

Detection of pine tree diseases using multispectral imagery



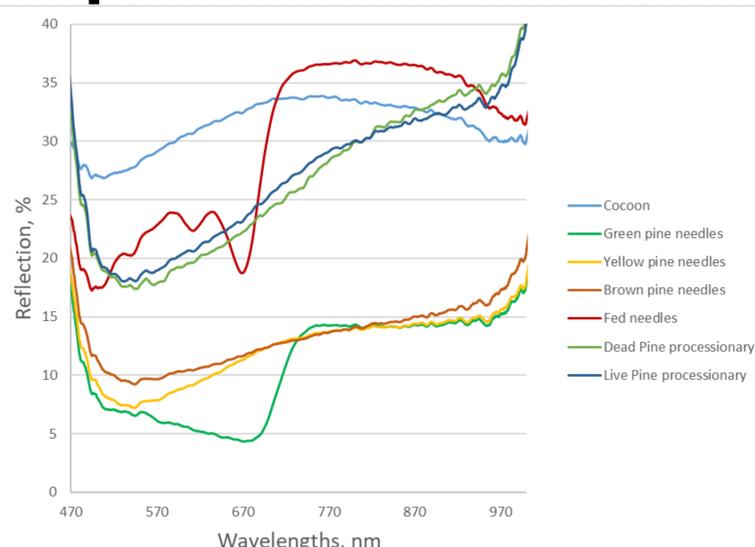
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Actuality of the problem

The condition of coniferous forests in Bulgaria has deteriorated significantly due to the spread of various diseases. A large-scale infestation of the pine processionary moth (*Thaumetopoea pityocampa*) has been observed for several years. The larvae feed on pine needles, and in the advanced stage, they can cause the death of the trees. Measures to combat it are not highly effective. This leads to serious economic losses for enterprises operating in the field of forestry. The study aims to assess the possibility of diagnosing pine infestation of the pine processionary moth using remote sensing, which would lead to minimizing economic losses. The results show that using remote sensing to diagnose the state of pine plantations can be a basis for improving economic results.



Spectral characteristic



	NDVI	GNDVI
Cocoon	0.008	0.076
Green pine needles	0.515	0.349
Yellow pine needles	0.124	0.300
Brown pine needles	0.120	0.207
Fed needles	0.293	0.259

Remote detection methods and economic calculations

Research methods include ongoing simultaneous measurement with multispectral cameras MAPIR Survey3N NGB (NIR+Green+Blue) and RGN (Red+Green+NIR), which are placed on a DJI drone. The diffuse reflectance spectra of pine needles, larvae and cocoon were obtained using USB4000 (Ocean Optics, Inc) in the region from 450 to 1100 nm. Fiber optics reflectance probe were used for each spectral acquisition.

The economical calculations were made with a stand of black pine trees with an average height of 10 m and a stem width of 56 cm with a distribution of 24 trees per hectare, and the prices are wholesale from the State Forestry of the Republic of Bulgaria as of 01.05.2025



DJI drone with multispectral cameras MAPIR NGB and RGN - a view from below



Image 1. RGB aerial photo at a height of 20 m. in the visible part of the spectrum /location of the forest area near Trakia University/ - 01.04.2025

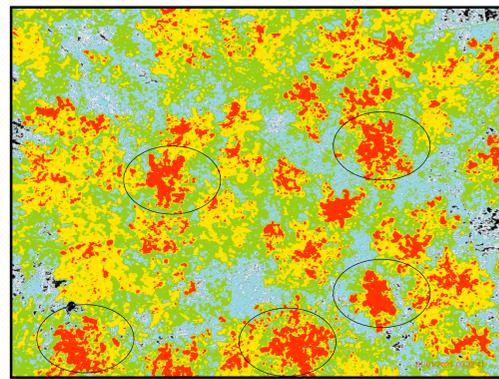


Image 2. Spectral processed image. The diseased parts of the tree vegetation are marked with red color

Economic effects of early detection and control of insects (pine processionary moth (*Thaumetopoea pityocampa*))

1. Aerial photography with spectral cameras can determine the spread of the processionary moth infection.
2. Treatment of infected areas can be carried out using specialized drones to spray chemicals and combat processionary moths at preset coordinates based on spectral images of the forest vegetation.
3. If 40% of a 100-hectare pine forest were affected, this would result in losses of 145 000 EUR. With precise treatment methods (spectral cameras for diagnostics and a specialized drone for spraying), losses can be reduced by 95%.



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