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Spatiotemporal Analysis of Land Use Change and Gully Expansion in the Idemili Drainage Area, Southeastern Nigeria.

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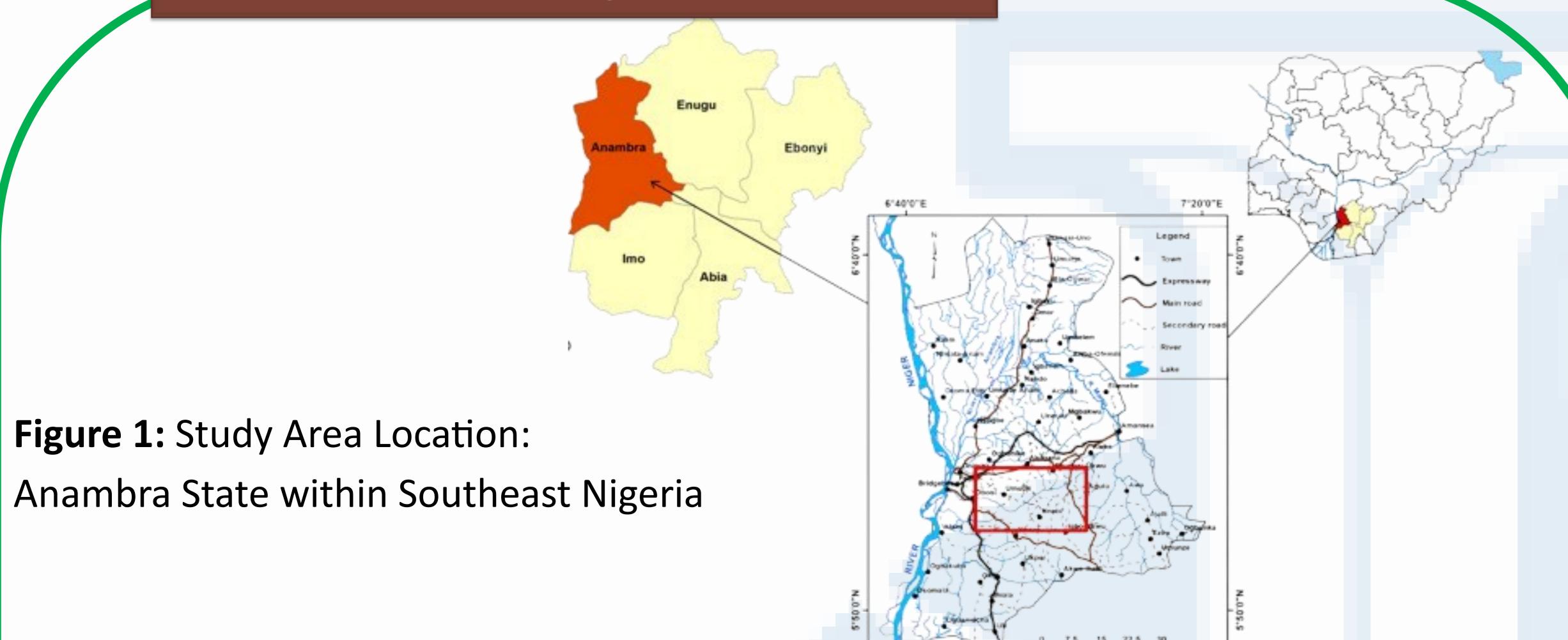
INTRODUCTION & AIM

Gully erosion is a major driver of land degradation in southeastern Nigeria, with the Idemili Drainage Area experiencing severe ecological impacts, destruction of infrastructure, loss of farmland, and displacement of communities. The growing intensity of these events highlights the need for a scientific understanding of their causes. A key factor believed to accelerate gully formation is Land Use and Land Cover (LULC) change, driven by urbanization, deforestation, and agricultural expansion, which alter hydrological processes, increase runoff, reduce infiltration, and weaken soil stability. Although the link between LULC and erosion is widely acknowledged, site-specific quantitative evidence remains limited. Addressing this gap requires detailed spatiotemporal investigations that move beyond broad generalizations. This study aims to investigate the dynamics of LULC changes over a period of 33 years (1992–2025) and their implications to gully development as a result of the transformations. **AIMS**

- •To analyze the land use and land cover changes in the study area over the past 33 years (1992–2025)
- Quantify LULC changes (1992–2025)
- To provide recommendations for sustainable land use practices and strategies for mitigating gully erosion



METHOD



Data Acquisition and Preprocessing

Four sets of Landsat imagery were acquired from the USGS Earth Explorer [1]platform: Landsat 4-5 TM (1992), Landsat 7 ETM+ (2002), and Landsat 8 OLI (2013, 2015). All images underwent geometric, radiometric, and atmospheric corrections, and were selected

