Spatial Transformation and Land Cover Dynamics in a Peri-Urban Corridor: A 30-Year Geospatial Analysis of Religious Tourism Impact in Mowe-Ibafo, Nigeria

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Abstract- This study investigates the spatio-temporal land use and land cover (LULC) changes driven by religious tourism in the Mowe-Ibafo corridor, a peri-urban axis along the Lagos-Ibadan Expressway, Nigeria, between 1990 and 2020. Utilizing multi-temporal Landsat satellite imagery (ETM+), the research employed supervised classification and derived spectral indices (NDVI, NDBI) to quantify and visualize urban expansion and vegetation loss. The findings reveal a systematic conversion of vegetated and agricultural lands to built-up areas, with forest/wetland and farmland declining by 26.05 sq km and 10.95 sq km, respectively, while built-up areas expanded by 54.34 sq km. Regression analyses confirmed a strong negative correlation (R^2 up to 0.991) between the Normalized Difference Built-up Index (NDBI) and the Normalized Difference Vegetation Index (NDVI), statistically validating that urban growth directly reduces green cover. Accuracy assessments yielded an overall classification accuracy of 88% (Kappa = 0.84). The study attributes this rapid spatial transformation to the agglomeration of mega religious camps, which have acted as urban growth poles, attracting ancillary development. The paper concludes that unplanned faith-based urbanism, while economically stimulative, poses significant challenges for sustainable land management, ecosystem services, and climate resilience in peri-urban regions. It underscores the urgent need for integrated spatial planning that incorporates religious tourism as a key driver of land change in sub-Saharan African cities.

Keywords: Religious Tourism; Land Use/Land Cover (LULC) Change; Peri-Urbanization; Remote Sensing; GIS; NDVI; NDBI; Urban Growth Poles; Nigeria.

I. INTRODUCTION

Peri-urban areas, characterized by their transitional nature between urban and rural landscapes, are among the most dynamic and rapidly changing spaces in the Global South (Simon et al., 2006). In sub-Saharan Africa, these transformations are often driven by a complex interplay of population pressure, infrastructure development, and niche economic activities (Andreasen et al., 2017). In Southwestern Nigeria, religious tourism has emerged as a potent, yet understudied, force fundamentally reshaping spatial structures and land economics (Adedibu, 2019; Obateru & Ogunjemite, 2022). The proliferation of large-scale faith-based camps, offering spiritual retreats, mega-conventions, and pilgrimage sites, has created new forms of "sacred urbanism" that defy conventional urban growth models.

The Mowe-Ibafo corridor along the Lagos-Ibadan Expressway presents a quintessential case study. Within a 30-kilometer stretch, this peri-urban axis hosts several of Nigeria's largest religious camps, including the Redeemed Christian Church of God (RCCG) Redemption Camp, the Mountain of Fire and Miracles Ministries (MFM) Prayer City, the Nasrul-Lahi-l-Fathi Society (NASFAT) prayer ground, and the Deeper Life Bible Church Camp. These camps attract millions of visitors annually, generating profound socio-economic and spatial repercussions (Owoyemi, 2025; Okon, 2018).

While existing literature has begun to explore the socio-economic impacts of religious tourism (Bello & Bello, 2017; Ezenagu et al., 2021), rigorous longitudinal geospatial analyses quantifying its direct spatial footprint remain scarce. There is a critical gap in understanding the scale, rate, and pattern of land cover change directly attributable to this phenomenon. This study addresses this gap by employing remote sensing and Geographic Information Systems (GIS) to assess LULC changes from 1990 to 2020. It aims to:

1. Quantify the spatio-temporal dynamics of LULC in the Mowe-Ibafo corridor.

2. Analyze the relationship between urbanization (using NDBI) and vegetation health (using NDVI).
3. Discuss the implications of faith-driven urban expansion for sustainable peri-urban planning in Nigeria and similar contexts.

II. MATERIALS AND METHODS

2.1. Study Area

The study area encompasses the Mowe-Ibafo settlements within the Obafemi-Owode Local Government Area of Ogun State, Nigeria (Figure 1). Geographically, it lies between Latitudes 6°44'N and 6°54'N and Longitudes 3°22'E and 3°30'E. This corridor is a classic linear settlement pattern stretched along the Lagos-Ibadan Expressway, approximately 31 km from the Lagos boundary. Its location within the commuter belt of Lagos, Nigeria's economic capital, subjects it to spillover growth pressures, which are significantly amplified by the presence of the religious camps (Jimoh, 2020).

