Decadal Spatio-Temporal Dynamics of Vegetation Change Across Ecological Gradients in Southern Taraba, Nigeria (2014–2024)

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Abstract: Vegetation resources in Nigeria are increasingly under pressure from population growth, agriculture, and climate variability. This study analysed vegetation change across Southern Taraba between 2014 and 2024 using Landsat imagery, the Normalized Difference Vegetation Index (NDVI), and supervised classification. Results indicate a 40–45% decline in vegetation cover, with farmland and built-up areas expanding rapidly. NDVI values decreased consistently across the decade, reflecting deterioration in vegetation health. Major drivers of change include agricultural expansion, logging, settlement growth, and infrastructural development. The findings underscore the urgent need for zoning regulations, community-led reforestation initiatives, and the integration of geospatial monitoring into land management policies to safeguard ecological stability and livelihoods in Southern Taraba.

Keywords: *Vegetation Dynamics, Remote Sensing, NDVI, Land Cover Change, Southern Taraba, GIS.*

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I. INTRODUCTION

Vegetation plays a crucial role in regulating climate, conserving biodiversity, and supporting agricultural productivity. In sub-Saharan Africa, however, rapid land cover transformation has intensified ecological degradation. Nigeria has experienced widespread vegetation loss driven by farming, logging, urbanization, and recurrent bush fires. These pressures are particularly acute in regions where communities depend heavily on natural resources.

Southern Taraba, located in northeastern Nigeria, is ecologically diverse, ranging from riparian forests to savannah grasslands. Yet over the last two decades, this area has witnessed severe vegetation decline. Agricultural expansion, population growth, and infrastructural projects have fragmented natural habitats, while seasonal climate variability has placed further stress on ecosystems.

Despite the region’s ecological and economic significance, there is limited empirical research on long-term vegetation trends in Southern Taraba. Most studies either focus on broader national patterns or other ecological zones, leaving a gap in localized, data-driven assessments. This study addresses this gap by applying geospatial tools to examine decadal vegetation changes, providing evidence to guide environmental policy and sustainable land use practices.

II. LITERATURE REVIEW

Remote sensing and GIS have become indispensable in monitoring vegetation change. Vegetation indices such as NDVI provide an efficient means of quantifying greenness and detecting temporal variations (Tucker, 1979; Jensen, 2007). Numerous studies have documented vegetation decline across Nigeria, attributing it to agricultural expansion, urbanization, deforestation, and climate variability (Ayuba & Maryah, 2005; Oruonye & Abbas, 2011).

Globally, regions such as South America and sub-Saharan Africa record some of the highest deforestation rates (FAO, 2020). In Nigeria, vegetation change studies are abundant in the savannah and Sahel zones, but remain sparse for Southern Taraba. Earlier research in Takum and Wukari LGAs has highlighted localized vegetation loss due to farming and road expansion (Aremu & Bala, 2017; Chigbu et al., 2021). However, consistent multi-temporal analysis spanning a decade remains limited.

This paper contributes by combining NDVI-based analysis with supervised classification to provide a

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comprehensive spatio-temporal assessment of vegetation trends in Southern Taraba from 2014 to 2024.

III. METHODOLOGY

➢ *Study Area:*

Southern Taraba covers LGAs such as Takum, Ussa, Donga, Wukari, and Ibi, lying between latitudes 6°30′–8°00′ N and longitudes 9°30′–11°00′ E. The region experiences a tropical wet-and-dry climate, with rainfall ranging from 1,200–1,800 mm annually and diverse vegetation types including savannah grasslands, gallery forests, and farmland.

➢ *Data Sources:*

- Landsat 8 OLI/TIRS imagery for 2014, 2019, and 2024 (30 m resolution, USGS).
- Administrative boundaries from OSGOF and GADM.
- Ancillary datasets: climate records (NiMet) and population data (NPC).

