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A MACHINE LEARNING FRAMEWORK FOR PREDICTING MINING-DRIVEN LAND USE CHANGES: A CASE STUDY FOR SUSTAINABLE RESOURCE MANAGEMENT IN SHURUGWI, ZIMBABWE

Abstract

Understanding trends in land use and land cover changes provides essential insights for biodiversity monitoring and conservation planning,particularly in regions experiencing rapid resource extraction. This study develops a machine learning framework to predict future land use and land cover (LULC) changes. The use case is Ward 18, Shurugwi, Zimbabwe, where intensifying mining activities challenge sustainable resource management. While satellite data and machine learning have proven effective for predicting LULC changes in urban Zimbabwe, their application in rural mining contexts remains limited. The research leverages historical data from 2017 to 2023 using Digital Earth Africa platform to create a predictive model that can support proactive environmental management decisions. Using Earth Observation (EO) image analysis and supervised classification with maximum likelihood algorithms, the study tracks annual changes across forest cover, water cover, barren land, and cropland. Ground truthing and overlay analysis of mining areas provide validation of the classification results. The historical training data includes systematic changes in forest cover and mining expansion, patterns used by the ML algorithm to predict future patterns of change. While focused on Shurugwi, the developed framework offers a reproducible approach for predicting mining-driven LULC changes in similar contexts globally. This methodology provides environmental managers and policymakers with a tool to anticipate land cover changes and implement timely interventions, supporting the development of sustainable resource management strategies that balance economic development with environmental conservation.

Keywords: deforestation, earth observation data, land useland cover changes, predictive modeling, sustainable resource management