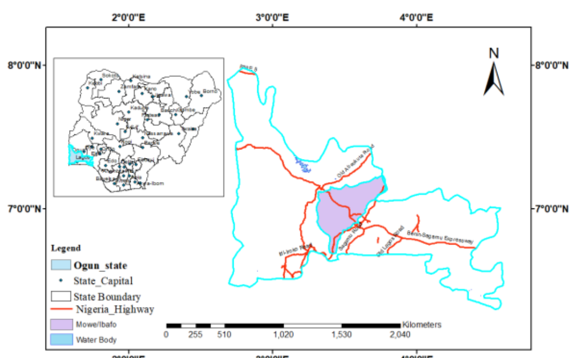

Figure 1: Location of the Mowe-Ibafo study area within Ogun State, Nigeria, showing its position along the Lagos-Ibadan Expressway.

2.2. Data Sources and Preprocessing

Multi-temporal cloud-free Landsat 7 Enhanced Thematic Mapper Plus (ETM+) satellite images for the epochs 1990, 2000, 2010, and 2020 were downloaded from the United States Geological Survey (USGS) Earth Explorer portal (http://earthexplorer.usgs.gov). The specific path/row was 191/055. All images were acquired during the dry season (November-February) to minimize atmospheric and phenological variability. Preprocessing steps in ERDAS Imagine 2015 included:

- Radiometric Correction: Conversion of digital numbers to spectral radiance and then to top-of-atmosphere reflectance.
- Geometric Correction: Images were co-registered to a common Universal Transverse Mercator (UTM) coordinate system (Zone 31N) using ground control points, with a root mean square error (RMSE) of less than 0.5 pixels.
- Image Subsetting: The area of interest (AOI) covering Mowe-Ibafo was extracted from each scene.

2.3. Land Use/Land Cover (LULC) Classification

A supervised classification approach using the Maximum Likelihood algorithm (MLC) was employed. This method is widely recognized for its robustness in LULC mapping (Lu & Weng, 2007). Five LULC classes were defined based on field knowledge, Google Earth high-resolution imagery, and topographic maps:

1. Built-up Area: Residential, commercial, institutional buildings, and paved surfaces.
2. Forest/Wetland: Dense tree cover, natural forests, and wetland vegetation.
3. Farmland: Cultivated lands, croplands, and fallow fields.
4. Bare Surface: Exposed soil, sand, cleared land, and construction sites.
5. Water Body: Rivers, streams, and ponds.

Training samples (ROIs) for each class were carefully selected for each epoch. Post-classification, a 3x3 majority filter was applied to reduce spectral noise.

2.4. Accuracy Assessment

Classification accuracy was evaluated using a stratified random sampling method to generate reference points. High-resolution historical imagery from Google Earth and field knowledge from the 2022 survey served as the reference data. An error matrix (confusion matrix) was constructed for the 2020 classification to calculate Producer's Accuracy, User's Accuracy, Overall Accuracy, and the Kappa Coefficient (Congalton & Green, 2019).

2.5. Derivation of Spectral Indices and Change Analysis

To augment the LULC analysis and quantify urban and vegetation dynamics, two spectral indices were computed:

1. Normalized Difference Vegetation Index (NDVI): Measures vegetation health and density.

NDVI=(NIR−Red)(NIR+Red)*NDVI*=(*NIR*+*Red*)(*NIR* −*Red*)

Values range from -1 to +1, with higher positive values indicating healthier, denser vegetation.

2. Normalized Difference Built-up Index (NDBI): Highlights built-up and impervious surfaces.

NDBI=(SWIR1−NIR)(SWIR1+NIR)*NDBI*=(*SWIR*1+ *NIR*)(*SWIR*1−*NIR*)

Positive values typically indicate built-up areas, while negative values represent non-built-up land (Zha et al., 2003).

The spatial-temporal trends of these indices were analyzed. Furthermore, linear regression and correlation analyses were performed between the mean NDVI and NDBI values for sampled points across the four epochs to statistically examine their relationship.

