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LEVERAGING THE UGANDA NATIONAL LAND INFORMATION SYSTEM FOR CLIMATE CHANGE PREDICTION SPATIAL ANALYSIS OF LAND TENURE AND LAND USE PATTERNS

Richard OPUT, Jimmy ALANI, Godfrey TOKO, Martha MUGARURA, Harriet ACHOLA and Joseph MIVULE, Uganda

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Introduction

Climate change is a significant threat to Uganda's socio-economic and environmental stability. As a country heavily reliant on agriculture and natural resources, Uganda faces heightened vulnerability to erratic weather patterns, increased flooding, and prolonged droughts. These impacts are closely tied to land use and management practices. Inefficient land governance, deforestation, and unplanned urbanization exacerbate the challenges posed by climate change.

The Uganda National Land Information System (UgNLIS) has transformed land administration by digitizing land tenure records and providing a spatial platform for analyzing land use. This paper explores the role of UgNLIS in addressing climate change, focusing on its capacity to facilitate predictive analysis, inform policy decisions, and promote sustainable land-use practices.

- Population: ~48 million (2024 estimate)
- Youthful population: Over 75% under the age of 30
- Urbanization rate: ~24% of the population lives in urban areas
- Major cities: Kampala (capital), Gulu, Mbarara, Jinja

Land Cover in Uganda

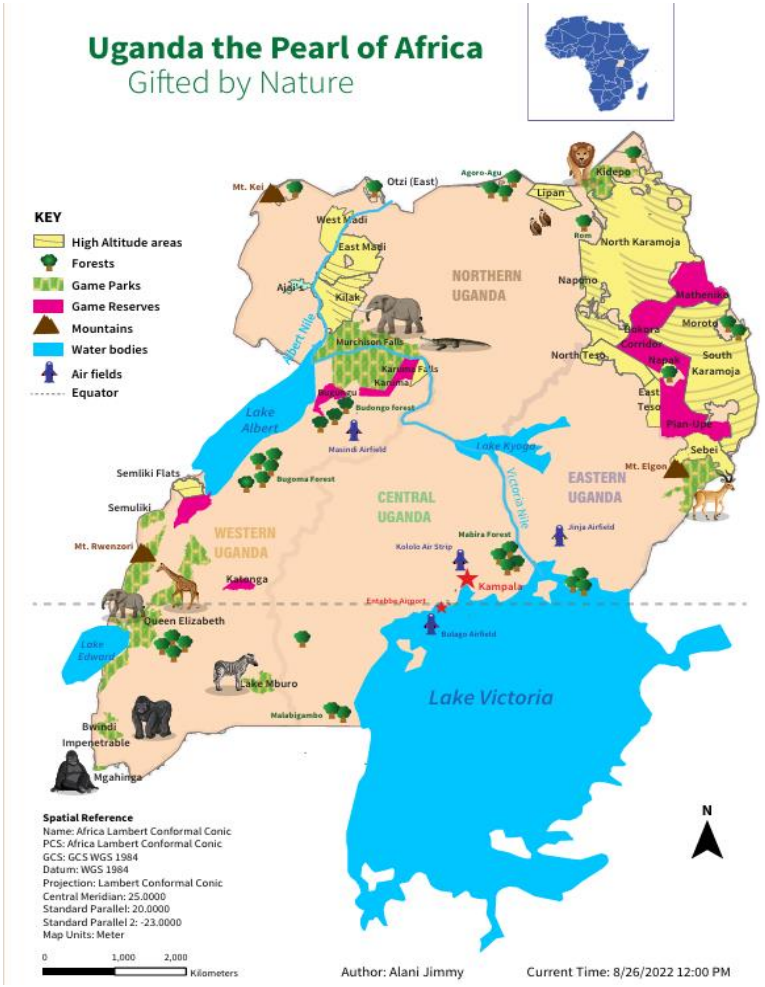
- Total land area: ~241,000 sq. km

Major land cover types:

- Forests and woodlands (~15%)
- Wetlands (~10%)
- Agricultural land (~70%)
- Built-up/urban areas (~3%)

Notable ecosystems:

- Tropical rainforests (e.g., Mabira, Bwindi)
- Savannah grasslands
- Wetland systems along Lake Victoria and Nile River