➢ *Data Processing:*

- Preprocessing: Images were corrected geometrically and radiometrically, with atmospheric corrections applied. Cloud masking was done using the Fmask algorithm.
- NDVI Computation: NDVI was derived using Band 5 (NIR) and Band 4 (RED), with values categorized into low (<0.2), moderate (0.2–0.4), and high (0.4–0.6) vegetation.
- Classification: Supervised classification with the Maximum Likelihood Algorithm was used to classify land cover into vegetation, farmland, built-up, bare land, and water bodies.
- Change Detection: Post-classification comparison was applied to detect transitions between classes across the three timeframes.
- Accuracy Assessment: A confusion matrix with 100 random points was used to calculate accuracy, yielding overall accuracies above 85% and kappa coefficients between 0.79 and 0.84.

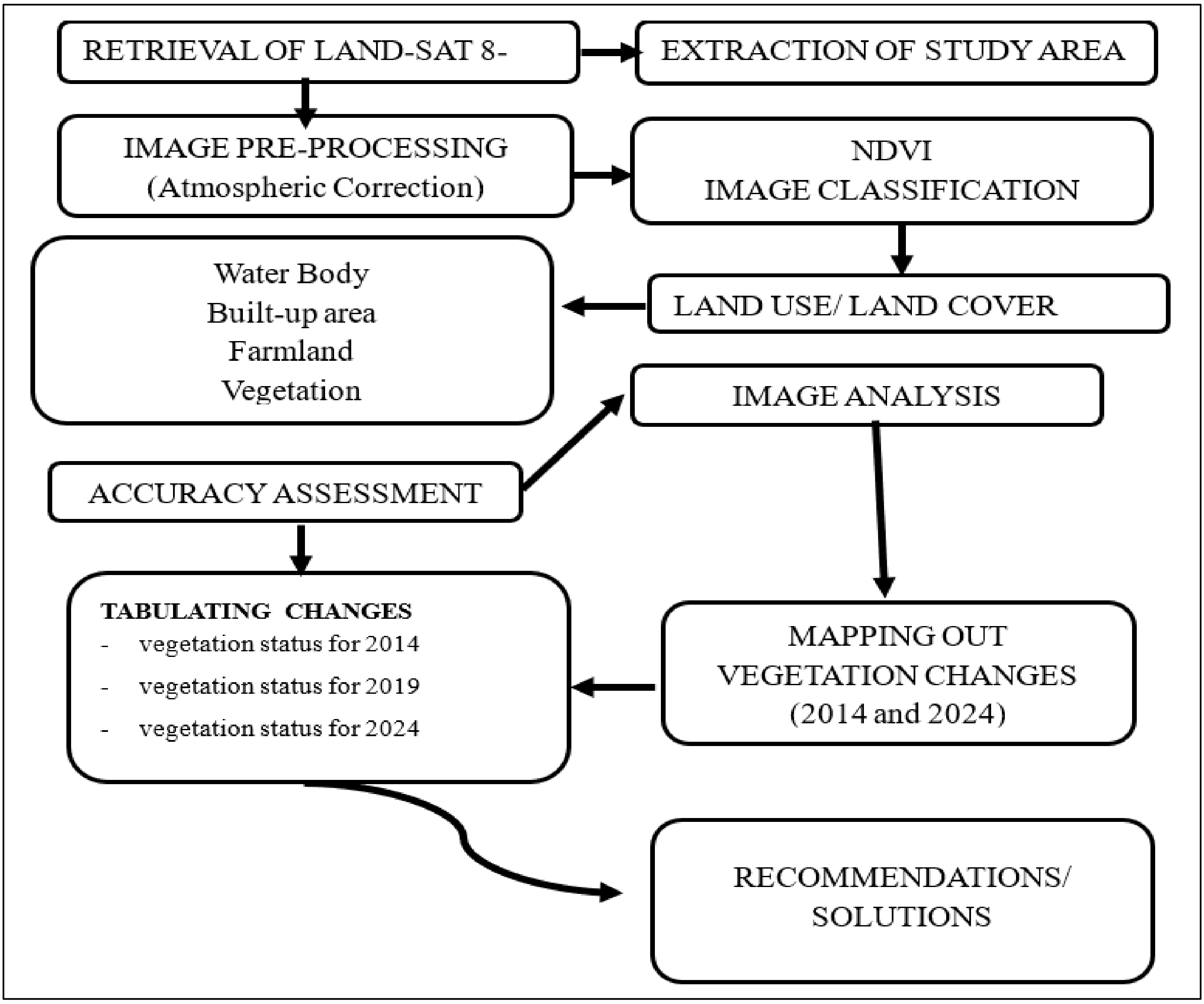

Fig 1 Flowchart of Methodology
Source: Author 2025

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IV. RESULTS AND DISCUSSION

Table 1 Land Cover Statistics for Southern Taraba (2014–2024).

Land Cover Class	2014 (km²)	2019 (km²)	2024 (km²)	% Change (2014–2024)
Vegetation	11,830	7,410	6,090	–45%
Farmland	7,030	9,030	10,280	+46%
Built-up Area	2,020	5,060	8,040	+298%
Bare Land	9,020	7,140	6,550	–27%
Water Body	1,020	940	400	–61%

➢ *Discussion:*

The findings highlight an alarming trend of vegetation loss, with over 40% of natural cover lost within a decade. The rapid rise in built-up areas (almost 300% increase) underscores the impact of urban growth on ecological resources. The conversion