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Drivers of Informal Settlement Growth and Land Use Change in Dar es Salaam: Insights from Remote Sensing and GIS (1995-2024)

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Abstract

This paper explores the drivers of informal settlement expansion and assesses the consequences of inadequate urban planning. It integrates quantitative analysis using Landsat imagery and spatial analysis with ArcGIS Pro, alongside qualitative data from focus groups and interviews. Land cover changes from 1995 to 2024 were evaluated using supervised image classification with a random forest classifier in R to generate land use land cover classes. The analysis revealed significant changes in land use. Agricultural areas increased from 396.7km² to 555.17km², while built-up areas expanded from 72.55km² to 403.44km². In contrast, the forest, bushland, and grassland areas declined significantly. The key drivers of informal settlement growth include financial constraints, political interference, challenges to formalization, and poor coordination among stakeholders. Financial constraints impede comprehensive planning and infrastructure development, while political interference weakens land-use policies. Bureaucratic and financial barriers to formalization lead to unauthorized construction, and the lack of institutional coordination exacerbates fragmented planning and informal industrial growth. Thus, addressing the rapid expansion of informal settlements requires significant financial investments, a strong political commitment, enhanced coordination, and increased public awareness to support sustainable urban planning.

Keywords: *urban planning, spatial analysis, change detection, unplanned settlement, urbanization*

1. Introduction

1.1 Background

Urban planning in developing countries, and particularly in East Africa, faces complex challenges driven by rapid urbanization, governance issues, and intricate land-use dynamics (Magina, Kyessi & Kombe, 2020). Rapid population growth and rural-to-urban migration in African urban centres have overwhelmed infrastructure and services, leading to informal settlements, fragmented land use, and inadequate service provision (Worrall et al., 2017; Lugakingira et al., 2013, Faust & Pomes-Jimenez, 2020).

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In East Africa, countries such as Tanzania, Kenya, and Uganda face these issues within diverse sociocultural and political contexts; with weak governance and politics contributing to unplanned urban growth and spatial disorganization (Lindner, 2010; Gwaleba, 2018; Simon, Yamungu & Lyimo, 2022). Governance lapses such as corruption and inadequate policy frameworks hinder the effectiveness of urban planning interventions in these regions (Myers, 2022). Additionally, land-use conflicts, ambiguous property rights, and insufficient stakeholder coordination further complicate efforts to create sustainable urban environments (Mbilinyi et al., 2023).

In Dar es Salaam, Tanzania, rapid urbanization has intensified governance challenges, including corruption, inadequate policy frameworks, and political interference: all of which hinder sustainable urban development (Bhanjee, 2019; Myers, 2022). The city is experiencing significant population growth and urban expansion, which results in complex governance issues that profoundly impact its sustainable development (Yuan et al., 2023). Studies by Simon et al. (2022), and Mbilinyi et al. (2023), identify several recurring challenges that impede effective urban planning. Financial constraint has emerged as the pivotal barrier that limits comprehensive planning and infrastructure development essential to accommodate the ever-growing urban populations (Bhanjee & Zhang, 2021). Also, political interference in decision-making often favours short-term gains, thus leading to urban sprawl and the proliferation of informal settlements, and thereby undermining the long-term sustainability of cities (Croese et al., 2023; Simon et al., 2023).

As mentioned earlier, the expansion of informal settlements in Dar es Salaam, Tanzania, is a pressing urban challenge. A combination of various factors—including rapid urbanization, land tenure issues, poverty, and inadequate urban planning—drive this phenomenon. Addressing these challenges requires integrated governance mechanisms that facilitate participatory planning, streamline land tenure systems, and promote sustainable urban development (Gwaleba, 2018; Nuhu, 2019; Croese et al., 2023).