- **Climate Information**
- **Climate type**: Tropical (wet and dry seasons)
- **Rainfall:** Varies from 800 mm to 2,000 mm annually
- **Temperature:** Average range: 16°C to 28°C
- Higher elevations (e.g., Mount Elgon, Rwenzori) are cooler
- **Climate risks:** Increasing frequency of droughts and floods
- Erratic rainfall and prolonged dry spells
- Rising temperatures and deforestation impact water resources and agriculture

Actions Being Taken to Combat Climate Change

- **Policy & Strategy:** Uganda National Climate Change Policy (NCCP)
- Tree planting campaigns and afforestation programs
- Climate Smart Agriculture (CSA) initiatives
- Technology & Data Use
- Leveraging UgNLIS and satellite imagery for monitoring land use and environmental changes

Uganda's Land Management Challenges

In Uganda, over 80% of land is under customary tenure, characterized by informal governance and a lack of documentation. This scenario limits the potential for climate-smart investments and adaptation initiatives. Studies highlight that insecure land tenure and weak governance exacerbate land degradation and conflict, undermining climate resilience.

The rapid pace of urbanization in Uganda further complicates land management. The loss of wetlands, deforestation, and encroachment on protected areas are key contributors to increased GHG emissions and reduced ecological resilience. Uganda's National Land Policy (2013) and National Urban Policy (2017) emphasize the need for integrated approaches to address these issues, aligning with the goals of sustainable development and climate adaptation.

Role of UgNLIS in Climate Resilience

Improved Land Governance:

- Reduces conflicts and enhances transparency in land transactions

Improved Physical Planning:

- Minimizes informal settlements and boosts socio-economic mobility

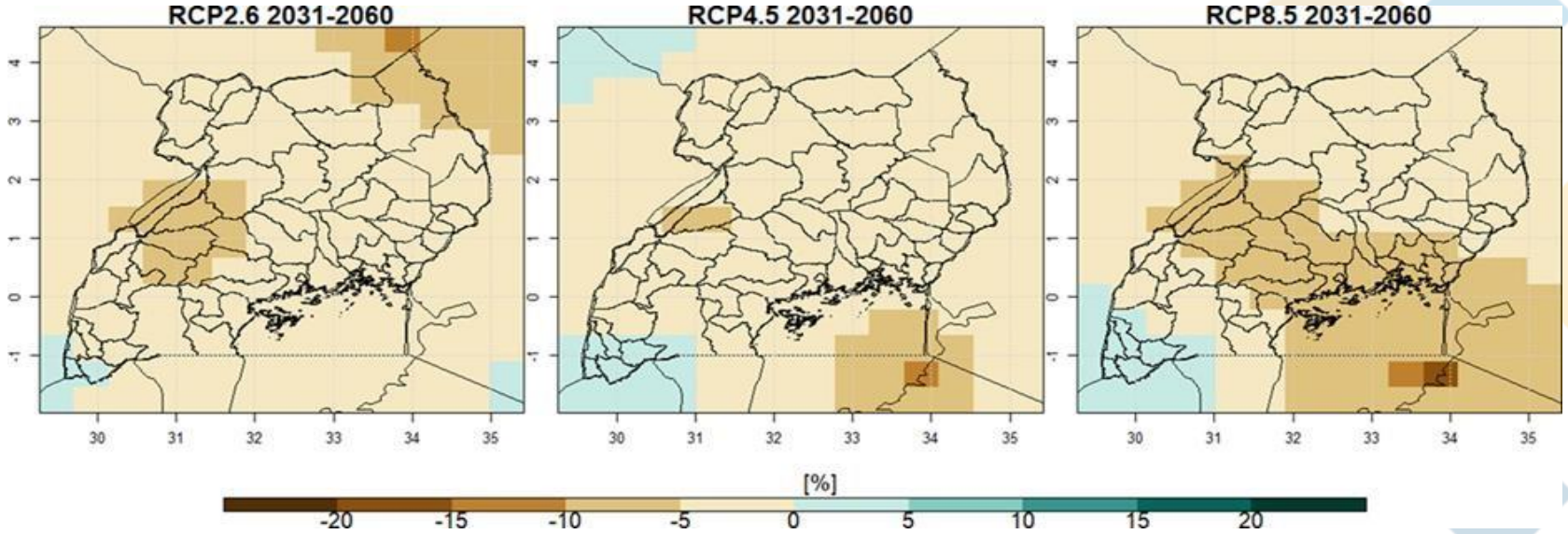
Spatial Analysis for Climate Adaptation:

- Identifies vulnerable areas and models climate impacts for resilience

Integration of National Policies:

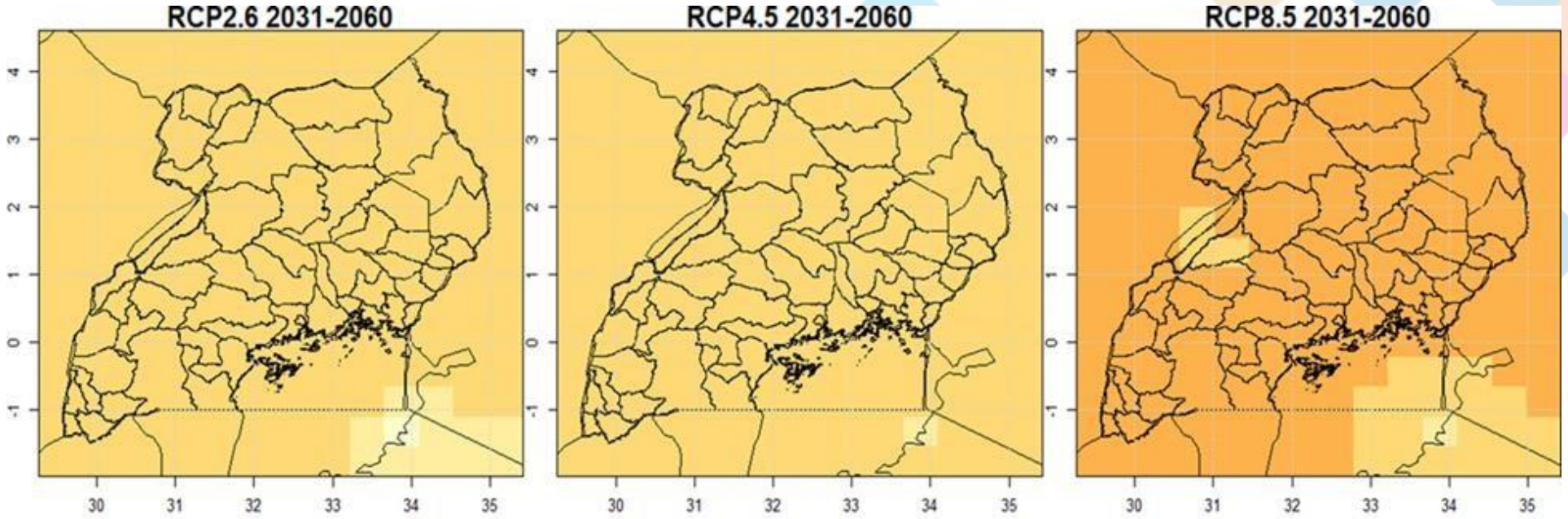
- Aligns land-use decisions with Uganda's National Climate Change Policy (2015)

Brief on the Projected Climate Analysis- R/F



Under RCP 2.6, Masindi, Hoima area as well as Karamoja region rainfall is projected to decrease by 5 to 10 %. Under RCP 4.5, increase of 5 to 10% in SW Uganda Highlands. Meanwhile, under RCP 8.5, decrease by 5 to 15% in most parts of central Uganda and an increase by 5 to 10% in SW Uganda. These rainfall patterns can be well articulated with secure land use pattern analysis for comprehensive climate change mitigation.

Brief on the Projected Climate Analysis- Temp



- It should be noted from the maps that the Mean annual Temperature projections at climate level (2031-2060) show projected temperature increases of:
- 1 to 1.5^{o}C under RCP 2.6 and RCP 4.5 for most parts of the country
- 1.5 to 2.5^{o}C for RCP 8.5 relate to the 1981-2010 average

Methodology

Data Sources and Pilot Research

This study utilized data from the Uganda National Land Information System (UgNLIS), supported by a collaborative pilot research phase between the University of Zurich (UZH) and the Ministry of Lands, Housing and Urban Development at the National Land Information Center (NLIC).
Key data components included parcel and transaction Data

- 307,832 registered parcels
- 131,668 land transactions
- 192,190 parcels with transaction records

Spatial Data

Shapefiles covering 200,166 parcels from Busiro Ministry Zonal Office

Why Busiro?

Busiro was selected as the pilot study area because of its:

- High transaction volume
- Varied tenure types

Substantial land-use changes over time

This diversity made it ideal for developing and testing spatial analysis methodologies before potential national scale application.

