Land use dynamics and environmental changes in Michigan County using Support Vector Machine

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Abstract

Land use dynamics and environmental changes are critical factors affecting ecosystems, biodiversity, and human livelihoods. In this study, land use dynamics and associated environmental changes in Michigan County were appraised using Support Vector Machine (SVM) analysis. Utilizing Landsat satellite imagery for the summer seasons of the years 2019 to 2023, this study aimed to understand the temporal patterns of land use changes and their impact on the environment. SVM, a powerful machine learning algorithm, offers robust classification capabilities suitable for analyzing satellite imagery. By employing SVM, this study was able to classify land cover types, allowing for precise identification of changes in land use over the study period. The multi-temporal Landsat data provided valuable insights into the dynamics of land cover transitions, including developed areas, water body, forests, and barren/open surfaces. Findings reveal significant alterations in land use patterns across the County during the five-year study period. These changes are indicative of both natural processes and anthropogenic activities, for instance, the area covered with water fluctuated during the period, 51 km^2, 40 km^2, 35 km^2, 40 km^2 and 39 km^2 for years 2019, 2020, 2021, 2022, and 2023, respectively. More so, the study observed potential corresponding environmental impacts, including habitat loss, and soil degradation, where the area covered with bare or open surfaces increased drastically over the study area. 307 km2, 148 km2, 67 km2, 119 km^2 and 294 km^2 covered by baren or surfaces for years 2019, 2020, 2021, 2022 and 2023, respectively.

Keywords: Land Use Dynamics; Support Vector Machine; Remote Sending Data, Environmental Changes

Background

The natural environment provides several ecosystem services for human wellbeing, health, survival, and livelihoods, which directly and indirectly contribute to human society. The study on land use dynamics and environmental changes in Michigan County using Support Vector Machine (SVM) analysis aims to address critical concerns regarding the impact of human activities and natural processes on the local environment. Michigan County, characterized by diverse landscapes and ecosystems, faces increasing pressure from urbanization, industrialization, and agricultural expansion, leading to significant changes in land cover patterns over time (Shirkey et al., 2023). These changes have far-reaching implications for ecosystem health, biodiversity, and human well-being (Orimoloye et al., 2022). Traditional methods of land use analysis often lack the precision and scalability required to accurately assess and monitor dynamic changes in land cover. To overcome these limitations, the study leverages SVM, a powerful machine learning algorithm capable of classifying land cover types with high accuracy and efficiency. By analyzing multi-temporal Landsat satellite imagery spanning five years (2019-2023), the research aims to identify and quantify temporal patterns of land use changes across Michigan County. Understanding these dynamics is crucial for informing evidence-based decision-making processes related to land management, conservation, and sustainable development. By employing advanced geospatial techniques such as SVM analysis, the study seeks to provide valuable insights into the drivers and consequences of land use changes in Michigan County. Ultimately, the research endeavors to contribute to the development of informed strategies aimed at mitigating environmental degradation, preserving biodiversity, and promoting sustainable land use practices in the region.

Materials and Methods

Methodological Framework

The research methodology involved land use change analysis using Landsat 8 imagery spanning five years (2019-2023) over Kalamazoo County. ArcGIS Pro was utilized for data processing and analysis. The process included preprocessing of Landsat imagery, such as atmospheric correction and image enhancement. Subsequently, a Support Vector Machine (SVM) algorithm was employed for land use classification, categorizing the imagery into distinct land use features. The SVM classification facilitated the identification and mapping of land cover changes over the study period. The methodology provided a systematic approach to understanding temporal land use dynamics and changes within the study area.

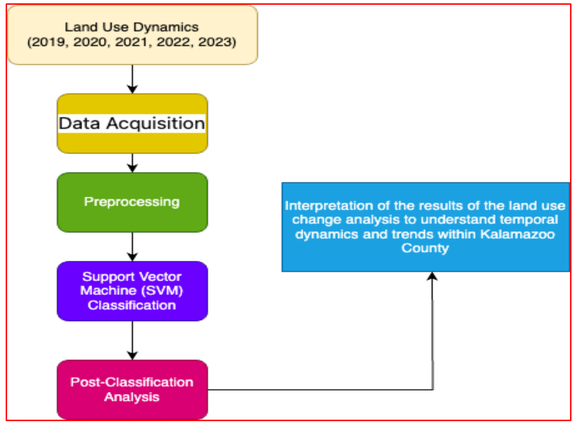

Figure 1: Methodology Workflow

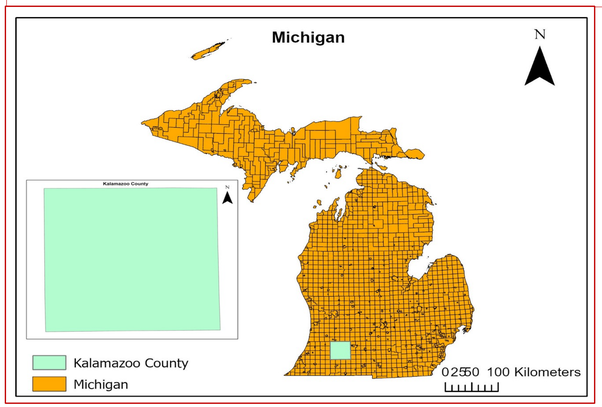

Figure 2: Study Area

Results

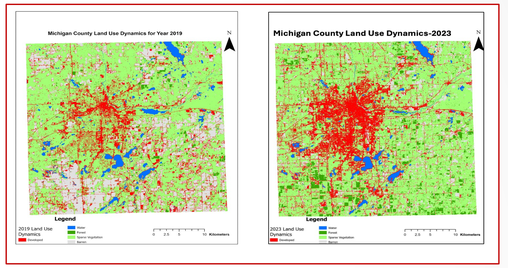

Figure 3. Land Use Dynamics for Years 2019 and 2023

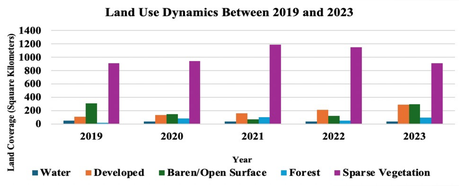

Figure 4: Variation in Land Use Dynamics Between 2019 and 2023 across Michigan County

Conclusion

The research findings highlight the significant impact of land use dynamics on ecosystems, biodiversity, and human livelihoods in Michigan County. Utilizing Landsat imagery and Support Vector Machine analysis, the study identified notable temporal patterns and alterations in land cover types over the five-year period. These changes, influenced by both natural processes and human activities, underscore the importance of informed land management and conservation efforts. The integration of remote sensing data and machine learning techniques offers valuable insights for policymakers and stakeholders to develop strategies aimed at mitigating adverse environmental impacts, preserving biodiversity, and promoting ecosystem resilience in dynamic landscapes like Michigan County.

References

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