Several studies have examined the expansion of informal settlements in Dar es Salaam. For example, Zhang et al. (2020) analysed the morphological characteristics of informal settlements and proposed strategies for sustainable development. Abebe (2011) has modelled their growth; while Sirueri (2015) compared settlement patterns in Dar es Salaam with those in Nairobi. On their part, Wolff et al. (2021) defined peri-urban areas based on a multidimensional characterization of spatiotemporal land use along an urban-rural gradient in Dar es Salaam, Tanzania. Sliuzas (2004) addressed the challenges of managing informal settlements; Wolff et al. (2021) defined the peri-urban multidimensional characterization of spatiotemporal land use along an urban-

rural gradient in Dar es Salaam. Also, other studies have explored factors driving the expansion of informal settlements, including informal land management (Kombe & Kreibich, 2000), urban typologies (Lupala, 2002), regulatory frameworks (Kironde, 2006), water management (Kyessi, 2005), and urban planning governance (Msangi, 2011).

The application of remote sensing (RS), geographic information systems (GIS), and ground surveys is crucial for detecting and understanding changes in land use and land cover (LULC) dynamics; as well as the underlying factors driving these changes. Hence, this paper aims to employ a supervised machine-learning classification approach (Twumasi et al., 2020; Loukika et al., 2021) to generate quantitative spatiotemporal data on land use/land cover (LULC) trends from 1995 to 2024 in Dar es Salaam. It also analyses existing land use data from 1982 to 2022, and explores community perceptions of the factors driving informal settlement expansion. Furthermore, by leveraging GIS to map informal settlements, this study analyses their spatial distribution and identifies areas most impacted by their expansion; thereby enhancing the understanding of LULC dynamics. This integration allows for a comprehensive understanding of how informal settlements interact with the broader urban environment, supporting informed urban planning and policymaking decisions.

1.2 Research Gap and Objective

A critical research gap persists in integrating the multifaceted drivers of informal settlement expansion, governance, land tenure, socioeconomic factors, and policy frameworks into a comprehensive, long-term spatial analysis. Few studies have employed remote sensing (RS) and geographic information systems (GIS) to examine land use and land cover (LULC) dynamics over extended periods, thereby limiting the ability to quantify spatiotemporal trends and inform evidence-based urban planning. This paper addresses this gap by combining RS and GIS techniques, together with ground surveys, to map and analyse the expansion of informal settlements in Dar es Salaam from 1995 to 2024. Using a supervised machine learning classification approach (Twumasi et al., 2020; Loukika et al., 2021), the paper quantifies land use and land cover (LULC) trends, investigates community perceptions of the driving factors behind the growth of informal settlements, and maps settlement distribution to support informed urban planning and policymaking.

1.3 Theoretical Framework

This study is grounded in the urban political ecology (UPE) theory (Zimmer, 2010; Tzaninis et al., 2021), and the land systems science concept (Verburg et al., 2015; Aspinall & Staiano, 2017) which provide a robust framework for understanding the growth of informal settlements. The UPE views urban landscapes as products of socio-political and environmental interactions, where

governance lapses—such as corruption and weak policy frameworks—shape land use patterns. On the other hand, the land systems science theory emphasizes the interplay between human activities and environmental changes, highlighting how rapid urbanization and inadequate planning drive transformations in land use and land cover (LULC). These theories guide the analysis by examining how governance, economic, and social factors interact with spatial changes in Dar es Salaam.

2 Context and Methods

2.1 Study Area

The Dar es Salaam metropolitan city is situated on the East African coast, within sub-Saharan Africa, between 6°48' S and 39°17' E (Figure 1). It is the largest city in Tanzania, covering an area of 1,493km^2, currently houses around 6 million people, and is experiencing rapid population growth (URT, 2022). The population density is presently recorded at 3,133 inhabitants per square kilometre. Its population is projected to increase to 9.7 million by 2030, and to 15.6 million by 2050 (URT, 2013). The city occupies a significant role in the country as the primary port hub, commercial capital; and the national focal point for business, education, and culture (Mzava et al., 2019).