of forest to farmland threatens biodiversity and long-term agricultural sustainability. These results align with earlier studies in Taraba (Oruonye & Abbas, 2011; Chigbu et al., 2021), but extend the evidence by providing a decadal, multi-temporal analysis of vegetation decline.

- NDVI Trends: NDVI declined steadily from 2014 to 2024, with increasing areas falling into low and moderate vegetation categories. By 2024, large portions of Southern Taraba recorded NDVI values below 0.4, indicating widespread vegetation stress.
- Land Cover Change: Vegetation area shrank from 11,830 km² in 2014 to 6,090 km² in 2024, while farmland and built-up areas expanded significantly. Farmland increased by more than 3,000 km², and built-up land more than tripled, reflecting population growth and urban sprawl.
- Change Detection: The dominant transitions were from vegetation to farmland (1,250 km²) and from vegetation to built-up areas (1,320 km²). Conversion was concentrated along riverbanks, road corridors, and densely populated zones such as Takum and Wukari.
- Drivers of Change: Population increase, shifting cultivation, logging, fuelwood harvesting, and infrastructural expansion were the main drivers. These findings align with earlier studies linking vegetation loss to anthropogenic pressures in Taraba (Oruonye & Abbas, 2011).
- Implications: Declining vegetation threatens biodiversity, agricultural productivity, and ecosystem services. Without interventions, the region risks irreversible land degradation, undermining livelihoods and resilience against climate variability.

