**Significance Analysis of Normalized Indices in Machine Learning Based Land Use and Land Cover Classification in an Urban Landscape**

Urbanization and industrialization have been rapidly transforming land use and cover, impacting various aspects of the environment. To address resulting challenges, up-to-date land use and land cover (LULC) mapping is crucial. Recent developments in satellite remote sensing, including advanced satellite sensors and drones, offer higher resolutions and spectral bands. The current state-of-the-art involves utilizing machine learning (ML) and deep learning (DL) algorithms to automate land cover mapping, facilitating faster and more accurate analyses of remotely sensed data. The proven effectiveness of spectral indices like NDVI, NDBI, NDWI, BSI in assessing diverse features such as vegetation, built up, water, and open surfaces has prompted researchers to leverage their potential in ML based multiclass LULC classification. This is done by incorporating the indices with the regular satellite bands. However, the significance of this incorporation yet been understudied. Does the inclusion really improve the performance of ML algorithms? This research focuses on empirically investigating the impact of integrating spectral indices with satellite bands in LULC classification, considering both classification accuracy and computation time complexity.

The research applied representative algorithms from tree-based, discriminative, and neural network categories using solely satellite bands and satellite bands in conjunction with spectral indices for Phnom Penh city in Cambodia. The findings indicated that, for the specific urban area, Artificial Neural Network (ANN) and Support Vector Machine (SVM) models trained without indices exhibited higher overall accuracies (88.25% and 88%, respectively) compared to the Random Forest (RF) model trained with indices (84.75%). The study also noted that the impact of including indices varied among the classes considered, improving accuracies in tree-based ML algorithms but diminishing them in discriminative and DL algorithms. However, the inclusion of indices significantly enhanced model training times in discriminative and DL algorithms while increasing fitting time in the remaining type. Additionally, the study generated an updated LULC map for the year 2023 in the specified area.

The research makes a valuable contribution in assessing the feasibility of integrating index-based data into machine learning models for enhanced LULC classification. Additionally, it provides insights for future studies to carefully choose ML/DL algorithms by weighing the trade-offs between class-wise accuracies, overall accuracies, and computational complexities. Although the study focused on four specific indices, the same methodology can be applied to explore the significance of a broader range of indices and auxiliary data in similar investigations in LULC mapping and change detection.

Keywords: Artificial Neural Network; Support Vector Machine; Random Forest; Land Use Land Cover Mapping; Normalized Indices; Google Earth Engine