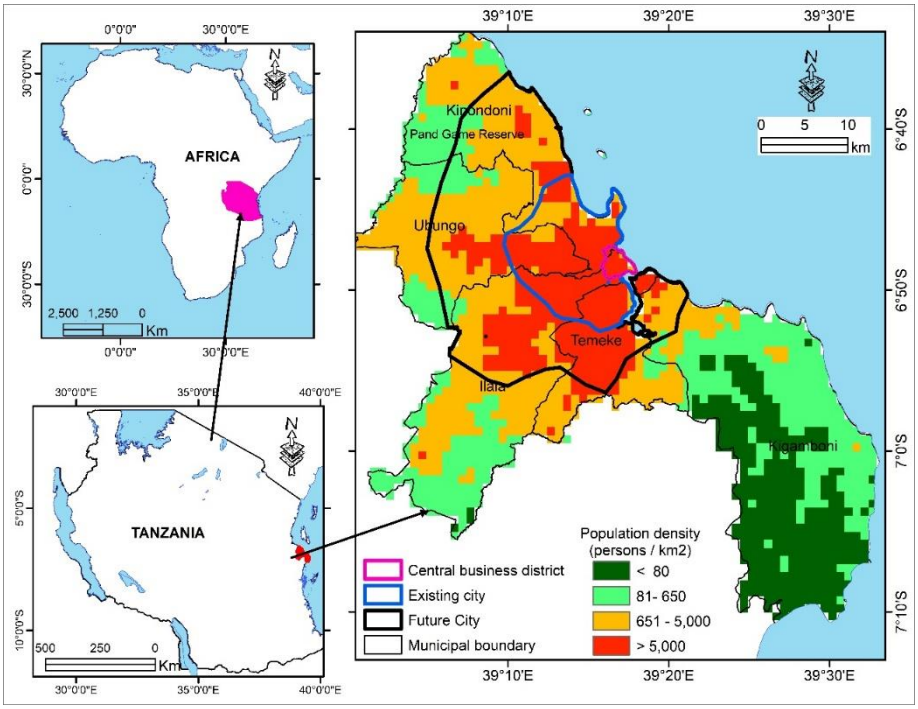

Figure 1: The Location of the Dar es Salaam Metropolitan City
Source: Author, 2025

Owing to its proximity to the equator and the warm Indian Ocean, the city has a modified tropical climate, with annual mean maximum and minimum temperatures ranging from 29°C to 32°C (December to March), and 19°C to 25°C (June to September). Additionally, the city receives an average annual precipitation of between 800mm and 1,300mm (Kibassa & Shemdoe, 2016).

2.2 Research Design

This paper adopted a mixed-methods research design, integrating qualitative and quantitative approaches to provide a comprehensive understanding of the drivers of the expansion of informal settlements in Dar es Salaam. The qualitative data were collected through key informant interviews (KIIs), on-site observations, and focus group discussions (FGDs) to explore stakeholders' perspectives and contextual factors that influence informal settlement growth. Quantitative data were gathered using geospatial techniques employing GIS and remote sensing tools, specifically ArcGIS Pro and R (version 4.3.2), to analyse changes in land use and land cover over time. This dual approach enabled a robust examination of both spatial dynamics and socioeconomic drivers of the expansion of informal settlements.

2.3 Sampling Techniques and Participants

This study employed purposive sampling to ensure the selection of individuals with relevant knowledge and experience in land use and urban development processes in Dar es Salaam. Participants were drawn from three municipal councils of Temeke, Ubungo, and the Dar es Salaam City Council (DCC); and specifically from six wards: Buza, Kijichi, Mbezi, Kimara, Tabata, and Segerea. A total of 39 individuals participated in the study, including 29 participants in FGDs and 10 in KIIs. The participants represented a diverse range of stakeholders, such as land use planners, environmental officers, community leaders, and local residents.

