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Scaling Up Above-Ground Biomass for *Khaya senegalensis* from Tree Level to Stand Level Using Sentinel-2 Based Dataset**Mendis, B.W.K.C.¹, Herath, H.M.T.P.¹, Lakmali, W.A.S.^{1*}, Karunaratne, S.²,
Amarasinghe W.V.T.D.³**¹*Department of Plantation Management, Wayamba University of Sri Lanka, Gonawila, Sri Lanka*²*CSIRO Agriculture and Food, Canberra, Australia*³*Research, Development and Training Division, State Timber Corporation, Sri Lanka*[*lakmaliwas@wyb.ac.lk](mailto:lakmaliwas@wyb.ac.lk)**Abstract**

Khaya senegalensis is an emerging option for climate change mitigating strategies, however, quantifying the carbon sequestration potential of *Khaya* in Sri Lankan conditions remains a critical concern. Tree-level biomass models exist for *Khaya*, they lack in spatial representation, which is crucial for stand-level carbon stock estimates. This study developed stand-level models to representation of the stand variability, emphasizing the efficiency of remote sensing in capturing spatial features and spatial heterogeneity. Therefore, this study aimed to develop remote sensing-based stand scale above-ground biomass (AGB)/above-ground carbon (AGC) prediction models using the relationship between remote sensing-based vegetation indices and estimated AGB/AGC based on the field measurements. The field data were collected from 53 sample plots of *Khaya senegalensis* monoculture forest plantation located in the intermediate zone, Sri Lanka. The Conditional Latin Hypercube sampling (cLHS) method was used to identify the sample points. The tree biomass and carbon content were derived using a tree-level allometric model available in the literature, collecting substantial field data such as diameter at breast height (DBH), tree height, and stocking density. This tree-level carbon content was scaled up to the plot level, building the relationship between the total AGB of the plot and the plot structural variables (Stand Basal Area-BA, Stand Mean height-H, and Stand Density-SD). In this study, AGB was modelled with 7 vegetation indices derived using Sentinel-2 imagery. The Classification and Regression Tree (CART) model was fitted as the final model since AGB, and vegetation indices perform a complex and nonlinear relationship. The k-fold cross-validation method was used to validate the final model. The selected plot scale, field models have higher R²-adj and lower error statistics. Finally selected plot scale allometric model was $AGB = aBA^bSD^{b1} + \epsilon$ [RSE (4.781), RSS (1143), AIC (321.169), BIC (329.051), RMSE (4.644 Mgha⁻¹), MAE (3.342), R²-adj (0.9)] and remote sensing-based stand scale AGB model was based on the four vegetation indices namely, Normalized Vegetation Index (NDVI), Sentinel-2 Red Edge Position (S2REP), Enhanced Vegetation Index (EVI), and Normalized Difference Index (NDI) 45. Between AGB and vegetation indices were revealed higher variability and a more complex combination. This discloses when modelling AGB/AGC using remote sensing-based indices, tree-based machine learning algorithms are more appropriate than linear regression modelling. However, to generalize this model across Sri Lanka, further testing needs to be done with a large dataset.

Keywords: *Khaya senegalensis*, Biomass, Remote sensing, Allometric equation, Up-scaling