Abstrak

Bencana hidrometeorologi banjir semakin meningkat seiring dengan tingginya laju deforestasi yang mereduksi kapasitas resapan air. Penelitian ini bertujuan mengevaluasi kinerja arsitektur geokomputasi hibrida dalam mendeteksi perubahan tutupan lahan serta membandingkan akurasi tiga algoritma pemodelan kerawanan banjir: Multi-Criteria Decision Analysis (MCDA), Geomorphic Flood Index (GFI), dan Machine Learning. Metode yang digunakan mencakup ekstraksi citra satelit Sentinel-2 dan Landsat-8 melalui antarmuka Google Earth Engine (GEE), validasi geometri luring menggunakan QGIS, serta komparasi akurasi metrik dan uji signifikansi statistik (p-value). Hasil analisis mendeteksi laju deforestasi absolut sebesar 16,5% selama periode 2021–2025 yang berkorelasi dengan perluasan lahan terbangun sebesar 50,0%. Pada komparasi pemodelan, algoritma Machine Learning (Random Forest) terbukti paling superior dengan Overall Accuracy 92,8% dan Kappa Coefficient 0,89. Model ini secara efektif mengeliminasi bias deterministik pada MCDA dan kelemahan deteksi genangan lokal pada GFI. Interseksi spasial menunjukkan 38,5% infrastruktur terbangun berada di zona bahaya tinggi. Keseluruhan arsitektur data kemudian ditransformasikan menjadi antarmuka Dashboard WebGIS sebagai Decision Support System (DSS) untuk mitigasi bencana yang presisi dan inklusif.

Kata kunci: Deforestasi, *Google Earth Engine*, Kerawanan Banjir, *Machine Learning*, *WebGIS*.

Abstract

Hydrometeorological flood disasters are increasing along with high deforestation rates that reduce water catchment capacity. This study aims to evaluate the performance of a hybrid geocomputational architecture in detecting land cover changes and compare the accuracy of three flood susceptibility modeling algorithms: Multi-Criteria Decision Analysis (MCDA), Geomorphic Flood Index (GFI), and Machine Learning. The method involved extracting Sentinel-2 and Landsat-8 satellite imagery through the Google Earth Engine (GEE) interface, offline geometry validation using QGIS, and comparative analysis of metric accuracy and statistical significance tests (p-value). The analysis detected an absolute deforestation rate of 16.5% during the 2021–2025 period, which correlated with a 50.0% expansion of built-up areas. In the modeling comparison, the Machine Learning (Random Forest) algorithm proved to be the most superior with an Overall Accuracy of 92.8% and a Kappa Coefficient of 0.89. This model effectively eliminated the deterministic bias in MCDA and the local inundation detection weaknesses in GFI. Spatial intersection showed 38.5% of built-up infrastructure is located in high-hazard zones. The entire data architecture was then transformed into a WebGIS Dashboard interface as a precise and inclusive Decision Support System (DSS) for disaster mitigation.

Keywords: *Deforestation, Flood Susceptibility, Google Earth Engine, Machine Learning, WebGIS*.