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Detection of forest disturbance using UAV multispectral imagery

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This study presents a new methodology for assessment of the spatial and qualitative aspects of forest disturbance at high spatial and spectral resolution based on coupling the use of multispectral imaging sensor with the UAV photogrammetry. The aim of this study was to test a workflow enabling the detection and classification of different stages of forest disturbance and its progress at the level of individual trees. The study area is located in the Sumava Mountains, Central Europe, affected by repeated and extensive bark beetle (Ips typographus [L.]) outbreaks, resulting from windstorms that repeatedly damaged the large areas of the montane forests. After two decades since the initial disturbance, an extensive forest decay but also a rapid regeneration of forest vegetation with an increasing diversity of species is occurring.

We have used the multirotor imaging platform MikroKopter OctoXL coupled with the miniaturized multispectral sensor Tetracam MicroMCA 6, delivering six-band multispectral imagery with high spatial resolution. The multispectral imagery was radiometrically corrected (noise, vignette and nonuniform quantum efficiency reduction) based on an investigation of camera radiometric properties in laboratory combined with vicarious atmospheric correction using modified empirical line approach. The radiometric accuracy of the multispectral images was compared with field measurements using a calibrated handheld spectrometer. The image enhancement phase included computed selected vegetation indices as support to original spectral bands for image classification to detect forest disturbance status on the stand. We have identified three indices, suitable for a distinct identification of the different forest disturbance categories in the conditions of a highly heterogeneous mixture of forest status categories - the Normalized Difference Vegetation Index, Simple Ratio 800/650 Pigment specific simple ratio B1 and Red-edge Index. The advanced classification techniques (Support Vector Machines, Random Forest) were used for classification of the spatial distribution of the detected qualitative categories of the forest quality status.

The results proved that the miniaturized multispectral sensors coupled with UAV platforms enable much more detailed insight into the mechanism and dynamics of the forest disturbance, compared to the conventional remote sensing data products with high potential for applications in nature conservation and forest management.