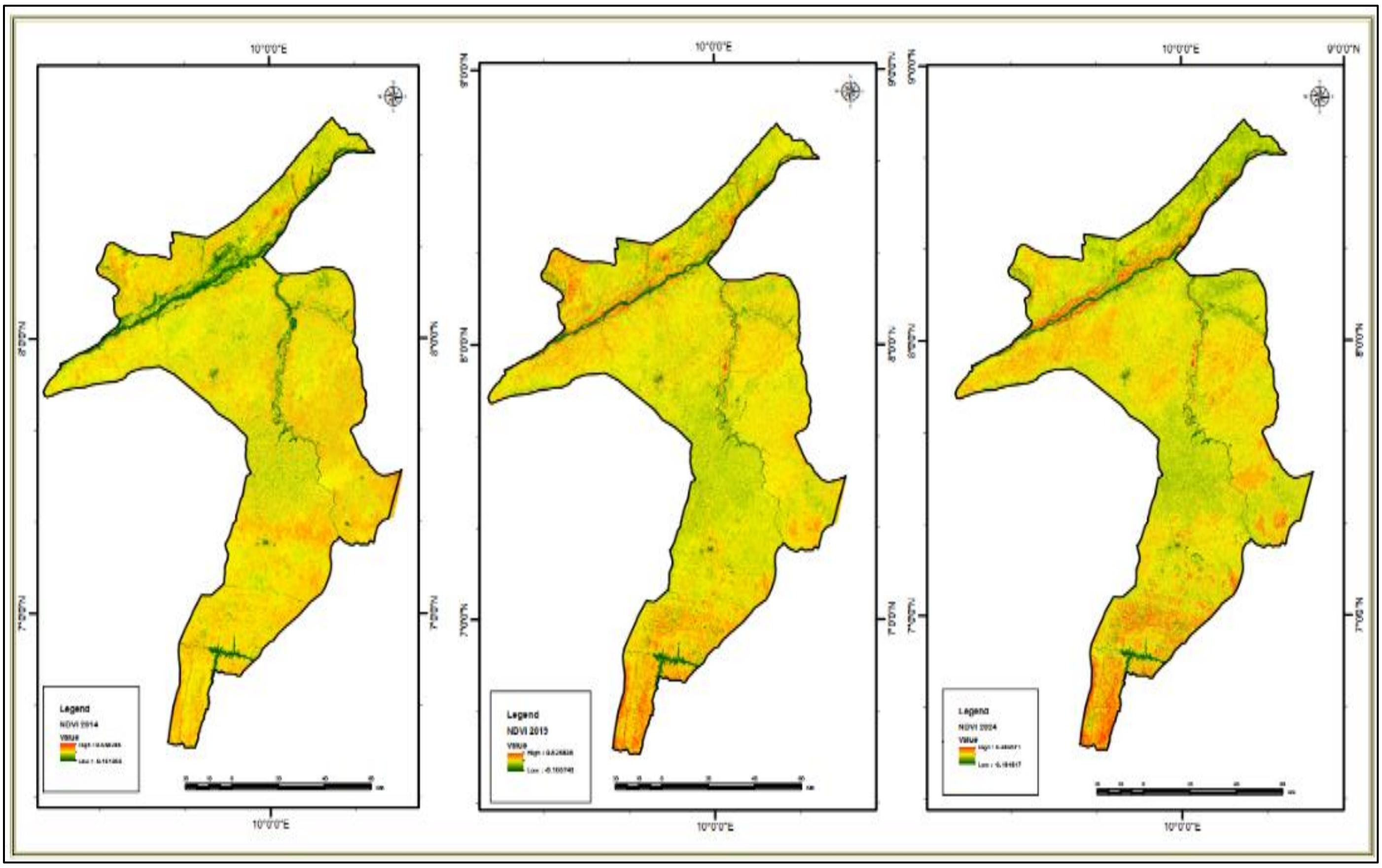

Fig 2 NDVI of 2014, 2019 and 2024
Source: Author 2025

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