MONITORING OF BARK BEETLE INFESTATION USING MULTITEMPORAL REGRESSION IN SPECTRAL TIME SERIES ACQUIRED BY UAV

Krausková Dominika[1], Žižlavská Nikola[1], Patočka Zdeněk[1], Martinek Petr[2], Žid Tomáš[2], Čermák Petr[2]

[1] Department of Forest Management and Applied Geoinformatics, Faculty of Forestry and Wood Technology, Mendel University in Brno, dominika.krauskova@mendelu.cz

[2] Department of Forest Protection and Wildlife Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, petr.martinek@mendelu.cz

INTRODUCTION

Permanent monitoring, early identification, and harvesting of affected trees are essential in forest protection. Remote sensing data are useful for detecting and monitoring areas infested by bark beetles [1], as they provide global, spatially continuous, and periodic data on vegetation condition [2]. Remote sensing data can also contribute to reduce costs associated with field campaigns. Early warning systems are needed to curb the spread as well as to help foresters know the factors facilitating bark beetle attack. The effects of bark beetle on leaf properties affect reflectance in the near-infrared (NIR) and shortwave infrared (SWIR) spectral domains (i.e., 730–1370 nm) [3]. Approaches based on multi-temporal spectral indices have proven to be the most effective to detect bark beetle effects at the green attack phase [4].

METHODOLOGY

In the first two years of the project, two localities (Proklest at University Forest Enterprise Křtiny and Deblín – Municipal Forests Brno) were captured repeatedly using an unmanned aerial vehicle equipped with multispectral camera (Figure 1). Data were collected every two weeks during the growing season and includes a ground investigation of tree defoliation using the ICP Forest methodology (Figure 2).

Figure 1 Unmanned aerial vehicle eBee SenseFly plus

Figure 2 Ground investigation

A normalized differential vegetation index (NDVI) and a normalized differential red edge index (NDRE) were calculated from each dataset for a given time point. In the created canopy height model, individual trees were identified, and mean values of vegetation indices were calculated (Figure 3). Since the values of vegetation indices differ during the vegetation period, a theoretical spectral model of tree behavior will be created using multitemporal regression [4], where the vegetation index at the beginning of the vegetation period represents the explanatory variable and other time points represent the response variable.

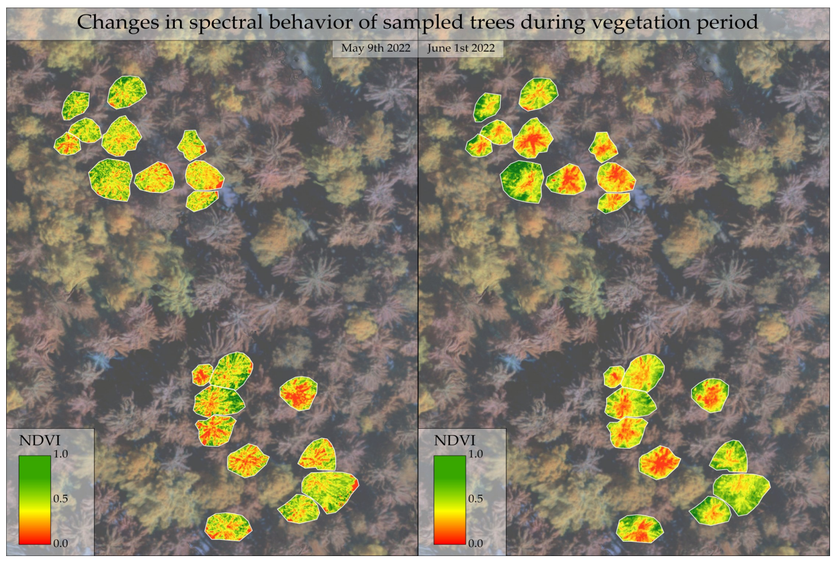

Figure 3 Normalized Difference Vegetation Index (NDVI) - changes in spectral behavior of sampled trees

Trees that show significant residual values will be the infested ones. The goal will be to find out at what moment the infected trees can be detected first (ideally in the green phase attack phase). Bitemporal regression models were constructed for the health status analysis, where the vegetation index (VI) from the beginning of growing season is used as the independent variable and VI during the growing season is used as the dependent variable (Figure 4). It is assumed, that residuals of these models will then represent infested trees.

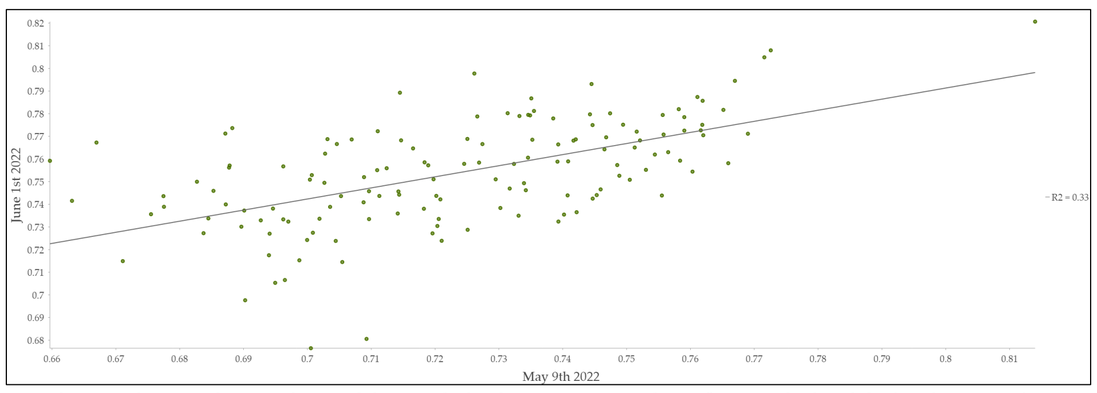

Figure 4 Bitemporal regression model—correlation between mean values of NDVI calculated during the vegetation period for sampled trees

Within the project, an article - ***Evaluating Recent and Future Climatic Suitability for the Cultivation of Norway Spruce in the Czech Republic in Comparison with Observed Tree Cover Loss between 2001 and 2020*** *- has already been published.*

References

1. Hall, R.J.; Castilla, G.; White, J.C.; Cooke, B.J.; Skakun, R.S. Remote sensing of forest pest damage: A review and lessons learned from a Canadian perspective. Can. Entomol. 2016, 148, S296–S356

2. Trumbore, S.; Brando, P.; Hartmann, H. Forest health and global change. Science 2015, 349, 814–818

3. Abdullah, H.; Skidmore, A.K.; Darvishzadeh, R.; Heurich, M. Sentinel-2 accurately maps green-attack stage of European spruce bark beetle (Ips typographus, L.) compared with Landsat-8. Remote Sens. Ecol. Conserv. 2019, 5, 87–106

4. Fernandez-Carrillo, A.; Patočka, Z.; Dobrovolný, L.; Franco-Nieto, A.; Revilla-Romero, B. Monitoring Bark Beetle Forest Damage in Central Europe. A Remote Sensing Approach Validated with Field Data. Remote Sens. 2020, 12, 3634.

https://www.ldf.mendelu.cz

ACKNOWLEDGEMENT

This research was supported and funded by Internal Grant Agency MENDELU within the project IGA LDF_TP_2021002 (Identification of forest damage using unmanned aerial vehicles)

MENDELU Faculty of Forestry and Wood Technology