Analytical Framework and Climate Lens

Land Cover & Use Analysis

- Land cover change was assessed from 2016 to 2022 using satellite imagery linked to UgNLIS parcel data.
- Significant increase in built-up areas (from 40% to 60%) was recorded, mostly at the cost of tree cover (down from 34% to 21%) and scrubland (15% to 7%).

Parcel Transformation Trends

- Subdivision rates rose from 7% (2016–2018) to 9% (2021–2022), signaling urban expansion.
- Amalgamation remained below 1%, suggesting little consolidation of land.
- Parcels transferred during this period were more likely to be developed or change use.

Rainfall Variability and Land Dynamics

- Rainfall patterns were overlaid with parcel transaction timelines.
- Parcels often experienced dry conditions before a transaction and increased rainfall around the time of transfer—suggesting climate-influenced land market activity.
- 2019–2020 had the highest rainfall average (418.9 cm/sqkm), while long droughts were prevalent before and largely absent in the mid-study period.

Tools and Techniques Used

GIS Software: ArcGIS/QGIS for shapefile and raster analysis

Remote Sensing: Satellite imagery classification for land cover

Temporal Analysis: Comparing climate data and transaction trends over defined periods

Statistical Methods: Regression and correlation of land use changes with climate variability

Visual Outputs (Graphs & Maps)

To visually support this methodology, we included:

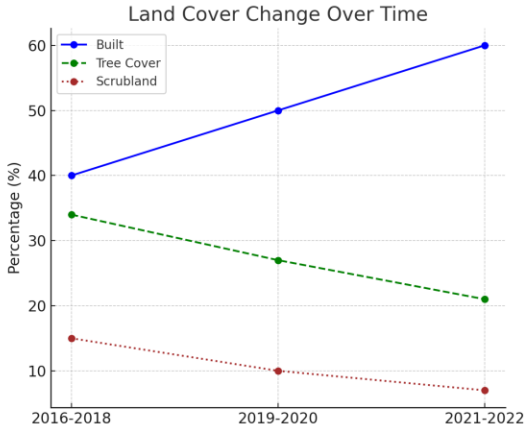
Graph 1: Land cover change from 2016 to 2022

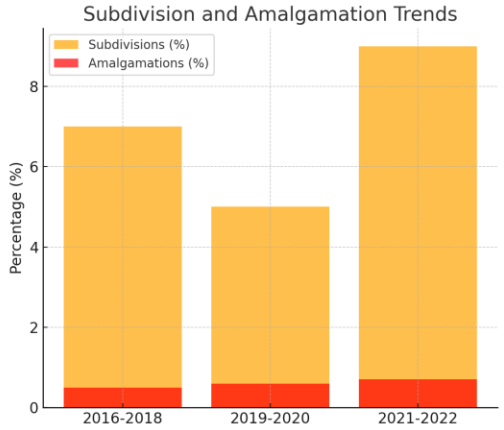
Graph 2: Subdivision and amalgamation trends over time

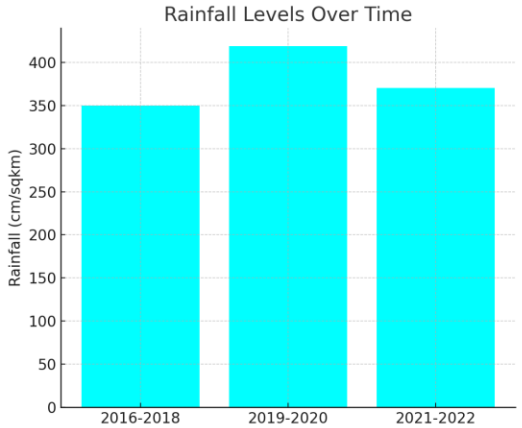
Graph 3: Rainfall variation across study periods

