Estimating the Plant Area Index and Phytomass of Mountain Grasslands from Multi-spectral Reflectance

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Background The plant area index (PAI) and phytomass (PM) are crucial input parameters for models which simulate the mass and energy exchange between ecosystems and the atmosphere. Aim of the present study was to estimate the plant area index and phytomass of mountain grasslands from multi-spectral measurements of radiation reflected from the plant canopies.

Methods Multi-spectral (400-1100 nm) reflectance measurements were made in 2006 with a portable spectroradiometer at 4 grasslands in Tyrol/Austria (Fig. 1). The investigated grasslands are mown 2-3 times per year (Fig. 2). Various reflectance indices were calculated and related to PAI and PM measurements (Fig. 3). The PAI and PM were measured concurrently with reflectance, using destructive optical methods and harvesting, respectively.

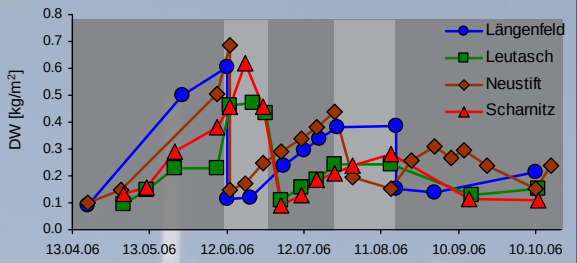

Figure 2 Dry weight (DW) of above-ground phytomasse at the four grassland sites. The shaded areas indicate the period of mowing.

Results The investigated grasslands were cut 2-3 time per year, resulting in a very dynamic canopy development, the PAI reaching values of up to 7 m^2 m^{-2} and PM up to 700 g m^{-2} (Fig. 2). For the PAI, all of the calculated reflectance indices (SR, NDVI, EVI, PRI) saturated at values of about 2-3 m^2 m^{-2}, preventing higher PAIs to be estimated with confidence (Fig. 3). In contrast, most of the investigated indices were linearly related to PM (Fig. 3). These relationships, however, usually possessed little predictive power (Fig. 3). Ground-based NDVI values compared poorly with the MODIS NDVI (250 m), which is thought to result from interference of non-grassland ecosystems surrounding the study sites (data not shown).

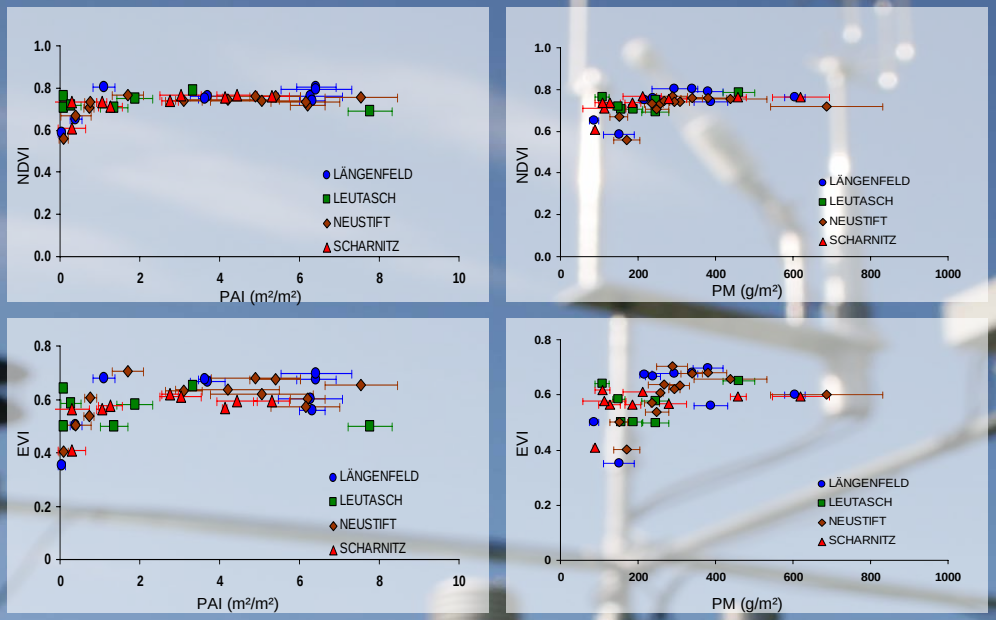

Figure3 Relation between the measured plant area index (PAI) and phytomass (PM) and NDVI and EVI. NDVI: (NIR-RED)/(NIR+RED); EVI: (NIR-RED)/(NIR+6*RED+7.5*BLUE+1)*2.5.

Figure 1 Location of study sites in Tyrol, Austria.

Conclusion Estimating PAI and/or PM of mountain grasslands by means of currently available vegetation indices derived from multi-spectral reflectance measurements remains a difficult task. This is due to fact that managed mountain grasslands exhibit high PAI and PM, as well as that many vegetation indices exhibit early signs of saturation. In order to reliably estimate PAI/PM from multi-spectral reflectance measurements novel vegetation indices are required – first attempts based on the near- and middle-infrared regions yield promising results.

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