

INTISARI

Banjir merupakan bencana hidrometeorologi paling dominan di Indonesia dengan 2.009 kejadian sepanjang tahun 2025. Bencana tersebut turut melanda wilayah utara dan tengah Pulau Sumatra pada November 2025. Kejadian banjir di Kabupaten Aceh Singkil tercatat sebanyak 43 kali pada periode 2004 s.d. 2023, termasuk di Kecamatan Gunung Meriah yang dilalui Sungai Lae Cinendang. Salah satu faktor yang memperburuk dampak banjir pada area tersebut adalah hilangnya fungsi sempadan sungai akibat alih fungsi lahan menjadi perkebunan sawit. Hal ini sejalan dengan kondisi tutupan lahan di kabupaten tersebut yang menunjukkan 34.956 ha atau 51% perkebunan sawit berada di luar kawasan peruntukan perkebunan. Kondisi ini bertentangan dengan Qanun Kabupaten Aceh Singkil Nomor 2 Tahun 2013 yang melarang kegiatan budidaya pada sempadan sungai. Besaran penyimpangan di kawasan tersebut perlu diidentifikasi secara spasial guna memetakan distribusi keruangannya sebagai dasar evaluasi pemanfaatan ruang. Keterbatasan informasi spasial saat ini menyebabkan luasan pelanggaran tersebut belum dapat dipetakan dan dievaluasi. Oleh karena itu, proyek akhir ini bertujuan mengevaluasi kesesuaian pemanfaatan lahan pada sempadan Sungai Lae Cinendang terhadap Rencana Tata Ruang Wilayah Kabupaten Aceh Singkil. Evaluasi ini dilakukan melalui klasifikasi tutupan lahan menggunakan GEOBIA dan algoritma *Random Forest* pada citra PlanetScope serta menghitung luas tiap kelas sebagai dasar penilaian kesesuaian.

Proyek akhir ini memanfaatkan citra PlanetScope SuperDove (resolusi 3 m) perekaman 3 Juni 2025 yang diolah melalui Google Earth Engine. Pemrosesan diawali dengan menyusun *dataset* masukan dari delapan *band* asli dan empat indeks spektral (NDWI, NDVI, NDRE, dan EVI). Klasifikasi tutupan lahan kemudian dilakukan dengan pendekatan *Geographic Object-Based Image Analysis* (GEOBIA), yang menggabungkan segmentasi *Simple Non-Iterative Clustering* (SNIC), reduksi tujuh fitur tekstur *Gray Level Co-occurrence Matrix* (GLCM) menjadi *Principal Component 1* (PC1) melalui *Principal Component Analysis* (PCA), serta algoritma *Random Forest*. Hasil klasifikasi kemudian diuji akurasi menggunakan 250 titik sampel *stratified random sampling* dengan acuan citra Pléiades Neo 4 resolusi spasial 0,3 m yang diakses melalui Google Earth Pro. Nilai akurasi dan estimasi luas dihitung dengan pembobotan proporsi luas kelas beserta selang kepercayaan 90%.

Hasil evaluasi pada sempadan sungai menunjukkan pemanfaatan lahan sesuai mencapai 291,42 ha (58,95%) dan pemanfaatan tidak sesuai sebesar 202,92 ha (41,05%) dari 494,34 ha lahan yang dinilai. Perkebunan sawit mendominasi pemanfaatan lahan tidak sesuai, yaitu seluas 164,01 ha (80,83%). Pemanfaatan lahan tidak sesuai terluas berada di Desa Cingkam sebesar 116,53 ha (57,42%). Secara keseluruhan, klasifikasi tutupan lahan pada area sempadan seluas 637,18 ha menghasilkan luasan vegetasi alami sebesar 291,42 ha (45,73%), perkebunan sawit 164,01 ha (25,74%), badan air 142,84 ha (22,42%), serta lahan terbuka dan terbangun 38,91 ha (6,10%). Adapun badan air dikecualikan dari penilaian karena bukan objek pemanfaatan lahan. Seluruh estimasi luasan ini diturunkan dari peta klasifikasi dengan *overall accuracy* sebesar 89,48% $\pm$ 4,18% sehingga hasil klasifikasi memenuhi ambang ketelitian minimum 85%.

Kata kunci: GEOBIA, PlanetScope, *Random Forest*, sempadan sungai, kesesuaian pemanfaatan ruang, perkebunan sawit, Aceh Singkil

ABSTRACT

Flooding is the most frequent hydrometeorological hazard in Indonesia, with 2,009 events throughout 2025. This disaster also affected the northern and central regions of Sumatra in November 2025. Flood events in Aceh Singkil Regency were recorded 43 times from 2004 to 2023, including in Gunung Meriah Sub-district, which is traversed by the Lae Cinendang River. One of the factors aggravating the flood impacts in this area is the loss of the river buffer's protective function due to land conversion into oil palm plantations. This aligns with the land cover condition in the regency, which indicates that 34,956 ha, or 51% of oil palm plantations, are located outside the designated plantation zones. This condition contradicts Aceh Singkil Regency Qanun No. 2 of 2013, which prohibits cultivation activities within river buffers. The extent of deviation in the area needs to be spatially identified to map its spatial distribution as a basis for spatial utilization evaluation. The current limitation of spatial information causes the extent of such violations to remain unmapped and unevaluated. Therefore, this final project aims to evaluate the conformity of land utilization within the Lae Cinendang river buffer against the Regional Spatial Plan of Aceh Singkil Regency. This evaluation is conducted through land cover classification using GEOBIA and a Random Forest algorithm on PlanetScope imagery, as well as calculating the area of each class as the basis for conformity assessment.

This final project utilized a PlanetScope SuperDove image (3 m resolution) acquired on June 3, 2025, processed through Google Earth Engine. The processing began by constructing an input dataset from the eight original bands and four spectral indices (NDWI, NDVI, NDRE, and EVI). Land cover classification was then performed using a Geographic Object-Based Image Analysis (GEOBIA) approach, combining Simple Non-Iterative Clustering (SNIC) segmentation, reduction of seven Gray Level Co-occurrence Matrix (GLCM) texture features into Principal Component 1 (PC1) via Principal Component Analysis (PCA), and a Random Forest algorithm. The classification results were subsequently assessed for accuracy using 250 sample points selected through stratified random sampling, referenced against Pléiades Neo 4 imagery with a 0.3 m spatial resolution accessed through Google Earth Pro. Accuracy values and area estimates were calculated using area-proportion weighting along with a 90% confidence interval.

The evaluation results in the river buffer indicate that conforming land utilization reaches 291.42 ha (58.95%) and non-conforming land utilization amounts to 202.92 ha (41.05%) of the 494.34 ha assessed area. Oil palm plantations dominate the non-conforming land utilization, covering 164.01 ha (80.83%). The most extensive non-conforming land utilization is located in Cingkam Village, covering 116.53 ha (57.42%). Overall, land cover classification in the 637.18 ha river buffer area yielded natural vegetation of 291.42 ha (45.73%), oil palm plantations of 164.01 ha (25.74%), water bodies of 142.84 ha (22.42%), and bare and built-up land of 38.91 ha (6.10%). Meanwhile, water bodies were excluded from the assessment as they are not objects of land utilization. All these area estimates were derived from the classification map with an overall accuracy of $89.48\% \pm 4.18\%$, thus the classification results meet the minimum accuracy threshold of 85%.

Keywords: GEOBIA, PlanetScope, Random Forest, riparian buffer, land-use conformity, oil palm, Aceh Singkil