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| **Multitemporal Multispectral UAV, Ecophysiology, and Genetic Data for Monitoring Forest Dieback in Remote-Abyssal Beech population** |
| **Introduction/Aim:**  In the context of climate change, forest tree populations extending beyond the continuous distribution range of the species, which serve as vital biodiversity hotspots, require intensive monitoring. This is particularly crucial due to the escalating impact of heatwaves and droughts, notably in the Mediterranean region.  In Italy, beech populations are facing significant challenges due to increasing heatwaves, droughts, and the fungus Biscogniauxia nummularia (Bull.) Kuntze. This fungus, an endophyte and opportunistic pathogen, is now emerging as the agent of charcoal canker disease, potentially threatening the conservation of small, disjunct and heterotopic populations. Aabyssal beech population is in 60 ha of the Castelvecchio Natural Reserve (Italy) and is vital biodiversity hotspots protected under the EU Natura 2000. Continuous monitoring of this type of beech forests is essential to understand the dynamics of the dieback and identify resilient plants.  **Methods:**  Directly monitoring all trees on the ground within the forest area is unfeasible. Thus, we implemented continuous monitoring of beech populations at low altitude by acquiring diverse data types, including: (i) tree health data at tree level, entailing the estimation of leaf chlorophyll content (Chl) using SPAD-502-Plus , (ii) genetic data at tree level using buds, and (iii) multispectral data capturing the entire area using a Micasense RedEdge-M camera mounted on a WINGTRA ONE fixed-wing UAV. To establish monitoring, each tree sampled on the ground for health status and genetic data was geolocated using a topographic GNSS receiver to correlate tree vitality data with UAV multispectral data. Two field campaigns were conducted one year apart in June/July, coinciding with the full leaf development period of beech trees. UAV multispectral data were processed, and orthomosaics were used to segment the crowns and calculate vegetation indices. Specifically, the RedEdge band was utilized to segment the crowns within the entire area using a Simple Linear Iterative Clustering algorithm (SLIC), and for each segmented crown, the Normalized Difference Vegetation Index (NDVI) and Normalized Difference Red Edge Index (NDRE) were calculated at a spatial resolution of 10 cm.  **Results:**  Overall, most sampled trees exhibited good canopy functionality, with Chl values ranging between 30 and 43, and NDVI and NDRE values ranging between 0.8 - 0.9 and 0.4 - 0.5 respectively. The results displayed significant correlation between NDRE and chlorophyll (r = 0.77; p=0.009) for sampled trees, while no significant correlation was found with NDVI (r=0.58, p>0.1), indicating the effectiveness of the NDRE index in estimating chlorophyll content, while NDVI seems to saturate. Utilizing the correlation results and segmented tree crowns, a threshold approach calibrated using NDRE and Chl enabled the mapping of tree dieback within the area and within each crown, indicating varying levels of dieback, such as dead canopy, stressed canopy, and healthy canopy.  **Conclusion:**  The second field campaign facilitated monitoring the dynamic of dieback within the populations and within each crown, aiding in the identification of beech trees more suited for gene conservation due to their enhanced resistance. Additionally, the analysis of dynamics allowed for the examination of environmental factors influencing the phenomenon, such as the scarcity of affected plants along drainage lines compared to other areas. |