A deliberate and structured protocol was followed to ensure the credibility and reliability of the data collection process. Participants were selected based on their knowledge of, or engagement with, the drivers of land use and land cover (LULC) changes in their respective wards. The data collection tools—comprising interview and discussion guides—were carefully developed to feature open-ended questions; encouraging a detailed and reflective responses on urban planning issues, land formalization, and governance challenges. All interviews and FGDs were conducted in inclusive, neutral settings designed to foster open dialogue, mutual respect, and broader participation, ensuring that a wide range of experiences and viewpoints were captured.

2.4 Data Types and Sources

This study utilized both primary and secondary data sources to investigate land use and land cover (LULC) changes, and the expansion of informal settlements in Dar es Salaam over time.

Primary Data

The primary data consisted of satellite imagery and qualitative field data. Landsat images were acquired from the United States Geological Survey (USGS) Earth Explorer portal (https://earthexplorer.usgs.gov/), focusing on Path 166 and Row 65. The selected imagery included Landsat 5 Thematic Mapper (TM) data for the years 1995 and 2009, as well as Landsat 8 Operational Land Imager (OLI) data for 2024. All images had a spatial resolution of 30 meters, and were captured during the dry season to minimize cloud contamination and enhance land cover differentiation. Image selection was based on two criteria: low cloud cover and seasonal consistency. The imagery was processed using open-source code by Ermida et al. (2020) within the Google Earth Engine, involving band stacking, atmospheric and radiometric corrections, cloud and shadow masking, gap filling (for the 1995 image), and clipping to the study area. The characteristics of the selected satellite images are summarized in Table 1.

Table 1: Attributes of Satellite Imagery Used

Year	Data Type	Sensor Type	Path/ Row	Acquisition Date	Spatial Resolution (meter)	Season
1995	Landsat 5	Thematic Mapper (TM)	166/65	25 June	30	Dry
2009	Landsat 5	Thematic Mapper (TM)	166/65	01 July	30	Dry
2024	Landsat 8	Operational Land Imager (OLI)	166/65	03 June	30	Dry

Source: USGS, 2024

Secondary Data

The secondary data included historical land use records used to trace settlement patterns over a longer temporal range. Specifically, the Dar es Salaam Land Use and Informal Settlement Dataset v1 (1982, 1992, 1998, 2002) was obtained from the Socioeconomic Data and Applications Center (SEDAC) (https://sedac.ciesin.columbia.edu). This dataset classifies land into five categories: informal settlements, planned residential areas, other urban areas, vacant and agricultural areas, and oceans and estuaries. In addition, simulated land use data for 2012 and 2022 were obtained from Lindner (2010), based on a cellular automata (CA) model. For consistency with the study's objectives, only the informal and planned residential categories were extracted for analysis.

The apparent inconsistency between the LULC dataset (1995–2024) and the land use dataset (1982–2022) arises from the integration of two complementary sources: satellite-derived LULC data, which began in 1995 due to excessive cloud cover limiting Landsat image usability in earlier years; and historical land use records used to extend the analysis of informal settlement dynamics before that period. This combined approach enabled a comprehensive and temporally extended analysis of both biophysical and socio-political dimensions of land use transformation in Dar es Salaam.

2.5. Data Processing

Pre-processing of Landsat imagery involved several essential steps executed within the Google Earth Engine. These included radiometric and atmospheric correction, cloud and shadow removal using QA bands, gap filling for the 1995 image, and image clipping to match the boundaries of the Dar es Salaam study area. Following pre-processing, training samples were digitized using high-resolution imagery from sources such as Google Earth, Bing Maps, and Planet; and were georeferenced using GPS devices. For each classification year, between 192 and 256 training polygons were created to ensure a robust sampling base. The supervised classification process was implemented using the Random Forest (RF) algorithm in R (version 4.3.2). This machine learning technique was employed to classify the images into seven land use/land cover categories: agricultural land, bushland, forestland, built-up area, bare soil, grassland, and water bodies. The accuracy of the classification was assessed using confusion matrices; with all classified maps achieving an overall accuracy exceeding 80% across all selected years.