III. RESULTS

3.1. Land Use and Land Cover Change (1990-2020)

The LULC maps (Figure 2) visually chronicle the dramatic transformation of the Mowe-Ibafo landscape over three decades. In 1990, the area was predominantly green, dominated by Forest/Wetland (442.90 sq km) and Farmland (414.80 sq km). By 2020, the built-up area (shown in red) had expanded aggressively, fragmenting and replacing these natural and semi-natural covers.

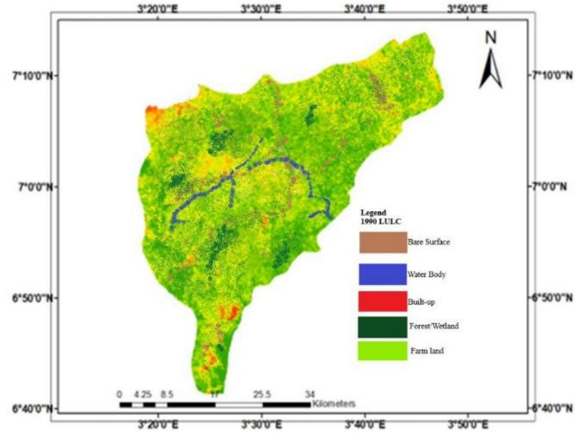

Figure 3.1: 1990 LULC

Source: Authour’s analysis, 2025

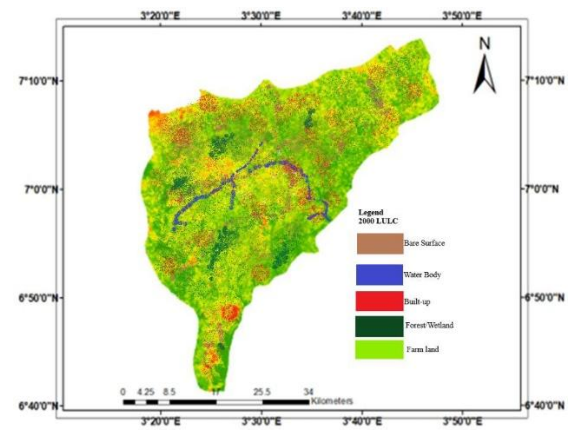

Figure 3.2: 2000 LULC

Source: Authour’s analysis, 2025

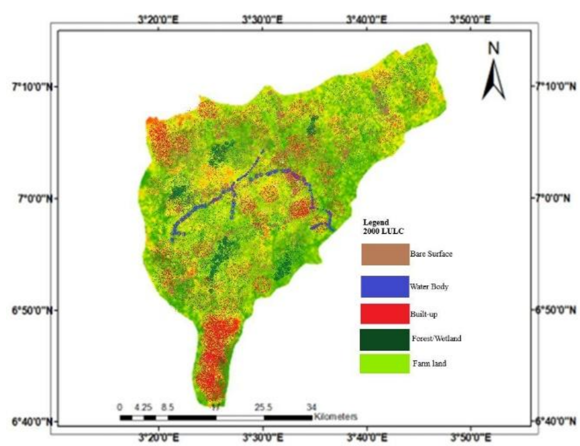

Figure 3.3: 2010 LULC

Source: Authour’s analysis, 2025

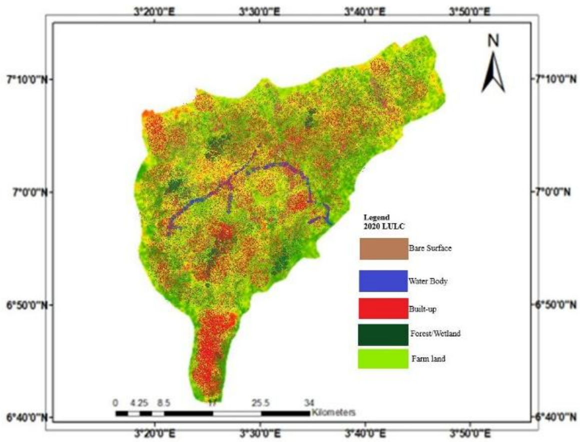

Figure 3.4: 2020 LULC
Source: Authour's analysis, 2025

Figures 3.1, 3.2, 3.3, 3.4: Time-series LULC classification maps showing the progressive expansion of built-up areas (red) at the expense of vegetation and farmland.