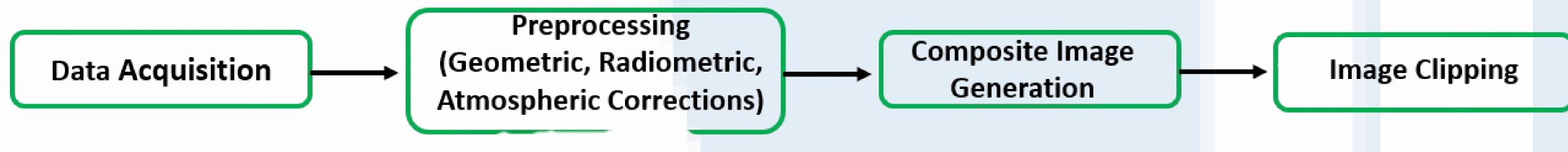
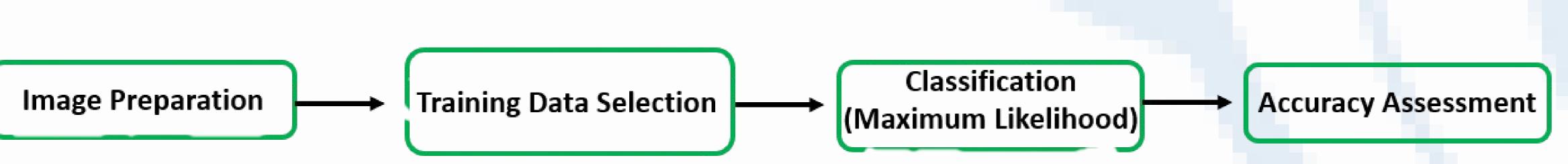


Image Processing and Classification

Composite images were generated from six bands and clipped to the study area using the Spatial Analyst tool in ArcGIS 10.8 [2]. Classification followed Anderson's (1976) Level 1 [3] system, defining barren land, built-up areas, farmland, forest, shrubs, and water. Supervised classification employed the maximum likelihood technique, sup-



Change Detection Analysis

Metrics Computed:

- Area Coverage: Calculated for each LULC class across all years
- •Magnitude of Change: Magnitude = Area_{Recent} Area_{Previous}
- Rate of Change: Rate = Percentage Recent Percentage Previous
- •Percentage Change: $\left(\frac{Final\ Value-Initial\ Value}{Initial\ Value}\right) \times 100$

CONCLUSION

- Human-driven LULC changes are primary erosion drivers
- Urgent need for sustainable land use planning

Recommendations

To mitigate this, sustainable land management practices, including effective urban planning, reforestation, and soil conservation techniques, are essential to address the challenges of gully development in Idemili.

RESULTS & DISCUSSION

Land Use and Land Cover (LULC) Change Overview (1992–2025)

The study analysed land cover changes across four time periods: 1992, 2002, 2013, and 2025. The following land cover classes were considered: Barren, Built-up, Farm land, Forest, and Shrub. The data reveal notable shifts in land cover over the 33-year period.

Table 1: Temporal Distribution of Land Use and Land Cover Classes in the Idemili Drainage Area

(1992 - 2025)

LULC Class	Area (1992)	Area (2002)	Area (2013)	Area (2025)
Barren	13.87 km²	12.94 km²	21.16 km²	16.78 km²
Built-up	20.52 km²	50.01 km²	66.39 km²	142.59 km²
Farm land	158.16 km²	103.38 km²	115.04 km²	80.29 km²
Forest	127.85 km²	150.18 km²	108.99 km²	82.73 km²
Shrub	20.64 km²	24.35 km²	29.38 km²	18.13 km²

Table 2: Percentage Change and Interpretation of LULC Dynamics in the Idemili Drainage Area

(1992-2025)

LULC Class	1992 Area (%)	2025 Area (%)	Absolute Change (%)	Relative Change	Interpretation
Built-up	6.01	41.75	+35.74	+595%	Nearly sixfold increase due to urban expansion
Farmland	47.33	24.04	-23.29	-49.23%	Significant decline in agricultural land
Forest	38.27	24.77	-13.50	-35.30%	Major reduction in forest cover
Shrubs	6.18	5.43	-0.75	-12.13%	Moderate decline in shrublands
Barren Land	4.10	4.93	+0.83	+20.24%	Slight increase in exposed land
Water Bodies	0.14	0.33	+0.19	+135.71%	Suggests altered drainage and runoff patterns

