

INTISARI

Pemetaan hutan tanaman dan pemantauan stok karbon hutan tanaman merupakan salah satu langkah penting dalam mendukung upaya mitigasi perubahan iklim. Penelitian ini bertujuan untuk (1) mengkaji akurasi penerapan algoritma *Random Forest* dalam pemetaan hutan tanaman *Eucalyptus* menggunakan citra Sentinel-1 dan Sentinel-2, serta (2) mengestimasi stok karbon atas permukaan hutan tanaman *Eucalyptus* di wilayah DAS Sepaku Tahun 2024. Data utama yang digunakan meliputi citra Sentinel-1 Level 1 GRD dan Sentinel-2 Level 2, dengan tahapan pra-pemrosesan berupa koreksi geometrik dan radiometrik, reduksi *noise*, normalisasi reflektansi, dan komposit median bebas awan. Variabel penelitian diekstraksi dari indeks vegetasi citra sentinel-2 (NDVI, EVI, GNDVI, SAVI), variabel tekstur *Gray-Level Co-Occurance Matrix* (GLCM) citra sentinel-1 dan sentinel-2 (Entropy, Variance, Dissimilarity), serta variabel radar sentinel-1 (VV, VH, RVI, dan *Radar Mean*). Analisis dilakukan menggunakan algoritma *Random Forest* untuk dua pendekatan, yaitu klasifikasi penutup lahan yang akan digunakan untuk pemetaan hutan tanaman *Eucalyptus* dan regresi untuk estimasi stok karbon atas permukaan hutan tanaman *Eucalyptus*. Hasil penelitian menunjukkan bahwa model klasifikasi hutan tanaman *Eucalyptus* memperoleh *User Accuracy* sebesar 87.43% dan *Intersection over Union* (IoU) sebesar 68.92%. Dalam konteks pemetaan spasial hutan tanaman, nilai IoU dinilai lebih relevan karena merepresentasikan tingkat kesesuaian spasial antara hasil klasifikasi dan data referensi. Namun, akurasi penelitian ini masih berada pada kategori menengah, menandakan bahwa model berbasis klasifikasi piksel digital belum sepenuhnya optimal dalam membedakan area hutan *Eucalyptus*. Untuk estimasi stok karbon atas permukaan, hasil terbaik diperoleh pada model regresi *Random Forest* dengan seleksi variabel berbasis *variable importance* menggunakan 10 variabel paling berpengaruh, yaitu GNDVI, NDVI, VH Entropy, VH Dissimilarity, VV Entropy, EVI, RVI, VH Variance, VV Variance, dan *Radar Mean*. Model ini menghasilkan koefisien determinasi (R^2) sebesar 67.02% dan RMSE sebesar 31.30 Kg/100m², dengan rentang error 16.79–26.13% dan akurasi tertinggi 73.87–83.21%. Hasil ini menunjukkan bahwa integrasi data multisensor Sentinel-1 dan Sentinel-2 dengan pendekatan pemilihan variabel prediktor dapat meningkatkan efisiensi dan akurasi model estimasi stok karbon hutan tanaman *Eucalyptus* di DAS Sepaku.

Kata Kunci: Hutan Tanaman *Eucalyptus*, *Random Forest*, Sentinel-1 dan Sentinel-2, Stok Karbon Atas Permukaan

ABSTRACT

Mapping of plantation forests and monitoring of forest carbon stocks are crucial steps in supporting climate change mitigation efforts. This study aims to (1) evaluate the accuracy of the Random Forest algorithm in mapping Eucalyptus plantation forests using Sentinel-1 and Sentinel-2 imagery, and (2) estimate the Above Ground Carbon (AGC) stock of Eucalyptus plantations within the Sepaku Watershed in 2024. The primary data used in this research included Sentinel-1 Level-1 GRD and Sentinel-2 Level-2 imagery. The preprocessing steps consisted of geometric and radiometric correction, noise reduction, reflectance normalization, and cloud-free median composite processing. Research variables were derived from Sentinel-2 vegetation indices (NDVI, EVI, GNDVI, and SAVI), Gray-Level Co-occurrence Matrix (GLCM) texture variables from Sentinel-1 and Sentinel-2 imagery (Entropy, Variance, and Dissimilarity), as well as Sentinel-1 radar variables (VV, VH, RVI, and Radar Mean). The analysis employed the Random Forest algorithm using two approaches: land cover classification for mapping Eucalyptus plantation forests and regression for estimating aboveground carbon stocks. The results showed that the Eucalyptus plantation classification model achieved a User Accuracy of 87.43% and an Intersection over Union (IoU) of 68.92%. In the context of spatial mapping, IoU was considered more relevant as it represents the degree of spatial agreement between the classification results and the reference data. However, the accuracy level in this study is classified as moderate, indicating that the pixel-based digital classification model is not yet fully optimal in distinguishing Eucalyptus plantation areas. For aboveground carbon estimation, the best performance was obtained from the Random Forest regression model using variable importance-based feature selection, involving the 10 most influential predictors: GNDVI, NDVI, VH Entropy, VH Dissimilarity, VV Entropy, EVI, RVI, VH Variance, VV Variance, and Radar Mean. This model achieved a coefficient of determination (R^2) of 67.02% and an RMSE of 31.30 Kg/100m², with an error range of 16.79–26.13% and accuracy between 73.87–83.21%. These results demonstrate that integrating multisensor Sentinel-1 and Sentinel-2 data with predictor variable selection can significantly enhance the efficiency and accuracy of aboveground carbon stock estimation models for Eucalyptus plantation forests in the Sepaku Watershed.

Keywords: *Eucalyptus Plantation Forest, Random Forest, Sentinel-1 and Sentinel-2, Above-Ground Carbon Stock*