The quantitative analysis confirms this visual narrative. Built-up area increased persistently from 325.61 sq km in 1990 to 379.95 sq km in 2020, a net gain of 54.34 sq km (16.7% increase). Conversely, Forest/Wetland experienced the most significant decline, dropping by 26.05 sq km, followed by Farmland, which decreased by 10.95 sq km. Bare surfaces showed a net decrease, often acting as a transitional class before conversion to built-up.

Table 3.1: Areal Extent and Change in LULC Classes in Mowe-Ibafo (1990-2020)

LULC Class	1990 (sq km)	2000 (sq km)	2010 (sq km)	2020 (sq km)	Net Change (1990-2020)	% Change
Built-up	325.61	364.12	376.72	379.95	+54.34	+16.7%
Forest/ Wetland	442.90	428.43	420.53	416.85	-26.05	-5.9%
Bare Surface	169.41	145.12	148.72	151.54	-17.87	-10.6%
Farmland	414.80	412.99	407.68	403.85	-10.95	-2.6%
Water Body	123.47	125.54	122.54	123.99	+0.52	+0.4%
Total	1476.19	1476.19	1476.19	1476.19	-	-

The accuracy assessment for the 2020 classification yielded an Overall Accuracy of 88% and a Kappa Coefficient of 0.84 (Table 2), indicating a substantial agreement between the classified map and reference data, and confirming the reliability of the change analysis.

Table 3.2: Accuracy Assessment Matrix for the 2020 LULC Classification

Class	Producer's Acc. (%)	User's Acc. (%)
Built-up	89	92
Forest/Wetland	83	85
Farmland	79	81
Bare Surface	88	86
Water Body	90	95
Overall Accuracy = 88%	Kappa Coefficient = 0.84	

3.2. Spectral Index Analysis: NDVI and NDBI Trends
The derived NDVI and NDBI maps provide a complementary, continuous-scale perspective on environmental change. The NDVI maps show a noticeable browning trend (shift from green to yellow/red) around the expressway and camp locations, indicating vegetation stress and loss. The NDBI maps show a corresponding intensification of built-up signals (red patches) in these same areas, particularly around the RCCG Redemption Camp (Mowe) and MFM Prayer City (Ibafo).

