FIELD HYPERSPECTRAL TECHNIQUES FOR EVALUATING THE PHONOLOGICAL CHANGES AND BIOPHYSICAL CONDITION OF FOREST OF KARKONOSZE MOUNTAINS AND BESKID ŻYWIECKI

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Forest health and the spatial and temporal distribution of forest biochemical and biophysical variables are an important issue of efficient forest monitoring. Remote sensing, particularly hyperspectral, has proven to be a promising tool to provide this information. Field hyperspectral data allows to obtain very precise information relating to vegetation condition. Due to many narrow ranges of the electromagnetic spectrum, it is possible to get detailed information on plant physiology (e.g. pigments content, water content, light use efficiency).

The aim of the study was to gain and compare spectral properties and biophysical parameters of forests of M&B UNESCO Karkonosze Mountain Reserve and Beskid Żywiecki mountain range in southern Poland. Measurements from different stages of the phenological phases were used in this study. In the 2014 field campaign, data was collected on 12 research polygons in May, June and August. The study focused on two dominant forest species: spruce (*Picea abies*) and beech (*Fagus sylvatica*).

Values of spectral reflectance were collected, using ASD FieldSpec 3 spectrometer (spectral range is 350 –2500 nm) with the Plant Probe and the Leaf Clip. Biophysical parameter were: Chlorophyll Index, Flavonol Index, Anthocyanin Index and Nitrogen Balance Index (NBI) measured using DUALEX SCIENTIFIC+TM tool, fluorescence of chlorophyll (Fv/F0, and Fv/Fm) measured with the OS1ppr and the thermodynamic air temperature (ta) and radiometric temperature of vegetation (ts) using IRTEC MINIRAY.

In addition to spectral properties, the spectra have enabled the calculations of a wide range of remote sensing vegetation indices, which were divided into followings groups: Broadband Greenness (e.g. NDVI,ARVI), Narrowband Greenness (e.g.NDVI705, VOG1), Leaf

Pigments (e.g. CRI1, ARI1), Light Use Efficiency (e.g. PRI, SIPI), Canopy Nitrogen (NDNI), Dry or Senescent Carbon (e.g. NDLI,PSRI) and Canopy Water Content (e.g. WBI, MSI). Pivotally, a vegetation index aims to define a simple relationship between the reflectance measured by a sensor in particular wavelengths and the parameter directly characterizing a plant or a vegetation stand. In the study indices were compared with biometrical measurements, using the Pearson and Spearman correlation. Spectral characteristics as well as vegetation indices were analyzed with the ANOVA statistical test to detect any significant changes over the growing season.

The studies have provided the information on the general condition of selected forest communities and the assessment of the phenological changes and biophysical state of forests in Karkonosze Mountains and Beskid Żywiecki. The general results can be outlined as follows: spectral signatures of each research polygon for both research areas were characteristic for plants in good condition; the qualitative and quantitative analysis of photosynthetic pigments showed significant differences between analyzed species; some of remote sensing groups of indicators reached significantly different values in particular periods of growing season (e.g. Narrowband Greenness, Canopy Water Content); the correlation between the indicators and biophysical parameters was disparate for each species.