2.6. Data Analysis

Land Use and Land Cover Change Analysis

To analyse spatial and temporal transformations, false-colour composites were first generated by combining near-infrared, red, and green bands from the satellite imagery, which enhanced the visual differentiation of land cover types. These composites aided in visual interpretation, and supported the training sample selection process. Supervised classification outputs were subsequently post-processed and analysed in ArcGIS 10.8 to generate thematic maps that depicted land use and land cover (LULC) distributions for 1995, 2009, and 2024. Change detection was conducted through cross-tabulation and overlay analysis, quantifying conversions between LULC categories over time. The percentage change in area for each land category was calculated using the formula:

$$\text{Percentage change} = \frac{final\ area - initial\ area}{initial\ area} \times 100$$

This approach, adopted from Abebe et al. (2019), was consistently applied to both the LULC data (1995–2024), and the historical land use data (1982–2022). The LULC dataset (1995–2024) and land use dataset (1982–2022) differ due to the use

of satellite-derived LULC data starting in 1995 (limited by cloud cover in earlier years) and historical land use records to extend the analysis of informal settlement dynamics. These calculations helped capture both net and proportional changes, highlighting expansions and reductions in specific land use types—particularly informal settlements and agricultural areas. The outputs were visualized through time-series tables, bar graphs, and pie charts to illustrate trends and spatial growth patterns of unplanned development on the city's periphery.

Qualitative Data Analysis

The qualitative component was instrumental in contextualizing the spatial data findings. Transcripts from key informant interviews (KIIs) and focus group discussions (FGDs) were imported into NVivo 12 for systematic coding and interpretation. A hybrid thematic analysis approach was employed, blending deductive coding—driven by existing literature and research questions—with inductive coding that emerged organically from participant narratives. Coding focused on identifying themes related to institutional coordination, policy enforcement, land tenure formalization, community awareness, and infrastructural constraints. This allowed for the triangulation of qualitative perceptions with quantitative findings, strengthening the credibility and depth of interpretation. Queries such as word frequency analysis, matrix coding, and auto-coding were also conducted to identify salient discourse patterns.

The integration of geospatial outputs and qualitative insights provided a comprehensive understanding of the multifaceted drivers influencing land use transitions in Dar es Salaam. This enriched perspective allowed the paper to go beyond pattern recognition and offer explanatory depth into the socio-political and economic processes that underlie informal settlement growth and landscape transformation.

3. Results

3.1 Accuracy Assessment

All classified images achieved overall accuracy rates above 80%, which is suitable for most remote-sensing tasks. The study utilized the ArcGIS Pro software to analyse land cover changes between 1995 and 2009, and between 2009 and 2024, creating maps and gathering key statistics.

3.2 LULC Change Trends

LULC change trends for the Dar es Salaam Metropolitan City (DMC) over the years 1995, 2009, and 2024 are presented in Figure 2 and Table 2. The results indicate that agricultural land (AL) saw the largest expansion: increasing from 396.7km² in 1995 to 555.17km² in 2024, with the most substantial change occurring between 1995 and 2009. Built-up areas (BUA) also showed considerable growth, from 72.55km² in 1995 to 403.44km² in 2024, reflecting rapid urbanization. In contrast, natural land covers, such as bushland (BL),

forest land (FL), and grassland (GL): all declined. Bushland experienced the most substantial loss, dropping from 668.97km² to 294.55km²; while forest land decreased from 296.09km² to 225.08km². Grassland declined from 178.58km² to 145.72km²; while water bodies (WB) remained relatively stable: with only a slight reduction from 23.58km² to 20.36km².

