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**Pemodelan Ketebalan Gambut Menggunakan DTM LiDAR dan Data Multisumber Dengan Pendekatan Machine
Learning di KHG Sungai Mendahara-Sungai Batanghari**
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

INTISARI

Ketebalan gambut merupakan parameter krusial dalam pengelolaan ekosistem gambut yang memerlukan informasi akurat. Metode konvensional seperti pengeboran masih digunakan karena akurasinya, namun memerlukan biaya tinggi dan waktu yang lama untuk area luas. Pemodelan ketebalan gambut menggunakan integrasi data DTM LiDAR, citra satelit Planetscope, data regional, dan data global menawarkan solusi efisien dan akurat. Penelitian ini bertujuan memodelkan prediksi ketebalan gambut menggunakan DTM dari LiDAR dan data multisumber dengan pendekatan *machine learning* di Kesatuan Hidrologis Gambut (KHG) Sungai Mendahara-Sungai Batanghari.

Penelitian dilakukan di area seluas 201.383 hektar menggunakan 358 data pengeboran ketebalan gambut yang telah dibersihkan dari *missing values* dan *outlier* dari total 1.183 titik awal. Sebanyak 17 kovariat digunakan meliputi parameter hidrotopografi DTM dari LiDAR (*elevation, slope, aspect*, *curvature,* TPI, TWI, SPI, MRVBF, *geomorphons*), indeks vegetasi NDVI, data tutupan lahan, data geologi, jarak ke sungai terdekat, ketebalan tanah global, ketebalan gambut global, karbon organik tanah global, dan model gangguan gravitasi. Seleksi fitur menggunakan algoritma *Boruta*, pembagian data dengan rasio 80:20 menggunakan *stratified sampling*, dan validasi model dengan *5-fold cross validation*. Tiga algoritma *machine learning* (*Random Forest, Cubist,* dan *XGBoost*) dibandingkan performanya melalui *hyperparameter tuning* berdasarkan metrik evaluasi RMSE, MAE, dan R^2.

Hasil seleksi fitur mengidentifikasi 11 kovariat signifikan, meliputi 10 kovariat terkonfirmasi (*Elevation*, MRVBF, *LandCover, Global_PeatThickness,* NDVI, *Gravity_Disturbance*, *Geologi, Global_Soil, NearestToRiver*, TPI) dan 1 kovariat *tentative* (*Geomorphons*). Evaluasi menunjukkan *Cubist* memberikan nilai terbaik dengan RMSE 70,88 cm, MAE 50,20 cm, dan R^2 0,82, lebih unggul dibandingkan *XGBoost* (RMSE 82,25 cm, R^2 0,75) dan *Random Forest* (RMSE 86,71 cm, R^2 0,73). Model *Cubist* menghasilkan peta spasial dengan pola distribusi ketebalan tertinggi terkonsentrasi di bagian tengah dan timur wilayah penelitian. Analisis *variable importance* mengidentifikasi *Elevation* sebagai kovariat paling berpengaruh dengan kontribusi 23,80% dalam prediksi ketebalan gambut.

Kata kunci: ketebalan gambut, DTM LiDAR, *machine learning*, KHG Sungai Mendahara-Sungai Batanghari, pemodelan gambut.

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ABSTRACT

Peat thickness is a crucial parameter in peatland ecosystem management that requires accurate information. Conventional methods such as coring are still used due to their accuracy, but they require high costs and considerable time for large areas. Peat thickness modeling using the integration of LiDAR DTM data, Planetscope satellite imagery, regional data, and global data offers an efficient and accurate solution. This study aims to model peat thickness estimation using LiDAR DTM and multisource data with a machine learning approach in the Peat Hydrological Unit (PHU) of Sungai Mendahara-Sungai Batanghari.

The study was conducted in an area of 201,383 hectares using 358 peat thickness coring data that had been cleaned from missing values and outliers from a total of 1,183 initial points. A total of 17 covariates were used, comprising LiDAR DTM hydrotopographic parameters (elevation, slope, aspect, curvature, TPI, TWI, SPI, MRVBF, geomorphons), NDVI vegetation index, land cover data, geological data, distance to nearest river, global soil thickness, global peat thickness, global soil organic carbon, and gravity disturbance model. Feature selection used the Boruta algorithm, data splitting with an 80:20 ratio using stratified sampling, and model validation with 5-fold cross-validation. Three machine learning algorithms (Random Forest, Cubist, and XGBoost) were compared for their performance through hyperparameter tuning based on evaluation metrics of RMSE, MAE, and R^2.

Feature selection results identified 11 significant covariates, comprising 10 confirmed covariates (Elevation, MRVBF, LandCover, Global_PeatThickness, NDVI, Gravity_Disturbance, Geology, Global_Soil, NearestToRiver, TPI) and 1 tentative covariate (Geomorphons). Evaluation showed that Cubist provided the best performance with an RMSE of 70.88 cm, MAE of 50.20 cm, and R^2 of 0.82, outperforming XGBoost (RMSE 82.25 cm, R^2 0.75) and Random Forest (RMSE 86.71 cm, R^2 0.73). The Cubist model produced a spatial map with the highest thickness distribution pattern concentrated in the central and eastern parts of the study area. Variable importance analysis identified Elevation as the most influential covariate with a contribution of 23.80% in peat thickness prediction.

Keywords: *Peat Thickness, DTM LiDAR, Machine learning, Mendahara River-Batanghari River PHU, peat modelling.*