Flood Risk Assessment in Niger Delta, Nigeria Using Geospatial and Machine Learning Approaches

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Abstract:

Flooding is among the most destructive hazards in Sub-Saharan Africa, frequently disrupting livelihoods, agriculture, and infrastructure. This study applies integrated geospatial and machine learning techniques to evaluate flood risk in Niger Delta, Rivers State, Nigeria, a hotspot within the Lower Niger Delta. Multi-temporal Landsat data (1975–2023), Sentinel-1 SAR (2018–2022), and satellite altimetry (2018–2024) were used to examine land use/land cover dynamics, flood inundation, and water level fluctuations. Findings show built-up areas expanded by 595% (10.09 km² in 1975 to 70.12 km² in 2023), while croplands shrank from 238.98 km² to 14.13 km². SAR data revealed October as the flood-peak month, with inundation increasing from 101.50 km² in 2018 to 180.63 km² in 2022. Altimetry confirmed seasonal peaks of 12–15 m, with a 1–2 month lag between upstream (Lokoja) and downstream tributaries. Machine learning models (Random Forest, Gradient Boosting, SVM) predicted flood susceptibility with high accuracy, with Random Forest performing best (91% accuracy, AUC = 0.93). The study highlights the combined influence of dam releases, climate variability, and unregulated urban expansion on flood risk. The integration of SAR, altimetry, and machine learning provides a robust framework for flood monitoring and early warning in poorly gauged river basins. Findings support the need for coordinated dam management, strict land use planning, and community-based adaptation strategies in the Niger Delta.

Keywords:

Flood risk, Sentinel-1 SAR, Satellite Altimetry, Machine Learning, Land Use Change, Niger Delta.