

INTISARI

Perekonomian Indonesia pada masa pandemi Covid-19 mengalami keadaan resesi terutama pada sektor industri kehutanan. Sektor industri tersebut menjadi komoditas ekspor utama sehingga hasil industri harus dijaga dengan baik. Permasalahan yang muncul kebutuhan kayu meningkat berbanding tebalik dengan produktivitas hutan alam yang menurun, maka diperlukan pembangunan Hutan Tanaman Industri (HTI). Aktivitas HTI yang dilakukan di Kabupaten Tanjung Jabung Barat, Provinsi Jambi pada pohon *Acacia mangium* diperlukan strategi optimal meliputi pembangunan pertanian dan perkebunan berkelanjutan serta pengelolaan hutan produksi dengan pendekatan analisis spasial melalui pemenuhan data spasial foto udara dan analisis spasial estimasi nilai tinggi tanaman melalui *Unmanned Aerial Vehicle* (UAV).

UAV dapat menghasilkan data foto udara dalam proses pemenuhan data spasial. UAV pada umumnya menggunakan penentuan posisi foto udara dengan pendekatan *local base*. Dalam hal ini, *local base* mengalami kendala yaitu mudah bergeser dan berpengaruh dengan cuaca. Permasalahan yang muncul dari penggunaan *local base* mendorong berkembangnya metode penentuan posisi foto udara menggunakan pendekatan *Continuously Operating Reference Station* (CORS) yang memiliki kelebihan dalam efisiensi waktu dan biaya. Salah satu permasalahan terkait data hasil pengukuran fotogrametri dengan pendekatan CORS yaitu ketelitian hasil *orthomosaic* dan CHM yang dihasilkan sehingga perlu dilakukan evaluasi ketelitian horizontal dan vertikalnya, serta tingkat signifikansi nilai estimasi tinggi pohon *Acacia mangium*. Evaluasi tersebut digunakan untuk mengetahui efektivitas metode pendekatan CORS *base* sebagai alternatif metode pendekatan *local base* sehingga dapat dimanfaatkan pada HTI pohon *Acacia mangium*.

Pengolahan foto udara dilakukan beberapa tahap meliputi penentuan posisi foto udara menggunakan metode *Post Processing Kinematic* (PPK), pembuatan *orthomosaic* dan *Digital Surface Model* (DSM) dengan metode *Structure from Motion* (SfM), pembuatan *Digital Terrain Model* (DTM) dengan metode *Slope Based Filtering* (SBF), pembuatan CHM dengan analisis spasial *raster calculation*, penentuan *point shape* dengan metode *template matching*, serta ekstraksi nilai tinggi pohon terhadap CHM. Hasil *orthomosaic*, CHM, dan estimasi nilai tinggi tanaman dilakukan uji statistik *Root Mean Square Error* (RMSE) dan uji statistik *paired sample t-test*.

Kualitas produk *orthomosaic* dan CHM diketahui melalui uji statistik. Nilai ketelitian posisi geometri dan posisi tinggi yang diperoleh dari uji RMSE terhadap 5 titik *Independent Check Point* (ICP). Pada uji statistik RMSE, penelitian aplikatif ini menghasilkan *orthomosaic* dan CHM dengan pendekatan *local base* memiliki RMSE horizontal 0,561 m dan RMSE vertikal 3,707 m. Nilai uji RMSE horizontal maupun vertikal tersebut lebih baik dibanding metode pendekatan CORS *base* yang memiliki RMSE horizontal 1,265 m dan RMSE vertikal 4,764 m. Tingkat keefektifan dan pengaruh yang signifikan dapat dilakukan uji statistik *paired sample t-test* terhadap 25 sampel pengukuran manual tinggi pohon *Acacia mangium* di lapangan terhadap produk CHM. Uji t-statistik menunjukkan CHM pendekatan *local base* memiliki t-hitung = 1,815 yang hampir sama dengan uji statistik CHM pendekatan CORS *base* yaitu t-hitung = 1,982. Berdasarkan standar nilai t-tabel dengan tingkat kepercayaan

95% adalah 2,063 dan hasil uji statistik menunjukkan $|t\text{-hitung}| < t\text{-tabel}$, maka produk CHM dengan pendekatan *local base* dan *CORS base* merupakan hasil produk yang baik. CHM yang dihasilkan telah merepresentasikan kondisi tinggi tanaman yang sesuai dan tidak berbeda signifikan secara statistik dengan pengukuran manual di lapangan.

