decagon SRS)**
- **Spectroradiometer (SVC HR-1024i)**

For each sensor red and NIR bands were used to generate NDVI time series. We filtered the time series and performed an **exploratory data analysis** based on **linear correlations.** Coefficients from the **linear model were combined with the mean NDVI** before and after an event to analyze changes in the NDVI response.

3. RESULTS

Comparison of Scales:

- **Harvesting** activities are clearly **represented in the NDVI** time series and the Sentinel-2 spatial subsets (Fig.3).
- **Different saturation** of the NDVI signals across sensors (Fig. 3).
- **Linear correlations** between NDVI from spectrometer measurements and other sensors are **dependent of site and sample number**
- Phenocam, Decagon and Sentinel-2 correlate with an **R^2 from 0.38** (Phenocam vs. Sentinel-2) **to 0.85** (Decagon vs. Sentinel-2)

Figure 3: NDVI signatures for each station in 2017 (middle) together with the scaled NDVI derived from Sentinel-2 images during a harvesting event (side)

Preliminary Results:

- A **reference database** of grassland management activities was created by visually interpreting Phenocam images.
- We compared **harvesting activities to sensor-derived information** generated by multiplying the mean NDVI to the slope of the linear model with a moving window of 2 weeks.
- Figure 4 shows that **harvesting activities can be detected** by the multiplication of both slope and mean NDVIs.

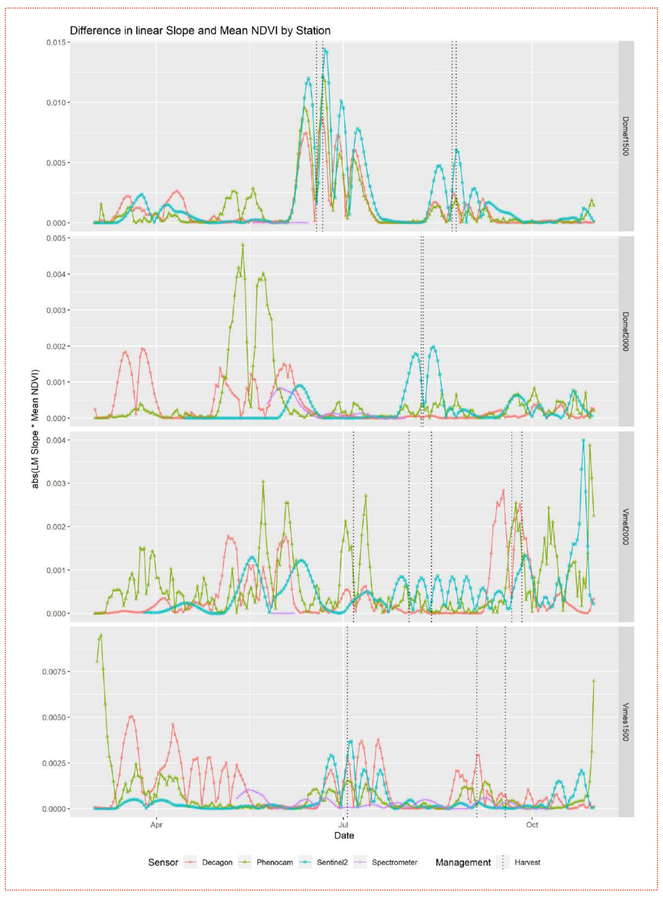


Figure 4: Detection of harvesting activities by combining the slope of the linear model to the mean NDVI value

4. CONCLUSION

- Linear correlations indicate that **NDVIs from different spatial scales are comparable.**
- NDVI comparison is **hampered by temporal mismatches**.
- NDVI spectra have **different saturation phases.**
- **Filtering is needed** to get comparable sensor specific time series.
- Including the slope of the linear model and mean NDVI values **increases the detection rate of harvesting activities** although the signals differ among scales.

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