FROM THE SKY TO THE CANOPY

A NEWER APPROACH TO PEST MONITORING IN SERBIAN FORESTRY

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ANNUAL MEETING OF REUFIS
Digital solutions for better forest health monitoring in Europe and Central Asia
Sopron, Hungary, 26-28 June 2023

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- Use of small unmanned aerial vehicles equipped with RGB and multispectral sensors are a fast and easy tool for acquiring the high amount of precise information which can be used for assessment of health status of vegetation, identification, and geolocation of the problematic areas.
- This kind of high-resolution imaging provided high levels of details, in 2D and 3D color-coded multispectral vegetation indices.

- Every surface, alive or dead, has certain spectral properties that are represented in certain spectral reflectance. Reflectance is a measure of how much energy a certain surface reflects at a specific wavelength
- Stress such as dehydration, pest or fungal infestation, or stress caused by a pathogen leads to degradation of the spongy layers of the leaves.
- This further causes absorption instead of reflectance of NIR (Near-Infrared) light.
- At the same time reflectance of Red light increases. This affects the numerical values of NDVI (Normalized Difference Vegetation Index) to become low.
- This is a fairly good indicator of stress in plants.
- The relationship between NIR and Red Edge levels of reflectance gives more information about the whole plant instead of the top levels of the canopy.

- In recent years, a new approach to health monitoring has been adopted in the forests of Serbia, using an unmanned aerial system (UAS) DJI Phantom 4 Pro, equipped with an integrated 20-megapixel RGB sensor and a narrow-band multispectral MicaSense RedEdge M sensor.

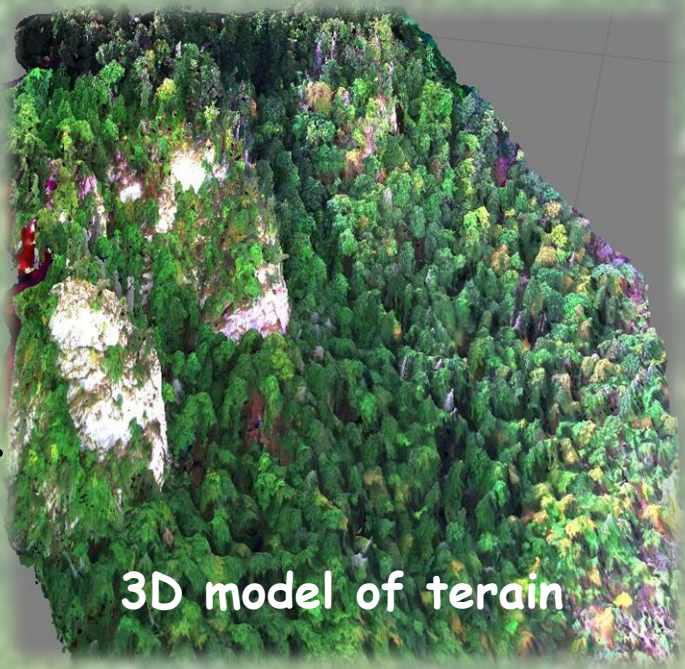
- On the following slides, I will briefly present 3 examples of the application of this method in monitoring the health status of individual forest stands in central Serbia and the results that have been achieved.

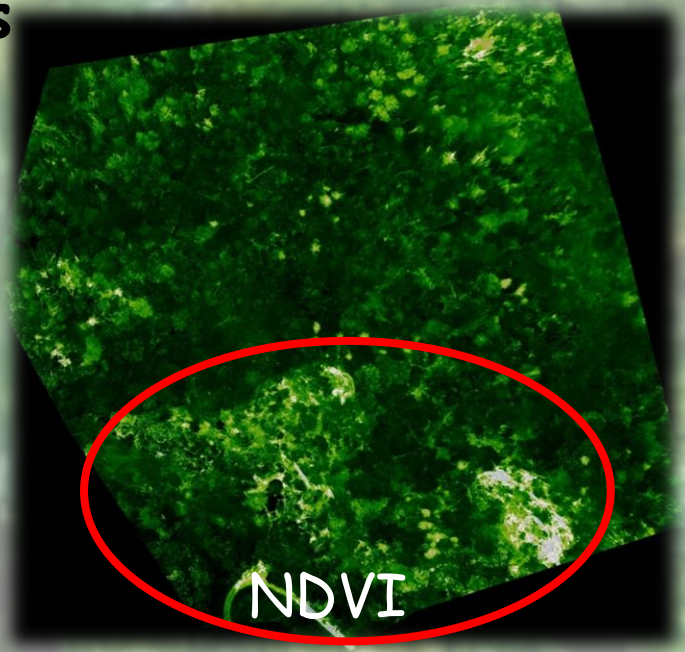
I example: *Health surveillance of Picea omorika (Pančić) Purkyne in the National Park Tara*

- *Picea omorika* (Serbian spruce) is a Balkan endemic and Tertiary relict that is nowadays naturally distributed only along the middle course of the Drina River (an area of approx. 10,000 km^2) in eastern Bosnia and Herzegovina, and western Serbia).

