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Sentinel-2 Perspective: Analyzing Land Use and Land Cover Dynamics in East and West Karbi Anglong

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Abstract
This study delves into the dynamics of land use and land cover (LULC) in East and West Karbi Anglong using Sentinel-2 satellite imagery. In response to escalating environmental changes, remote sensing technologies, particularly Sentinel-2, offer crucial insights for sustainable land management. Through an analysis of LULC patterns, the study aims to inform evidence-based decisions for environmental conservation and resource management in the region. The present study highlights the utility of remote sensing in LULC assessments and acknowledges the necessity for customized approaches in regions with distinctive features such as Karbi Anglong. Methodologically, temporally stratified Sentinel-2 datasets were utilized, with meticulous pre-processing and accuracy assessments ensuring reliability. Results indicate notable shifts in LULC classes, including urban expansion and vegetation decline. Despite limitations, such as potential inaccuracies in data processing, the study emphasizes the importance of monitoring environmental changes and advocating for sustainable land management strategies.

Keywords: Sentinel-2, Land Use/Land Cover, Temporal Analysis, Remote Sensing

1. Introduction

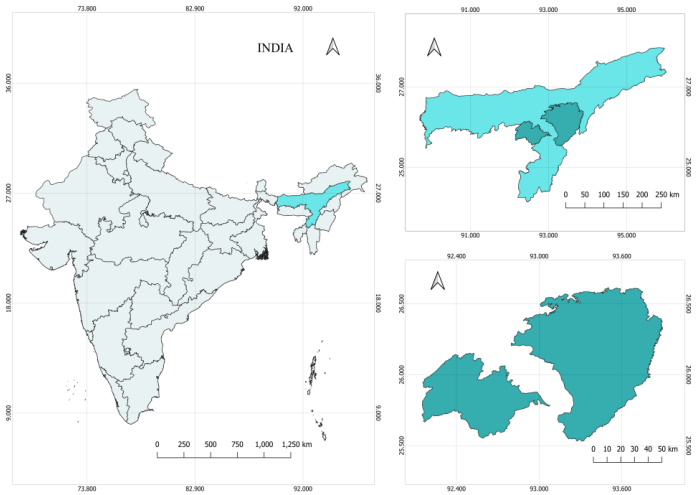
In an era characterized by unprecedented environmental changes and an ever-growing need for sustainable land management, remote sensing technologies have emerged as invaluable tools for understanding and monitoring Land Use and Land Cover (LULC) dynamics. Recent research has witnessed a significant rise in the utilization of advanced remote sensing techniques, particularly the Sentinel-2 mission within the European Union's Copernicus program. This mission, renowned for its multispectral capabilities and high spatial resolution, offers a unique perspective on land dynamics. Studies by Sanches et al., (2020) and Darius et al., (2020) have highlighted the importance of Sentinel-2 in enabling detailed LULC assessments, allowing for highly comprehensive analyses. Focusing specifically on the Karbi Anglong region, researchers have extensively employed remote sensing techniques to explore various aspects of LULC dynamics. For instance, Le Moine (2019) investigated the impact of anthropogenic activities on forest cover, identifying vulnerable areas prone to degradation. Similarly, Baidya et al., (2020) uncovered changes in land cover patterns in West Karbi Anglong, driven by an increased demand for cash crops and exploitation of forest resources. Dutta et al., (2020) emphasized the significance of considering changes in land cover, particularly in regions like Karbi

Anglong with diverse ecosystems, which play a pivotal role in shaping regional climatic conditions. The utilization of Sentinel-2 data has proven invaluable for diverse applications, facilitating the identification of trends and patterns over specific time frames. Karra et al., (2021) highlighted its utility in this regard. However, meticulous preprocessing procedures are essential in the preparatory stages of satellite imagery analysis, ensuring that resultant data maintains high standards of accuracy, uniformity, and compatibility for subsequent processing, as emphasized by Ramdani (2023). Additionally, accurate and reliable classification of land cover types is paramount in LULC analysis, as noted by Chughtai et al., (2021). In conclusion, this synthesis highlights the progressive role of remote sensing, particularly Sentinel-2, in LULC assessments, acknowledging the need for tailored approaches in regions with distinctive features like East and West Karbi Anglong.

