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| **Early detection of Bark Beetles by Drone Images differs in Endemic and Epidemic Populations** |
| European forests face increasing threats due to climate change-induced stressors, which create the perfect conditions for bark beetle outbreaks. The most important spruce forest pest in Europe is the European Spruce Bark Beetle (*Ips typographus* L.). Effective forest management of these beetles’ outbreaks necessitates the timely detection of recently attacked spruce trees, which is challenging given the difficulty in spotting symptoms on infested tree crowns. Population density is one of many factors that can affect infestation rate and symptoms development. This study compares the appearance of early symptoms in endemic and epidemic bark beetle populations using high-resolution UAV (Unmanned Aerial Vehicle) multispectral imagery.  In spring of 2022, host colonization by bark beetles was induced on groups of spruce trees growing in 10 sites in the Southern Alps, characterized by different population density (5 epidemic and 5 endemic). A multispectral sensor mounted on a drone captured images once every two weeks, from May to August 2022. The analyses of a set of vegetational indices allowed the actual infested trees’ reflectance features and symptoms appearance to be observed at each site, comparing them with those of unattacked trees.  Results show that high bark beetles population density triggers a more rapid and intense response regarding the emergence of symptoms. Infested trees were detected at least one month before symptoms became evident to the human eye (red phase) in epidemic sites, while this was not possible in endemic sites. Key performing vegetation indices included NDVI (Normalized Difference Vegetation Index), SAVI (Soil Adjust Vegetation Index, with a correction factor of 0.44), and NDRE (Normalized Difference Red Edge index).  This remote early-detection approach could make a great contribution to the development of tools for the automatic diagnosis of bark beetles’ infestations and provide useful guidance for the management of areas suffering pest outbreaks. |