- Natural sites of Serbian spruce are characterized by predominately unfavorable conditions, where its often occurs in association with tree species such as beech, silver fir, Norway spruce, Scots and Austrian pine.

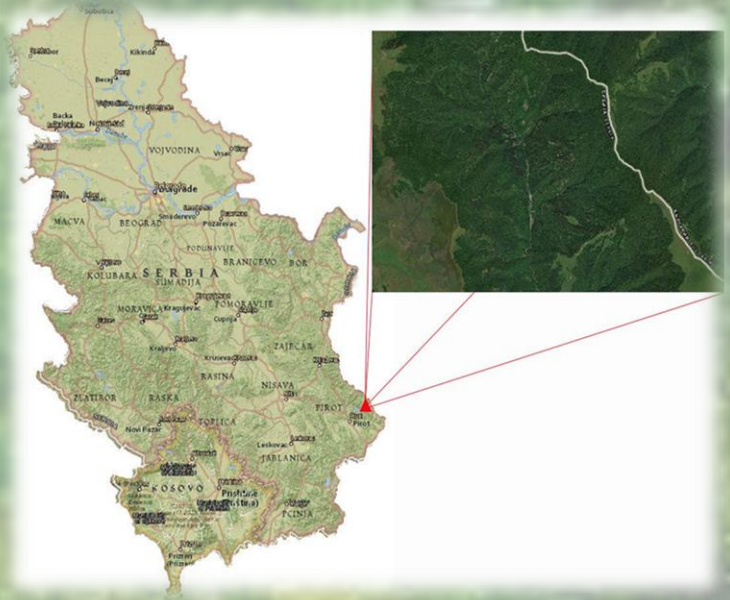
- The study was performed in areas of Bilješka Stena.
- Due to the extremely difficult terrain, small unmanned aerial systems (sUAS) were selected for terrain mapping and data gathering.
- The sampled area was 8 ha. Approximately 50 trees were directly identified as dead, while the application of vegetation indices (NDRE and NDVI) showed that a larger number of trees has lower index values.
- Bare surfaces and dry trees are shown in a lighter color.
- The darkest shades of green represent the most physiologically active trees.





The results of the study proved that the multispectral sensor and sUAV are useful tools for the early detection of tree stress, prediction of the dying process and planning the phytosanitary measures in the health monitoring of Serbian spruce stands in hard-to-reach areas.

II example: *Application of multispectral sensors and unmanned aerial system in Stara planina region*

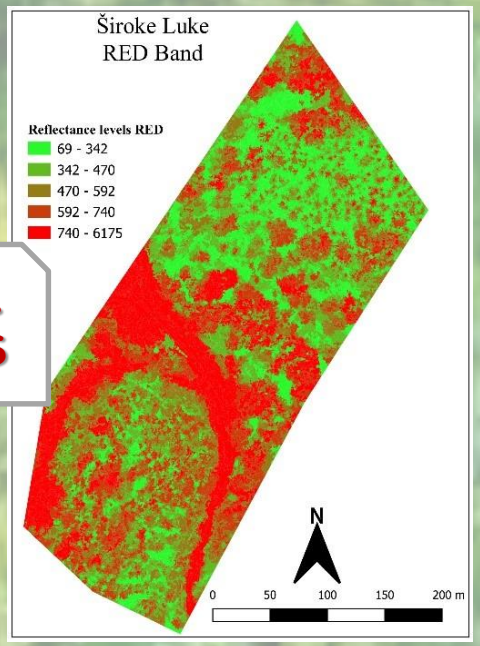


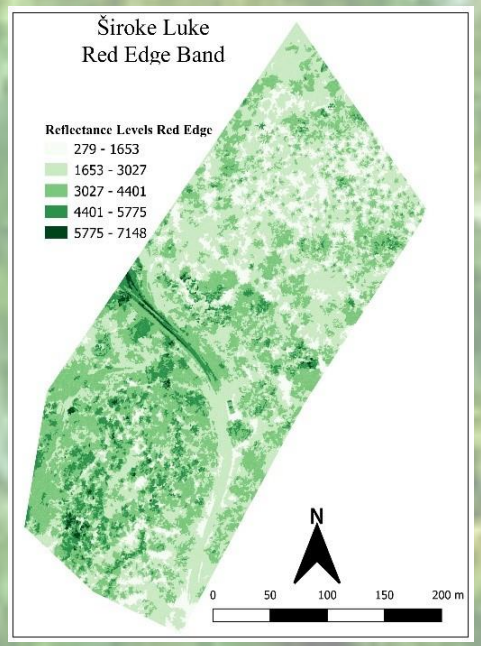
- In August 2020, a visual and multispectral recording of the forest vegetation was carried out at the location of Široke Luke, on Stara planina in Eastern Serbia.

