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Assessment of the Impact of Wildfire on the Physiological Condition of a Black Pine Stand Using Satellite and UAV Multispectral Imagery

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Forest fires represent one of the most significant drivers of forest ecosystem degradation, causing long-term impacts on forest vitality, stability, and safety. This paper presents the application of an integrated remote sensing approach for assessing the extent of tree dieback and physiological damage in an artificially established black pine [*Pinus nigra* J.F. Arnold.] stand affected by a wildfire that occurred in August 2024, within the Forest Administration (FA) Bujanovac, forest management unit Rujan. The study integrates Sentinel-2 satellite imagery acquired before and immediately after the fire with high-resolution RGB and calibrated multispectral data collected by an unmanned aerial system in May 2025. Photogrammetric processing resulted in high-resolution RGB and multispectral orthomosaics (up to 2.5 cm/pix), which were further analyzed using object-based image analysis (OBIA) and GIS techniques. Particular emphasis was placed on the analysis of the NDRE vegetation index as an indicator of physiological activity and chlorophyll content in mature trees. The results reveal a clear spatial differentiation between areas with completely dead trees, trees undergoing dieback, and trees with apparently preserved but reduced physiological activity. The analysis demonstrates that the impact of the wildfire is more extensive and severe than can be detected through visual field inspection alone, indicating an increased risk of secondary infestations and further stand decline. The presented methodology confirms the strong potential of unmanned aerial systems and multispectral remote sensing for operational forest health monitoring and decision-support in post-fire forest management.

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