

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

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Background The plant area index (PAI) is a crucial input parameter for models which simulate the mass and energy exchange between ecosystems and the atmosphere, as it provides a measure of above-ground plant material. PAI is defined as half the total area of all above-ground plant material per unit ground surface area.

Aim of the present study was to estimate the plant area index of mountain grasslands from multi-spectral measurements of radiation reflected from the plant canopies. Deriving PAI from spectral data can facilitate PAI measurements and allow PAI estimates on larger scale by using e.g. remotely sensed data.

Methods Multi-spectral (400-1100 nm) reflectance measurements were made in 2006 with a portable spectroradiometer at four grassland sites in Tyrol/Austria (Fig. 1). The investigated grasslands are cut 2-3 times per year (Fig. 2). Various reflectance indices were calculated and related to PAI on-site measurements (Fig. 3). The plant area index (PAI) was measured concurrently with reflectance, using destructive harvesting and optical methods.

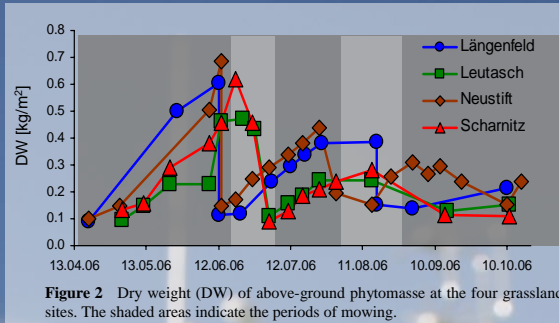


Figure 2 Dry weight (DW) of above-ground phytomass at the four grassland sites. The shaded areas indicate the periods of mowing.

Results The investigated grasslands showed a very dynamic canopy development, the PAI and the phytomass reaching values of up to 7 m² m⁻² and 0.7 kg m⁻² (Fig. 3).

The multi-spectral reflectance measurements were able to capture these seasonal dynamics only poorly, as most of the calculated reflectance indices saturated at PAIs of around 3 m² m⁻² at all sites (Fig. 3).

These results indicate that the current vegetation indices derived from multi-spectral reflectance measurements are inappropriate to estimate plant area index (PAI) of mountain grasslands.

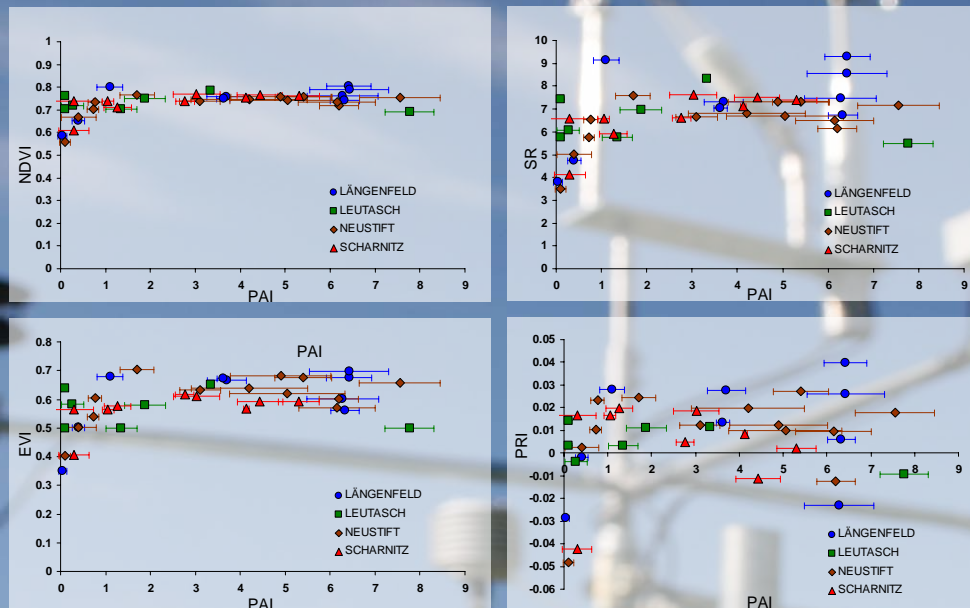


Figure 1 Location of study sites in Tyrol, Austria.

Figure 3 Relationship between the measured plant area index (PAI) and vegetation indices NDVI, SR, EVI, PRI.
 NDVI: Normalized Difference Vegetation Index $(NIR-RED)/(NIR+RED)$;
 SR: Simple Ratio (NIR/RED) ;
 EVI: Enhanced Vegetation Index $(NIR-RED)/(NIR+6*RED+7.5*BLUE+1)*2.5$;
 PRI: Photochemical Reflectance Index $(R531-R570)/(R531+R570)$