Kata Kunci: Hutan Tanaman Industri, *Acacia Mangium*, UAV, *Post Processing Kinematic*, *Canopy Height Model*, RMSE, *t-table*.

ABSTRACT

The Indonesian economy during the Covid-19 pandemic experienced a recession, especially in the forestry industry sector. The industrial sector was the main export commodity, so industrial output must be maintained properly. Problems arose when the need for wood increased in proportion to the decreasing productivity of natural forests, so it was necessary to develop industrial plantation forests. Industrial plantation forests activities were carried out in Tanjung Jabung Barat Regency, Jambi Province, on Acacia mangium trees. It required an optimal strategy including sustainable agricultural, plantation development, and production forest management with a spatial analysis approach through the fulfillment of aerial photo spatial data and spatial analysis of plant height estimation through Unmanned Aerial Vehicles (UAV).

UAV can produce aerial photo data in the process of fulfilling spatial data. UAV generally use aerial photo positioning with a local base approach. In this case, the local base was experiencing problems that quickly shifted and affected the weather. Problems arising from using local bases encouraged the development of aerial photography positioning methods using the Continuous Operating Reference Station (CORS) approach, which had time and cost efficiency advantages. One of the problems related to the photogrammetric measurement data using the CORS approach was the accuracy of the orthomosaic and CHM results; thus, it was necessary to evaluate the horizontal and vertical accuracy, as well as the significance level of the estimated height of the Acacia mangium tree. This evaluation was used to determine the effectiveness of the CORS base approach as an alternative to the local base approach method. Therefore, it could be utilized in the industrial plantation forests of Acacia mangium trees.

Aerial photo processing was carried out in several stages. They were determining the position of aerial photos using the Post Processing Kinematic (PPK) method, making orthomosaic and Digital Surface Model (DSM) with the Structure from Motion (SfM) method, making Digital Terrain Models (DTM) with the Slope Based Filtering (SBF) method., producing Canopy Height Models (CHM) by analyzing spatial raster calculation, determining point shape using template matching method, and extracting tree height values from CHM. The results of orthomosaic, CHM, and plant height estimation were carried out by the Root Mean Square Error (RMSE) statistical test and paired sample t-test statistical tests.

The quality of orthomosaic and CHM products was known through statistical tests. The value of the geometric and high positions accuracy was obtained from the RMSE test of 5 Independent Check Point (ICP) points. In the RMSE statistical test, this applicative study resulted in orthomosaic and CHM with a local base approach having a horizontal RMSE of 0.561 m and a vertical RMSE of 3.707 m. The value of the horizontal and vertical RMSE was better than the CORS base approach method, which has a horizontal RMSE of 1,265 m and a vertical RMSE of 4,764 m. A statistical paired sample t-test could measure the effectiveness and significant effect on 25 samples of manual measurement of Acacia mangium tree height in the field on CHM products. The t-statistical test showed that the CHM local base approach had a t-statistic = 1.815, which was almost the same as the CHM statistical test for the CORS base approach, namely t-statistic = 1.982. The standard t-table value with a 95%

confidence level was 2.063, and the results of statistical tests showed $|t\text{-count}| < t\text{-table}$. It could be concluded that the CHM product with a local base and CORS base approaches was excellent. The resulting CHM represented the appropriate plant height conditions and did not differ statistically significantly from manual measurements in the field.

Keywords: *Industrial Plantation Forest, Acacia mangium, UAV, Post Processing Kinematic, Canopy Height Model, RMSE, t-table.*