STUDIES OF IMPACT OF CHANGEABLE CLIMATIC CONDITIONS ON FOREST DEVELOPMENT USING REMOTE SENSING DATA FROM VARIOUS ACQUISITION LEVELS

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ABSTRACT

The goal of the presented work was to assess usefulness of remotely sensed data derived from various acquisition levels for studies of impact of changeable climatic conditions on forest development. In order to cover in the study various forest ecosystems five forest areas located in southern and northeastern Poland, which differ in species composition and in climatic impact, were selected – Bialowieska Forest, Knyszynska Forest, Borecka Forest, Beskid Żywiecki forests and Karkonosze Forests. Three forest characteristics were considered in the study: tree species, types of forest site and stand mixture (coniferous vs. deciduous). The methodical approach was based on analyzing various remote sensing based vegetation indices, which can characterize complementary aspects of forest parameters. The analysis has been done in a temporal profile covering vegetation period; it was combined with the study of the changes of meteorological parameters, in order to find possible relationships. Three levels of data acquisition were used: terrestrial measurements using hyperspectral data and other instruments; high resolution data from Landsat 5 TM, Landsat 8 OLI and SPOT 5 satellites and low resolution data from NOAA AVHRR. All levels of data acquisition are characterized by various spectral, spatial and temporal resolutions. Terrestrial measurements are characterized by very high spectral resolution but very low spatial and temporal sampling. The high resolution data are characterized by much worse spectral resolution and spatial resolution from 10 to 30 meters. The temporal resolution of satellite data (from 5 to 16 days) is strongly limited by meteorological conditions. The low resolution data have very low spatial resolution of 1 km and the poorest spectral resolution but the highest, one-day temporal resolution which in many cases gives possibility to overcome the problem of meteorological conditions.

The analysis performed during the studies shows that terrestrial hyperspectral measurements due to the very high spectral resolution gave the best possibility to find relationships between spectral RS indices and forest condition, however due to the limited sampling in space and time they can be used only as a reference for satellite-based methods. The analysis performed using high resolution data shows that changes of RS vegetation indices in forests during the vegetation period can be related to the changes of forest conditions due to the variation of climatic conditions, especially drought conditions, however this relationship varies for various

types of forest sites, stand mixture and tree species. Additionally, values of RS indices are strongly modified by stand mixtures and species composition. It means that the RS method for study of impact of climate variation on forest condition has to be based on the detailed map of types of forest sites and forest mixture and on such high resolution data which gave the possibility to analyze the temporal variation of vegetation indices separately for each class of forests. Due to this, low resolution RS data are not adequate for this purpose in Polish forests in a temperate zone, as only very small number of 1 km pixels can be found which are characterized by homogeneous type of forest and forest mixture. This type of data can show only the variability of vegetation growth at the onset of growing season due to climatic conditions at the end of winter / beginning of spring. The biggest limitation of high resolution data for study of impact of changeable climate on forest condition lies in a quite poor temporal resolution of data strongly limited by meteorological conditions. The use of Sentinel-2A and 2B data could be the best possible way to overcome this problem.

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