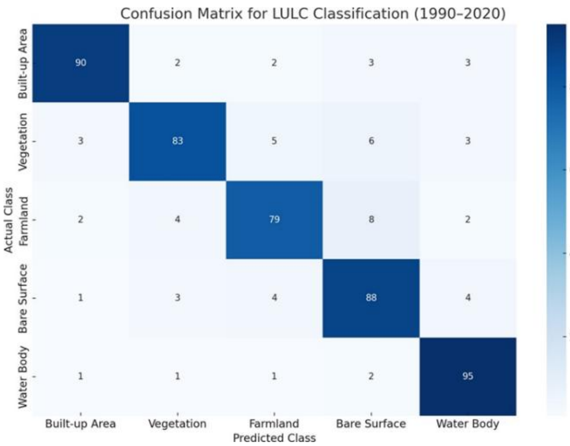

Figure 3.5: Confussion matrix

Source: Authour's analysis

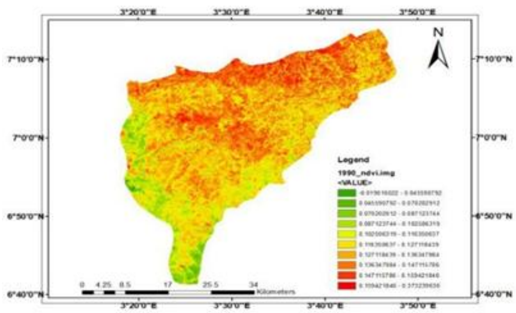

Figure 3.6: 1990 NDVI

Source: Author's field work 2025

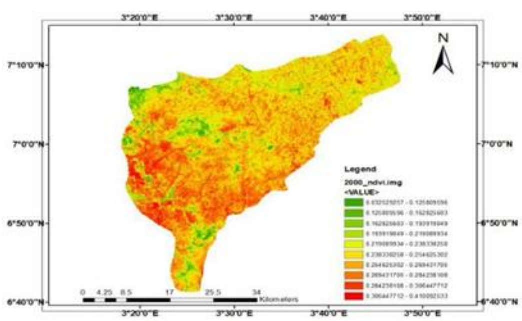

Figure 3.7: 2000 NDVI

Source: Author's field work 2025

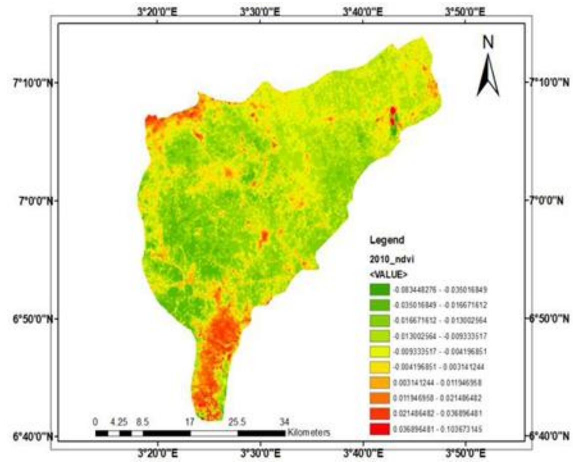

Figure 3.8: 2010 NDVI

Source: Author's field work 2025

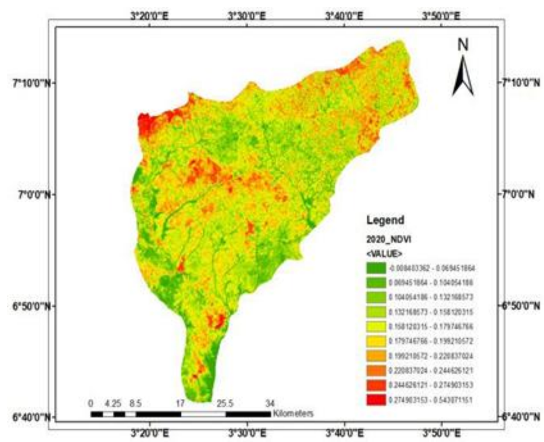

Figure 3.9: 2020 NDVI

Source: Author's field work 2025

Figure 3: NDVI maps (top) show declining vegetation vigor (green to red), while NDBI maps (bottom) show increasing built-up density (green to red) over time.

Derivation of Normalized Difference Built-up Index (NDBI)