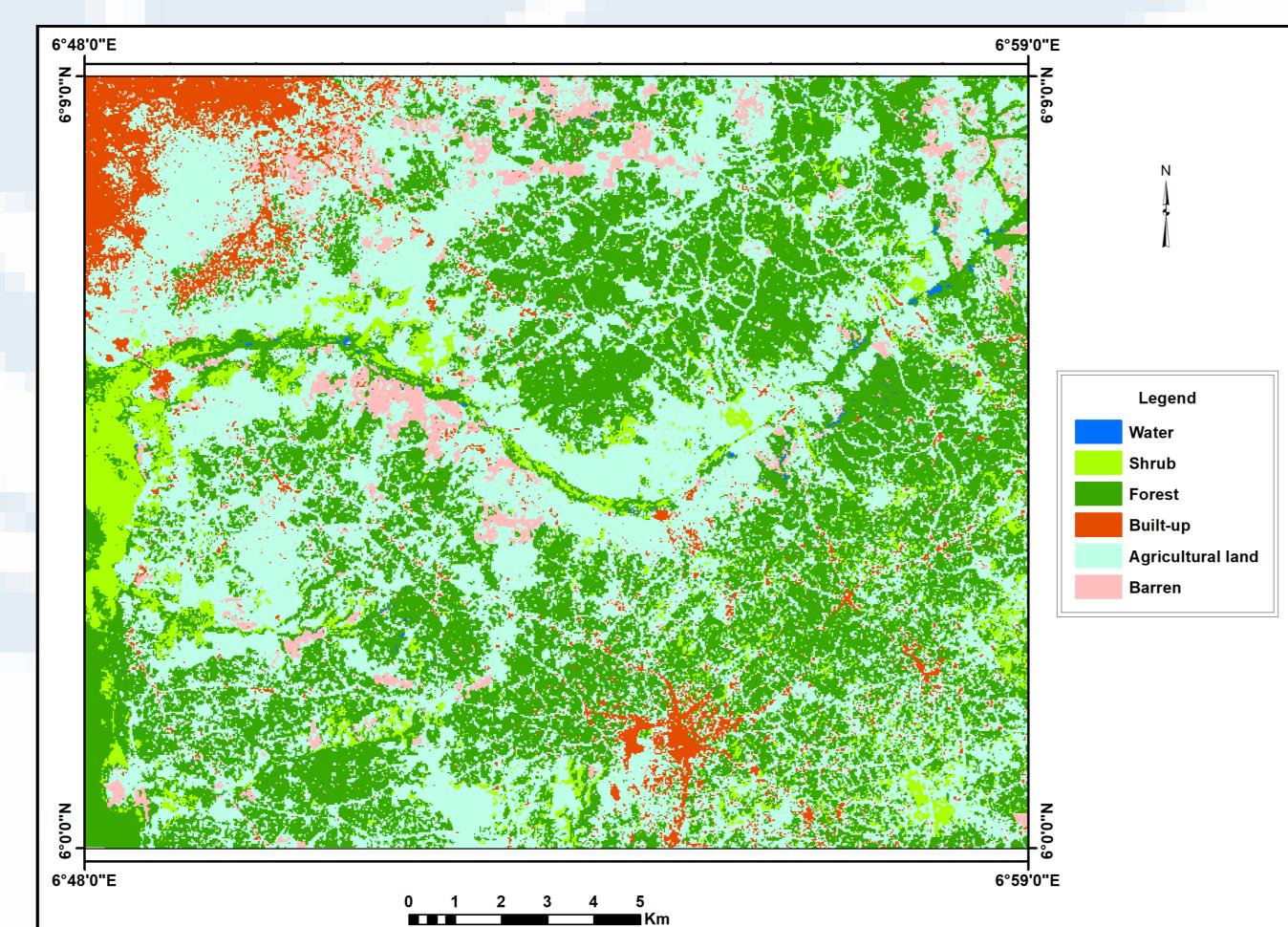


Figure 2: LULC Map 1992

Figure 3: LULC Map 2025

Land Cover Area by Class (1992-2025) 160 - Land Cover Class Barren Built-up Figure 4: Land Cover Area by Class (1992-2025)

The LULC changes over the past 33 years, characterized by significant urbanization, deforestation, and agricultural reduction, have contributed to the intensification of gully erosion in the study area. The loss of natural vegetation and the expansion of impervious surfaces have reduced the land's ability to absorb water, exacerbating surface runoff and leading to the formation of gullies.

FUTURE WORK / REFERENCES

Future research should focus on Future research should focus on integrating high-resolution satellite imagery and terrain data to enhance the spatial accuracy of erosion modeling in the Idemili Drainage Area. Incorporating hydrological simulations and soil characteristics would allow for predictive assessments of runoff and gully formation under varying land use scenarios.

[1]USGS Earth Explorer. https://earthexplorer.usgs.gov

[2] ESRI ArcGIS 10.8 Documentation. https://www.esri.com

[3] Anderson, J.R. et al. (1976). A Land Use and Land Cover Classification System for Use with Remote Sensor Data. USGS Professional Paper 964.

[4]Google Earth Engine. https://earthengine.google.com