

USE OF HIGH-RESOLUTION OPTICAL SATELLITE IMAGES FOR ANALYZING FOREST BIODIVERSITY AND VULNERABILITY TO VARIABLE CLIMATIC CONDITIONS

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ABSTRACT

The main objective of the presented work was to evaluate applicability of high-resolution optical satellite images for analyzing biodiversity of various forest ecosystems and to study impact of changeable climatic conditions, e.g. drought appearance on forest condition. In order to cover in the study various forest ecosystems three forest areas located in northeastern Poland, which differ in species composition and in climatic impact, were selected – Białowieża Forest, Knyszynska Forest and Borecka Forest. Three types of high-resolution satellite data were used for the analysis: Landsat 5 TM, Landsat 8 OLI and SPOT 5 images. The images were acquired for three vegetation seasons – 2006, 2014 and 2015, which were characterized by different climatic conditions, as expressed by meteorological data – air temperature and precipitation. The methodical approach was based on analyzing various satellite-based vegetation indices, which can characterize complementary aspects of forest condition, structure and species composition. The analysis has been done in a temporal profile covering vegetation period; it was combined with study of the changes of meteorological parameters, in order to find possible relationships. Three forest characteristics were considered in the study: tree species, types of forest site and stand mixture (coniferous vs. deciduous).

The results of the research work enabled to draw conclusions, that some dedicated satellite-based indices, which are sensitive to water stress in plants – Disease Water Stress Index (DSWI) and Normalized Difference Infrared Index (NDII) are efficient in differentiating forest ecosystem and characterizing its condition. In particular, DSWI index enables to make discrimination between two types of conifers – pine and spruce – and between some deciduous species at the early stage of growing season. The index is also influenced by type of forest site – coniferous forests located on dry sites tend to have lower DSWI values than those situated on fresh and humid sites. In case of deciduous forests stands located on fresh sites have higher DSWI values than those situated on humid sites. Also stand mixture has impact on DSWI values – mixing of conifers with hardwoods makes index increase, while deciduous stands mixed with conifers reveal DSWI decrease.

Analysis of relations between changes of vegetation indices within vegetation period and meteorological characteristics describing drought conditions revealed, that long drought periods, which appeared in 2015, have influence on satellite-based indices, decreasing more

their values than in normal year. Disease Water Stress Index (DSWI) was especially sensitive to drought appearance. It was also found that coniferous forest stands located on dry forest sites are more resistant to drought impact than those situated on humid and fresh sites.

The conclusions on applicability of vegetation indices derived from high-resolution satellite data for forest monitoring were supported with the results of analysis of vegetation parameters measured in the course of ground campaigns: pigment content, fluorescence level and spectral characteristics obtained with the use of hyperspectral instrument.

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