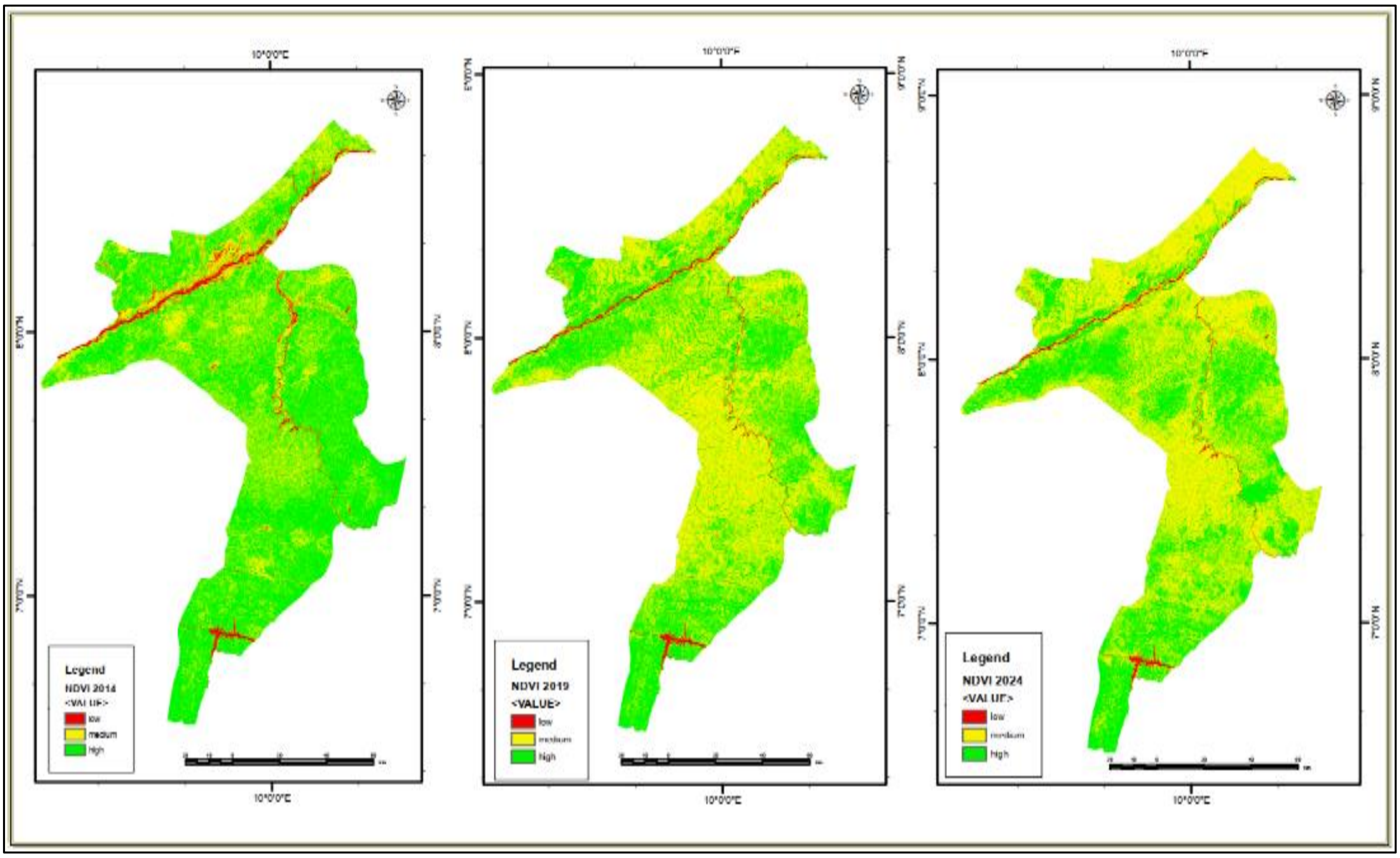

Fig 3 NDVI Showing the Density of Vegetation in 2014, 2019 and 2024
Source: Author 2025