2. Study Area

East Karbi Anglong and West Karbi Anglong are two administrative districts in the state of Assam situated within the geographic coordinates of 25º 33′ to 26º 35′ North latitude and 92º 10′ to 93º 50′ East longitude. The district is primarily hilly, with the terrain ranging from flat plains to rugged hills and mountains. The landscape is marked by numerous valleys, ridges, and steep slopes, making it predominantly suitable for agriculture and forestry. The hills and mountains are part of the Eastern Himalayas and exhibit a diverse amalgamation of land cover classifications, comprising agricultural expanses, sylvan regions, water bodies, and inhabited zones.

Figure 1: Map Showing Study Area



3. Methodology and Data

The temporal dynamics of LULC in the region under investigation was acquired from Sentinel-2 10m Land Use/Land Cover Time Series by Impact Observatory, Microsoft, and Environmental Systems Research Institute. Two distinct epochs, denoted as 46R_20180101-20190101 (acquired on 11-03-24) and 46R_20220101-20230101 (acquired on 04-03-24), were employed to analyze the evolving patterns of landscape features. The dataset nomenclature, '46R' denotes the geographical coverage of the region of interest, while the temporal range separated by the given time period corresponds to the years 2018-2019 and 2022-2023. Geospatial Data Abstraction Library (GDAL) Clipper was harnessed to meticulously derive a refined raster representation of our specified region of interest. This method was employed because of its capability to intelligently intersect the raster dataset with the mask layer, retaining only the pertinent geographic information crucial to our analytical objectives. The LULC

classification for the Sentinel-2 data utilized in this study was provided pre-classified, eliminating the need for in-house classification techniques. The acquired Sentinel-2 LULC data was generated through a deep learning algorithm trained on a vast corpus of more than five billion meticulously hand-labeled Sentinel-2 pixels, rendering it an exemplary data repository for the comprehensive examination of LULC dynamics. LULC classes namely water, vegetation, flooded vegetation, crops, built area, sand deposit, and rangeland were designated later on. To authenticate the precision of the classification the ground truth was established using a high resolution satellite basemap and the areas of agreement and disagreement were visually examined by overlaying reference data with the classified map.

4. Result and Discussion

In the span between 2018-2019 and 2022-2023, significant alterations have been observed in the Land Use and Land Cover (LULC) classes, indicating dynamic shifts in the landscape.