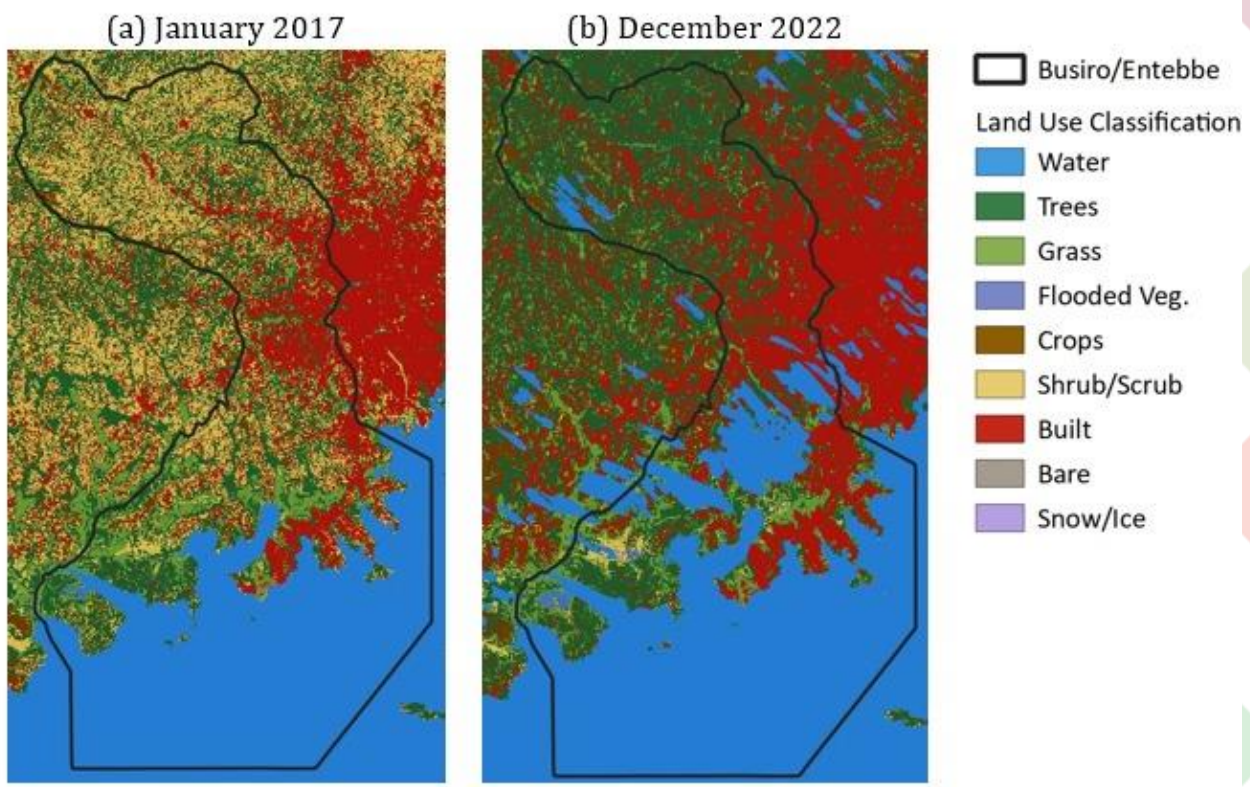
Map: Spatial visualization of Busiro parcel transformations and tenure diversity

Visual Outputs (Graphs & Maps)









Results and Discussion

1. Insights from UgNLIS

- Identified key land-use changes: urban sprawl, deforestation, wetland encroachment
- Linked these to increased GHG emissions and reduced ecological resilience
- Secure land tenure and planned urbanization correlate with higher climate resilience

2. Alignment with National Policies

- UgNLIS supports National Climate Change Policy with risk-informed land-use planning
- Promotes green infrastructure and compact, energy-efficient urban development (per National Urban Policy, 2017)

3. Challenges in Implementation

- Limited accessibility of Customary Tenure (covers 80% of Uganda's land)
- Inadequate technical capacity
- Need for stronger integration with national policies

Recommendations

Enhance UgNLIS Functionality
Integrate climate data and modeling tools for better adaptation and mitigation planning.

Capacity Building
Train staff and policymakers to effectively use UgNLIS in climate resilience efforts.

Promote Stakeholder Collaboration
Encourage cooperation between government, professionals, and communities to mainstream UgNLIS in climate strategies.

Policy Integration
Align UgNLIS with national policies like the National Climate Change Policy and Urban Policy.

Increase Public Awareness
Educate communities and local leaders about the role of UgNLIS in tackling climate change.

Conclusion

- UgNLIS is a vital tool in addressing land governance and climate change challenges.
- It supports spatial analysis for informed decision-making and climate adaptation.
- Benefits include reduced GHG emissions and improved socio-economic resilience.
- Realizing its full potential requires:
- Overcoming implementation challenges.
- Strengthening policy integration
- Fostering stakeholder collaboration
- UgNLIS promotes sustainable land management and supports Uganda's transition to a resilient and green economy.
- The study offers a framework for leveraging digital systems in sustainable development.