Investigations of Machine Learning and GIS Techniques for Land Use Land Cover Monitoring and Change Detection in Fayoum Governorate, Egypt

Thesis is Submitted By

Islam Atef Fouad Ahmed

B.Sc. (2018) - Civil Engineering Department

Faculty of Engineering - Fayoum University

A thesis submitted in partial fulfillment
of
the requirements for the degree of

Master of Science
in
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(Surveying and Geographic Information System)

FACULTY OF ENGINEERING, FAYOUM UNIVERSITY
FAYOUM, EGYPT
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Abstract

Studying, identifying, and closely monitoring land use/land cover (LULC) maps is essential for understanding their effects and achieving sustainable land management. This study aims to monitor the changes in LULC in the El-Fayoum Governorate over time (past, and future) to provide information for stakeholders involved in land use planning. The study utilized Google Earth Engine for Landsat image preprocessing to reduce time-consumption tasks. Three different image classification algorithms, namely maximum likelihood, random forest, and support vector machine were evaluated for generating LULC maps representing water, desert, built-up, and agricultural areas.

The results of the image classification process indicated that the support vector machine achieved the highest accuracy in terms of kappa coefficient (0.96), followed by Random Forest (0.909) and Maximum likelihood (0.878). The suitability map is used to allocate land cover more effectively and to make informed decisions based on visual representations of the area's most suitable for each land cover by utilizing biophysical and socioeconomic factors such as distance to canals, distance to roads, distance to urban areas, a digital elevation model (DEM), and the slope.

The hybrid CA-Markov model of the IDRISI-TerrSet software was utilized to simulate LULC changes, and the accuracy of the simulation was validated using 2020 imagery data from two different scenarios: S1 (2000-2010) and S2 (2012-2016). The effectiveness of the approach was assessed using the kappa index of agreement metric. The outcomes for the two distinct scenarios are as follows: for S1, kappa values were computed as $k_{standard}$: 0.3307, $k_{locations}$: 0.5224, and k_{no}: 0.2801; and for S2, kappa values were calculated as kstandard: 0.9738, klocations: 0.9713, and kno: 0.9684. So the second model was used to predict LULC in 2030.

Based on the second scenario, predicted 2030 compared to the year 2020 show that the built-up land cover class is projected to experience a rise of 35.88%. Furthermore, the agricultural land cover class is estimated to decrease by 4.08%. This study provides valuable insights into LULC changes, aiding stakeholders and decision-makers in making informed choices.