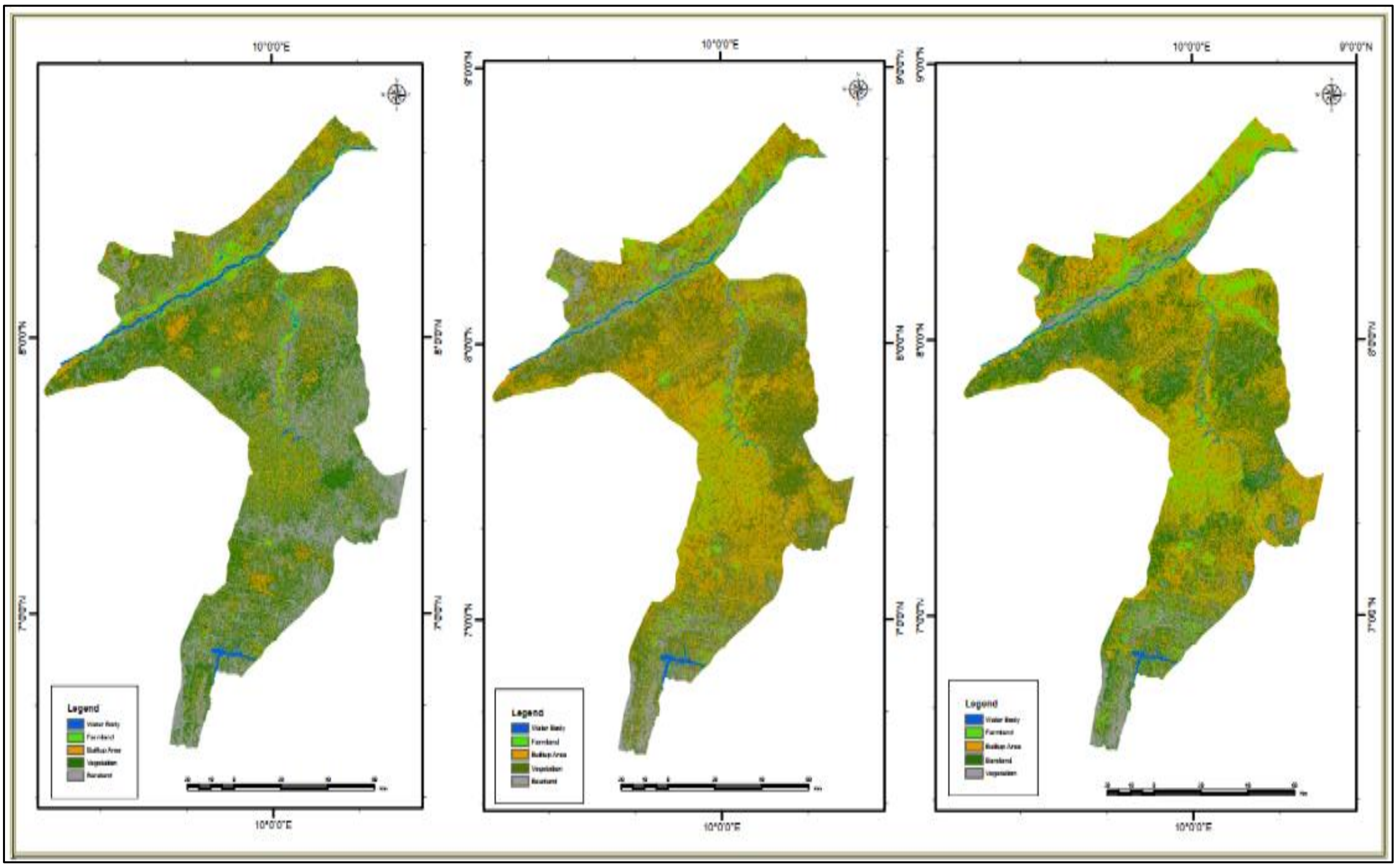

Fig 4 LULC Map of 2014, 2019, and 2020
Source: Author 2025

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V. CONCLUSION AND RECOMMENDATIONS

This study demonstrates that Southern Taraba experienced severe vegetation loss between 2014 and 2024, with farmland and built-up areas expanding at the expense of natural vegetation. Human activities, rather than climate variability alone, were the dominant drivers.

➢ *Recommendations:*

- Enforce land-use zoning and regulate agricultural encroachment into high-NDVI zones.
- Promote agroforestry and climate-smart farming to reduce pressure on natural vegetation.
- Integrate remote sensing and GIS into local government planning for real-time monitoring.
- Launch community-based reforestation programs and encourage adoption of alternative energy sources.

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