

ORIGINAL PAPER

Comparative Analysis of Machine Learning Classifiers for Remote Sensing Land-Use Classification in Equatorial Watershed Ecosystems

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Received: 12 August 2026 • Revised: 28 September 2026 • Accepted: 10 October 2026 • Published Online: 05 October 2026

Abstract

Assessing Random Forest, XGBoost, and Sentinel-2 multispectral transformer networks for tropical forest canopy degradation mapping. Ensemble classifiers attained 96.4% overall classification accuracy across complex cloud-covered terrain.

Keywords: Remote Sensing, Machine Learning, Random Forest, XGBoost, Sentinel-2, Watershed Monitoring

1. Introduction

Equatorial watershed ecosystems serve as indispensable global carbon sinks and hydrological regulators. Rapid agricultural expansion necessitates automated, high-frequency satellite surveillance capable of disaggregating secondary regrowth from degraded canopy structures.

2. Method

Ten-band Sentinel-2 L2A surface reflectance composites covering 18,500 km² were harmonized across a multi-temporal time series. Five machine learning classifiers (Random Forest, SVM, XGBoost, CatBoost, and a Vision Transformer) were evaluated against 3,200 ground-truth field points.

3. Results and Discussion

XGBoost coupled with normalized spectral indices achieved the optimal balance of inference throughput and classification accuracy (Overall Accuracy = 96.4%, Kappa = 0.94), reducing cloud-shadow misclassification by 42% compared to standard random forest baselines.

4. Conclusion

Tree-based gradient boosting models provide operational robustness and computational economy for near-real-time deforestation alerts in tropical mountainous catchment basins.

Declarations

Funding: This study was supported by institutional research development grants.

Conflicts of Interest: The authors declare that they have no competing financial or personal interests.

Data Availability: The dataset and analysis matrices associated with this study are available in the public data repository.

Author Contributions: All authors contributed equally to conceptualization, investigation, formal analysis, and manuscript preparation.

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