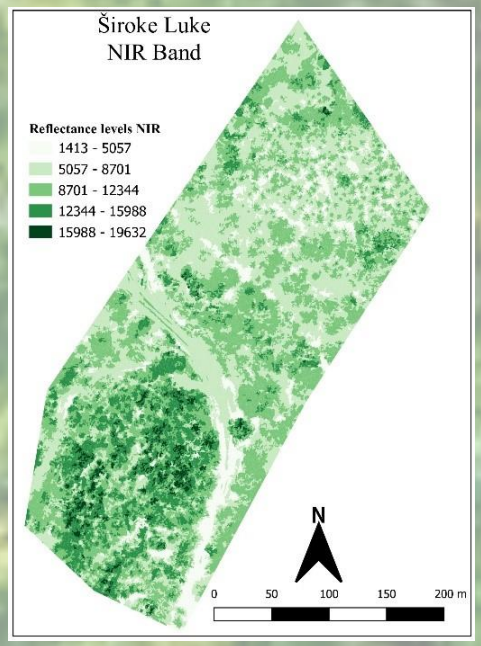
- Area of interest for this research was mixed coniferous/broadleaf forest, where the common beech is dominant species.

- NDVI values showed that certain areas have lower levels of activity, but it was still very high activity according to the index values.
- The NDRE index clearly showed the parts of the forest that have reduced physiological activity.
- NDRE map pointed out areas with higher levels of stress.
- It was confirmed that the area detected the drone was infested with beech weevil *Orchestes fagi* L.

MULTISPECTRAL ORTHOMOSAICS







Orchestes fagi is one of the most dangerous pests attacking the leaves of common beech.

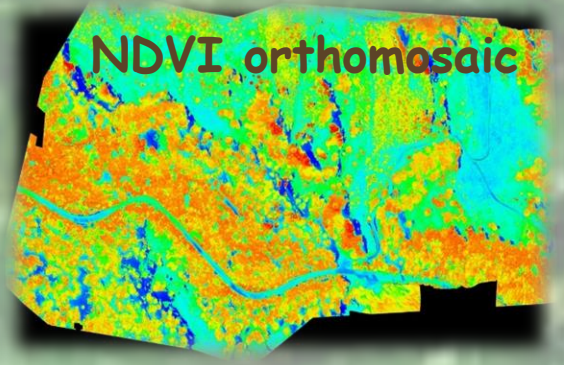
In this area, over 80% of all beech trees were attacked by beech leaf-mining weevil.

III example: Early detection of stress in forest stands of National park Kopaonik - management unit Samokovska Reka (Western Serbia)

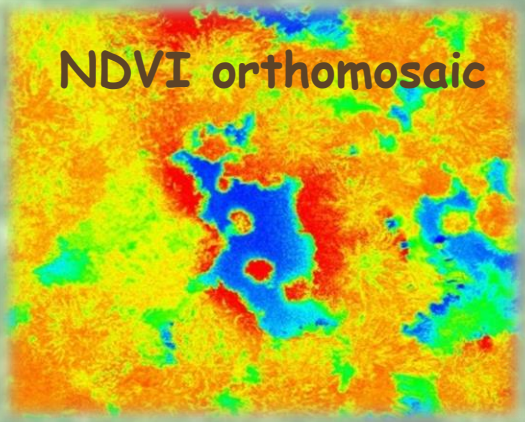
- The purpose of the study was testing the combination of small Unmanned Aerial Systems (sUAS) and ground-truthing for early detection and identification of apparently healthy, and physiologically active trees, that may be prone to the secondary infestation.
- Two study areas with approximately 37.3 ha were chosen.

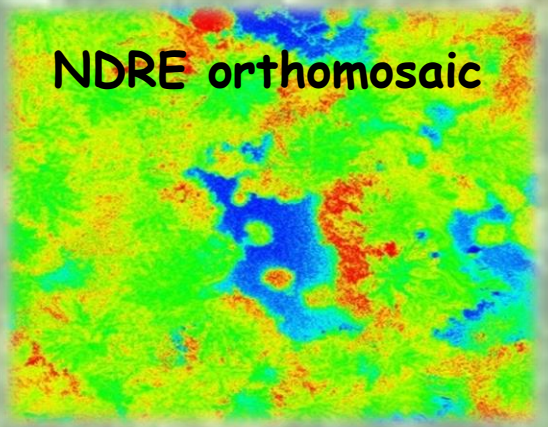
- Mapping of both study areas showed several parts with dead trees which are easily visible even in the RGB orthomosaic.
- NDVI vegetation indices showed several areas with lower index values that in the RGB orthomosaic looked healthy and physiologically active.
- NDRE vegetation index confirmed NDVI map, but it also showed more dramatic status with more pronounced low levels of the physiological activity of vegetation.

Study area 1



Study area 2





Terrestrial (in-situ) observations confirmed the poor state of the stand with a high number of dying trees, with the presence of fungi, and old entering and exiting holes of bark beetle.

Thank you for your attention