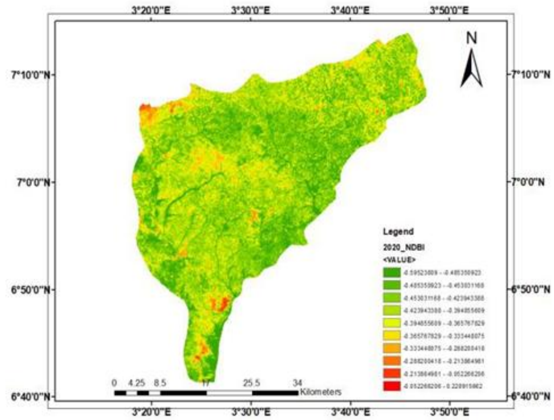

Figure 3.10: 1990 NDBI

Source: Author's field work 2025

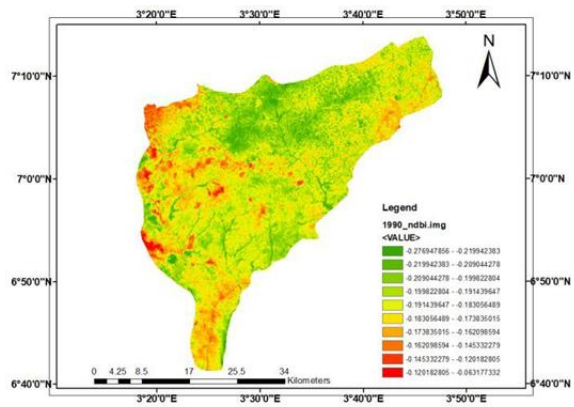

Figure 3.11: 2000 NDBI

Source: Author's field work 2025

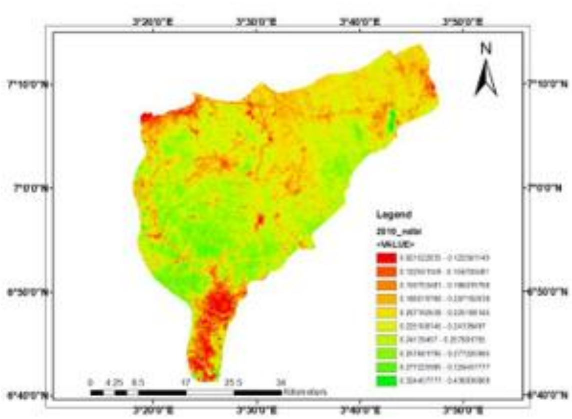

Figure 3.12: 2010 NDBI

Source: Author's field work 2025

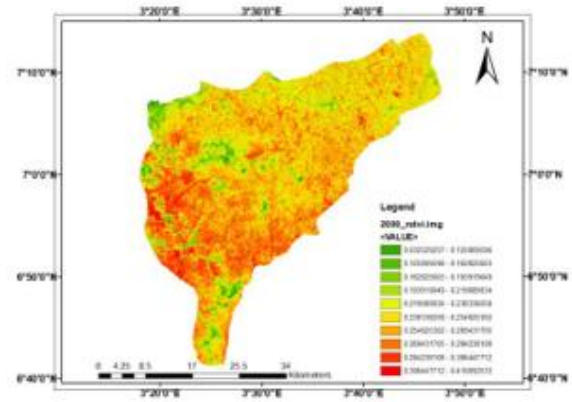

Figure 3.13: 2020 NDBI

Source: Author's field work 2025

The extracted values (Table 3) and subsequent regression analysis solidified this inverse relationship. For all epochs, the correlation between NDVI and NDBI was strongly negative. The 1990 regression model, for instance, was highly significant ($p = 2.42E\text{-}05$) with an R^2 of 0.991 (Table 4), meaning over 99% of the variation in the built-up index could be explained by the decrease in vegetation index.

Regression Statistic	Value
Multiple R	0.996
R Square	0.991
Adjusted R Square	0.989
Standard Error	1.477
Observations	10
F Significance	2.42E-05
NDBI Coefficient (p-value)	47.14 (2.42E-05)

Table 3.3: Sample Extracted NDVI and NDBI Values for Sampled Points

Sample Point	1990 NDVI	1990 NDBI	...	2020 NDVI	2020 NDBI
1	0.046	-0.220	...	0.069	-0.485
5	0.116	-0.183	...	0.180	-0.366
10	0.373	-0.063	...	0.543	0.229