Figure 2: LULC Map for Temporal Span of 2018-2019

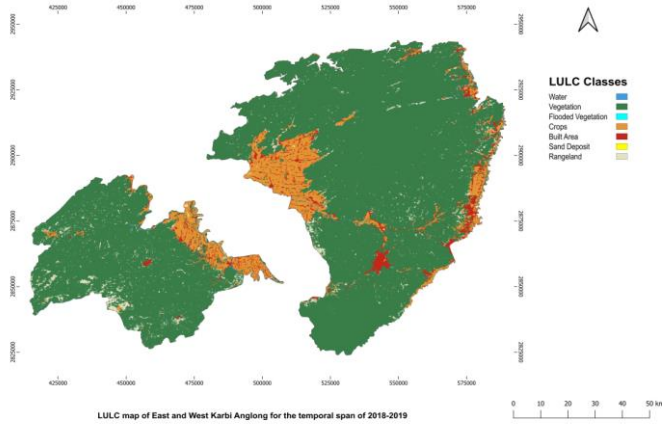


Figure 3: LULC Map for Temporal Span of 2022-2023

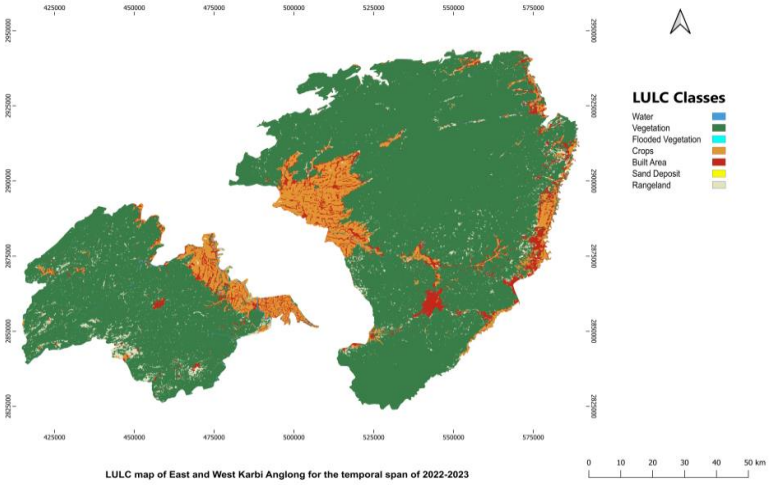


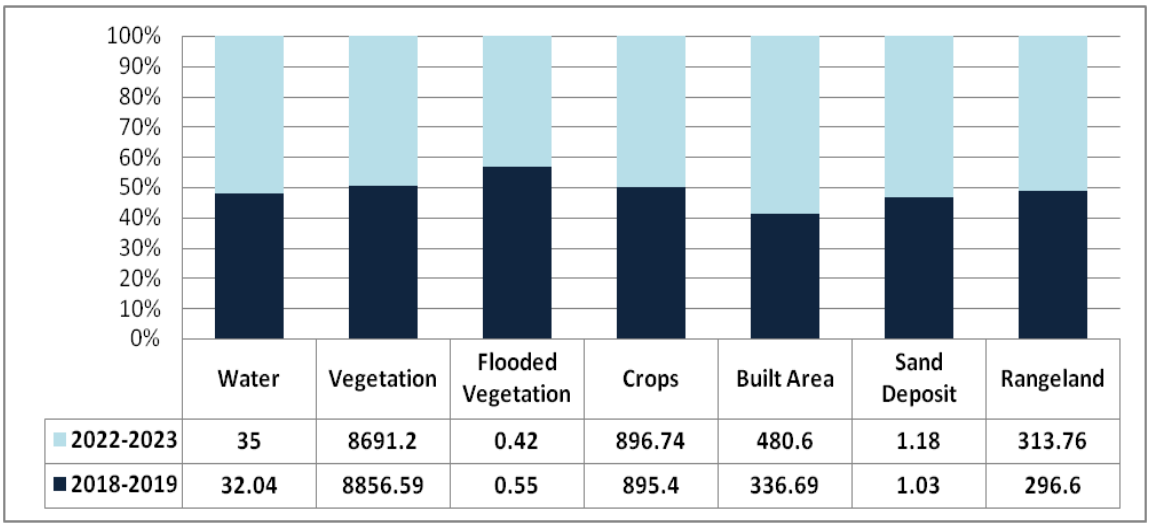
Table 1: LULC Area, Area % and Net Change Calculation

LULC Classes	2018-2019		2022-2023		Net Change in Area
	Area (km^2)	Area %	Area (km^2)	Area %	
Water	32.04	0.31	35.00	0.34	2.96

Vegetation	8856.59	85.00	8691.20	83.42	-165.39
Flooded Vegetation	0.55	0.01	0.42	0.00	-0.13
Crops	895.40	8.59	896.74	8.61	1.34
Built Area	336.69	3.23	480.60	4.61	143.91
Sand Deposit	1.03	0.01	1.18	0.01	0.15
Rangeland	296.60	2.85	313.76	3.01	17.16
Total	10418.90	100	10418.90	100	

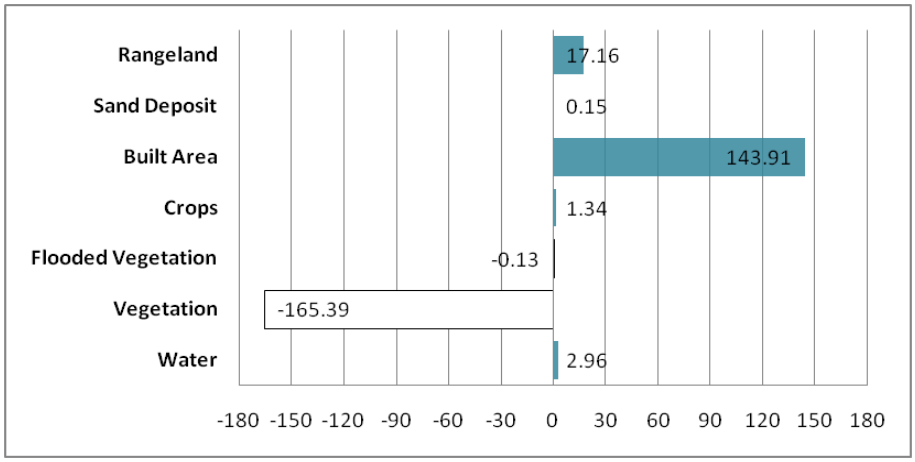
Water bodies expanded marginally, with an increase from 32.04 km² to 35.00 km², constituting a net gain of 2.96 km². Vegetation, encompassing a substantial portion of the land, experienced a reduction in area from 8856.59 km² to 8691.20 km², indicating a decline of 165.39 km². This decline might signal ecological stressors such as deforestation or land conversion. Flooded vegetation areas experienced a negligible loss. Cultivated areas, comprising crops, witnessed a slight expansion of 1.34 km². This minor increment suggests ongoing agricultural activities to meet the demands of food production.

