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Author: Mr. Sackdavong MANGKHASEUM
Kyushu Institute of Technology, Japan

Prof. Akitoshi HANAZAWA
Kyushu Institute of Technology, Japan

LEVERAGING MACHINE LEARNING ALGORITHMS AND OPEN-SOURCE SPATIAL DATASETS FOR LAND USE AND LAND COVER CHANGE IN THE NAM NGUM RIVER BASIN (NNRB), LAO PDR

Abstract

Monitoring transformations in land use and land cover (LULC) has significant effects on various aspects of the environment, including water resources, climate change, and biodiversity loss on a global scale. Exponential human population growth and the expansion of human land use have led to numerous changes and problems in ecosystems, food security, and increased pressure on natural resource management at all scales. Remote sensing and earth observation have been employed for this purpose for decades, providing the capability to detect changes over extensive geographical areas. This study investigated and classified spatio-temporal LULC changes in the Nam Ngum River Basin (NNRB), Lao PDR. Over the past few decades, significant economic and population growth has resulted in pronounced changes in land use and land cover (LULC) with high intensity in the NNRB, influencing the morphology of the river. For LULC mapping in this region, the analysis relies exclusively on multi-temporal images obtained with Sentinel-2 (10 m), Landsat-5 (30 m), and Landsat-8 (30 m). Leveraging the classification capabilities of widely employed decision tree-based classifiers comprising of Random Forest (RF), Gradient Boosting Decision Tree (GTB), Classification and Regression Tree (CART) in comparison with Support Vector Machine (SVM) and K-Nearest Neighbor (KNN) on the Google's cloud computing platform known as Google Earth Engine (GEE). LULC maps are generated at five-year intervals for 2009, 2014, 2019, and 2023 using post-classification change detection. The study's methodology uses unique RF, GTB, CART, SVM, and KNN models created as classifiers utilizing JavaScript in GEE. ArcGIS is the most effective tool for calculating the areas needed to identify shifts in land use and land cover classes. The results from this study identify six classes: built-up areas, cropland, barren land, water bodies, mixed-deciduous forest, and evergreen forest. This study has significant implications for the hydrological community. Accurate mapping of land use and land cover (LULC) and identifying changes are essential for modeling and evaluating the impacts of land use changes on water resources, watershed management, and water quality. The accuracy metrics, namely User, Kappa, and Producer, utilized in this study emphasize the model's effectiveness and efficiency for hydrological applications. The method proposed was initially employed in the region, and the findings contributed to improvements in local and regional policies and the decision-making process concerning urban development, as well as planning and water resource management, environmental conservation, and preventing extreme events such as floods in the Nam Ngum watershed areas.