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# Estimation of Mangrove Leaf Area Index using Unmanned Aerial Vehicle multispectral imagery

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Mangroves are essential ecosystems composed of salt-tolerant plants that grow in tropical and subtropical intertidal zones, acting as a vital link between aquatic and terrestrial ecosystems. Interest in mangrove preservation and restoration has been increasing in recent years due to their important role in climate regulation by capturing and preserving carbon. Despite their importance, these ecosystems are under huge pressure due to human activities. It is estimated that these environments have lost up to half of the area occupied under pristine conditions. Leaf area index (LAI) is a well-known biophysical parameter related to plant health, as it provides information on the water, energy, and CO2 exchange between plants and the atmosphere. Unmanned aerial vehicles (UAVs) have emerged in recent years as a viable solution for ecosystem monitoring, as they allow for rapid and frequent data acquisition of a wide range of wavelengths. In this work, we evaluated the potential of multispectral images acquired by a UAV to estimate the LAI of a mangrove (*Avicennia marina*) forest located in the coastal area of the Red Sea in the Kingdom of Saudi Arabia. Multicollinearity assessment was performed to select significant variables suited for estimating LAI, including five multispectral bands, a canopy height model, and eight vegetation indices. Multicollinearity assessment was performed with three approaches: the Least Absolute Shrinkage and Selection Operator (LASSO), Random Forest (RF) for variable selection, and Hierarchical Cluster Analysis (HCA). The capability of significant variables to estimate LAI was assessed using the Generalized Linear Model (GLM), RF and Support Vector Machine (SVM). Results showed high estimation accuracy of LAI ($R^2$ = 0.91 for GLM, $R^2$ = 0.89 for RF and $R^2$ = 0.90 for SVM). However, further analysis showed that it is possible to estimate LAI of the mangrove forest with reasonable accuracy ($R^2$ = 0.87 for GLM, $R^2$ = 0.78 for RF and $R^2$ = 0.87 for SVM) using only two variables, the canopy height model and the GreenNDVI. The same variables were used to estimate LAI at another mangrove site and similar results were obtained ($R^2$ = 0.74 for GLM, $R^2$ = 0.73 for RF and $R^2$ = 0.68 for SVM).