Figure 4: Percentage Comparison of LULC Area



Built-up areas exhibited a substantial rise from 336.69 km² to 480.60 km², reflecting a notable increase of 143.91 km². This significant expansion might be attributed to urbanization or infrastructural development, highlighting the pressures of population growth and urban sprawl. Sand deposits experienced a minimal increase from 1.03 km² to 1.18 km², indicating a slight rise of 0.15 km². Rangeland areas demonstrated a modest expansion from 296.60 km² to 313.76 km², marking an increase of 17.16 km². This augmentation suggests potential land management practices or ecological restoration efforts.

Figure 5: Net Change in Area 2018-2019 to 2022-2023



Overall, these findings emphasizes the dynamic nature of land use and land cover in East and West Karbi Anglong, reflecting both natural and anthropogenic influences on the region's landscape over the specified time period.

5. Limitations

During data processing, the process of resampling may slightly affect the accuracy of calculated area measurements. Another factor contributing to the discrepancy between the calculated and actual ground areas is edge effects. It occurs when pixel near the boundary of the study area are only partially included in the analysis, leading to underestimation of the total area. In our study, the boundary of the study area may have been susceptible to edge effects, particularly during the processing stage. Nevertheless, the computed area displays a marginal percentage error of approximately 0.14%, indicative of a data accuracy level reaching approximately 99.85%.

6. Conclusion

This study analyzed land use changes in East and West Karbi Anglong using Sentinel-2 satellite data. Between 2018-2019 and 2022-2023, notable shifts occurred; including increased urban areas and decreased vegetation cover. Minor changes were observed in water bodies, cultivated land, and other landscape features. Despite providing valuable insights, the study has limitations, such as potential inaccuracies during data processing. Nonetheless, it highlights the importance of monitoring environmental changes and emphasizes the need for sustainable land management strategies. Overall, Sentinel-2 imagery proves to be a valuable tool for understanding landscape dynamics and informing decision-making processes in environmental conservation and resource management.

References

1. Chaves, E.D., Picoli, M., Sanches, I.D. "Recent applications of Landsat 8/OLI and Sentinel-2/MSI for land use and land cover mapping: A systematic review." Remote Sensing 12.18 (2020): 3062.
2. Phiri, D., et al. "Sentinel-2 data for land cover/use mapping: A review." Remote Sensing 12.14 (2020): 2291.
3. Le Moine, R. "The land use cover changes from 1992 to 2011 in Karbi Anglong, Assam, India." 2012.

4. Baidya, S., et al. "Changes of land use land cover and floristic composition in sacred forests of West Karbi Anglong district, Assam, India." Tropical Plant Research 7.2 (2020): 296-308.
5. Datta, P., Bose, S. "Assessing the changes in climate extremes over Karbi Anglong district of Assam, North-East India." Spatial Information Research 28.5 (2020): 547-558.
6. Karra, K., et al. "Global land use/land cover with Sentinel 2 and deep learning." 2021 IEEE international geoscience and remote sensing symposium IGARSS. IEEE, 2021.
7. Picos, J., et al. "Event-based integrated assessment of environmental variables and wildfire severity through Sentinel-2 Data." Forests 10.11 (2019): 1021.
8. Ramdani, F. "Data Preprocessing." Exploring the Earth with QGIS: A Guide to Using Satellite Imagery at Its Full Potential. Cham: Springer Nature Switzerland, 2023. 15-23.
9. Chughtai, A.H., Abbasi, H., Karas, I.R. "A review on change detection method and accuracy assessment for land use land cover." Remote Sensing Applications: Society and Environment 22 (2021): 100482.