Table 3.4: Summary of Regression Analysis between NDBI and NDVI

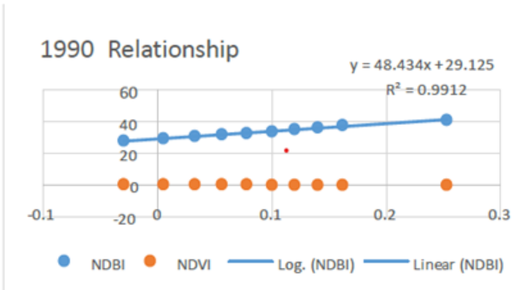

Figure 3.14: 1990 Correlation

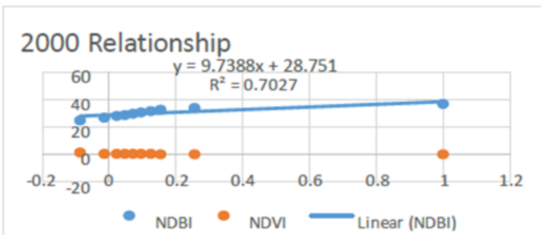

Figure 3.15: 2000 Correlation

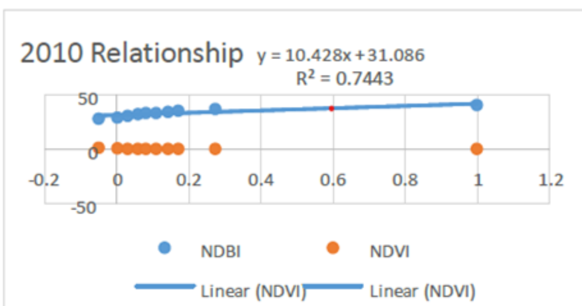

Figure 3.16: 2010 Correlation

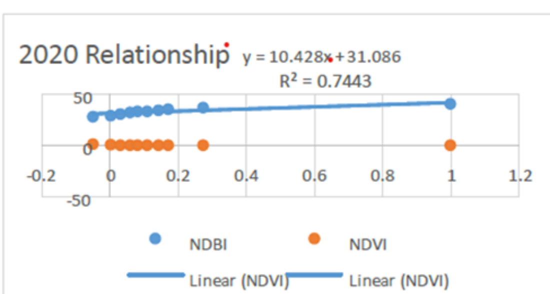

Figure 3.17: 2020 Correlation

IV. DISCUSSION

4.1. Religious Tourism as a Catalyst for Spatial Change

The documented LULC transition from a predominantly agrarian/vegetated landscape to an increasingly built-up one aligns precisely with the establishment and explosive growth of major faith camps from the late 1980s/1990s onward. The RCCG Redemption Camp, established in the 1980s, and the MFM Prayer City, founded in 1989, evolved from isolated prayer grounds into "cities within cities" (Adedibu, 2019). These complexes require vast land for worship auditoriums, residential quarters (e.g., RCCG's "Redemption City"), schools, and markets. Their gravitational pull attracts a permanent and transient population, catalyzing demand for housing, commerce, and services in the immediate vicinity (Olukole, 2022). This process exemplifies the "growth pole" theory, where a dominant industry (in this case, religious tourism) stimulates concentrated regional development (Perroux, 1950).

Our findings of a strong NDBI-NDVI correlation statistically validate the environmental trade-off inherent in this model of growth. The loss of forest and farmland signifies a reduction in ecosystem services, carbon sequestration, temperature regulation (urban heat island mitigation), biodiversity habitat, and local food production, which are critical for climate resilience in a rapidly urbanizing region (Gashaw et al., 2018).

4.2. Planning and Sustainability Implications

The spatial pattern of growth observed, linear expansion along the transport corridor and nodal clustering around camps, is largely unplanned. This has led to documented externalities: severe traffic congestion during events (Olanrewaju et al., 2016), strain on waste management systems, haphazard housing development, and the loss of environmentally sensitive areas. The planning vacuum stems from a lack of synergy between religious institutions, host communities, and local planning authorities, as noted in the study area (Ukpokolo & Okoye, 2013).

This case study highlights a critical challenge for urban planning in Africa: how to manage and integrate powerful, non-state actors like mega-churches into formal planning frameworks. The current laissez-faire approach is unsustainable. There is an urgent need for:

1. Faith-Sensitive Zoning Regulations: Delineating specific zones for large-scale religious assembly with required buffer zones, greenbelts, and infrastructure impact assessments.
2. Transit-Oriented Development (TOD) for Religious Nodes: Integrating park-and-ride facilities, dedicated shuttle services, and non-motorized transport pathways to manage event-related traffic.
3. Ecosystem-Based Compensation: Mandating that large religious developments contribute to regional ecological conservation funds or create on-site green infrastructure to offset their environmental footprint.

V. CONCLUSION

This study has provided empirical, geospatial evidence of the profound impact of religious tourism on peri-urban land systems in Nigeria. Over a 30-year period, the Mowe-Ibafo corridor underwent significant spatial transformation, characterized by substantial built-up expansion and concomitant vegetation loss, directly linked to the agglomeration of mega religious camps. The high-accuracy LULC maps and robust statistical analysis of spectral indices offer a reliable baseline for future monitoring.

The findings underscore that religious tourism is not merely a social or economic phenomenon but a significant driver of physical and environmental change. It represents a potent form of "faith-based urbanism" that is reshaping the African urban fabric. For policymakers and planners, ignoring this driver is no longer an option. The future sustainability of regions like Mowe-Ibafo depends on developing innovative, collaborative governance models that engage religious institutions as key stakeholders in the planning process. This will ensure that the economic and spiritual benefits of religious tourism do not come at an unacceptable cost to environmental integrity and long-term urban livability.

Future Research could employ higher-resolution imagery and landscape metrics to analyze fragmentation patterns in more detail, or use cellular automata models (e.g., SLEUTH) to simulate future growth scenarios under different planning interventions.

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