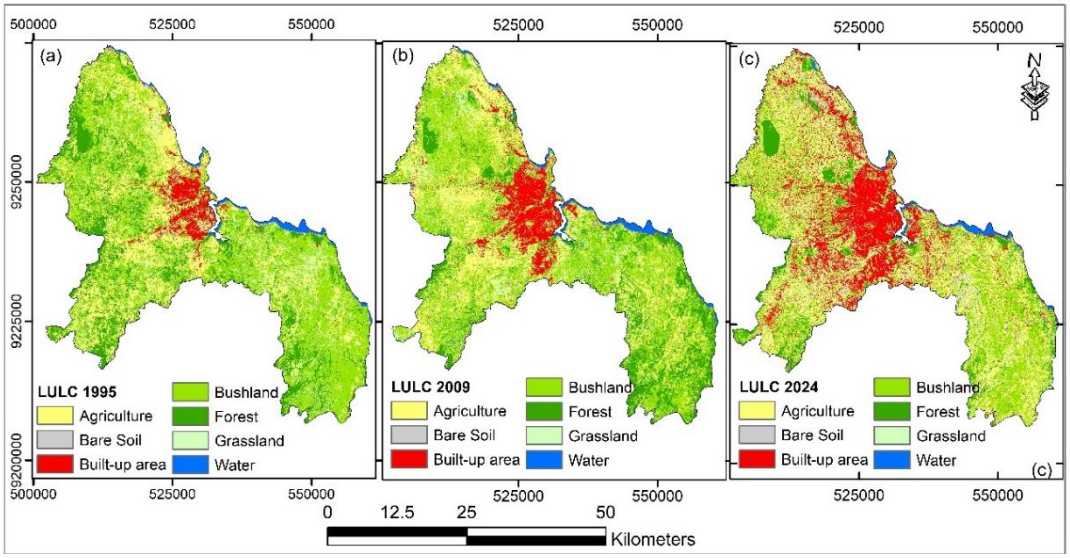

Figure 2: Land Cover Dynamics of the Main Land Use and Land Cover Classes in the DMC

Source: Landsat imagery obtained from USGS Earth Explorer

Table 2: Summary of LULC Change Results for Each LULC Class in the DMC (1995–2024)

LULC Classes	1995		2009		2024		Overall Change 1995–2024	
	Area (km²)	*Area (%)*	*Area (km²)*	*Area (%)*	*Area (km²)*	*Area (%)*	*Area (km²)*	*Area (%)*
AL	396.7	24	435.04	26.3	555.17	33.58	158.47	9.58
BSL	17.38	1.03	29.33	1.75	8.84	0.53	-8.54	-0.50
BUA	72.55	4.41	131.22	7.92	403.44	24.40	330.89	19.99
BL	668.97	40.45	619.44	37.42	294.55	17.82	-374.42	-22.63
FL	296.09	17.9	265.54	16.08	225.08	13.62	-71.01	-4.28
GL	178.58	10.82	147.08	8.89	145.72	8.81	-32.86	-2.01
WB	23.58	1.45	25.92	1.57	20.36	1.23	-3.22	-0.22
Total	**1,654**	**100**	**1,654**	**100**	**1,654**	**100**		

Key: AL = agricultural land; BSL = Bare Soil; BL =Bushland; BUA = Built-up area; FL = Forest land; GL=Grassland; WB=Water body

Source: Landsat 5 TM (1995, 2009), and Landsat 9 OLI (2024) satellite imagery

3.3. Land Use Change Detection

Figure 3 and Table 3 illustrate land use dynamics from 1982 to 2022. Informal settlements expanded significantly; increasing from 51.89km² in 1982 to 378.56km² in 2022, which represents a 629.5% increase. Planned residential areas also increased, rising from 43.22km² in 1982 to 167.19km² in 2022 (an increase of 286.9%). Other urban land uses, including infrastructure and commercial areas, experienced minimal change. Vacant and agricultural areas showed a marked decline, dropping from 810.69km² to 363.75km². Ocean and estuaries remained mostly constant with a slight decrease.

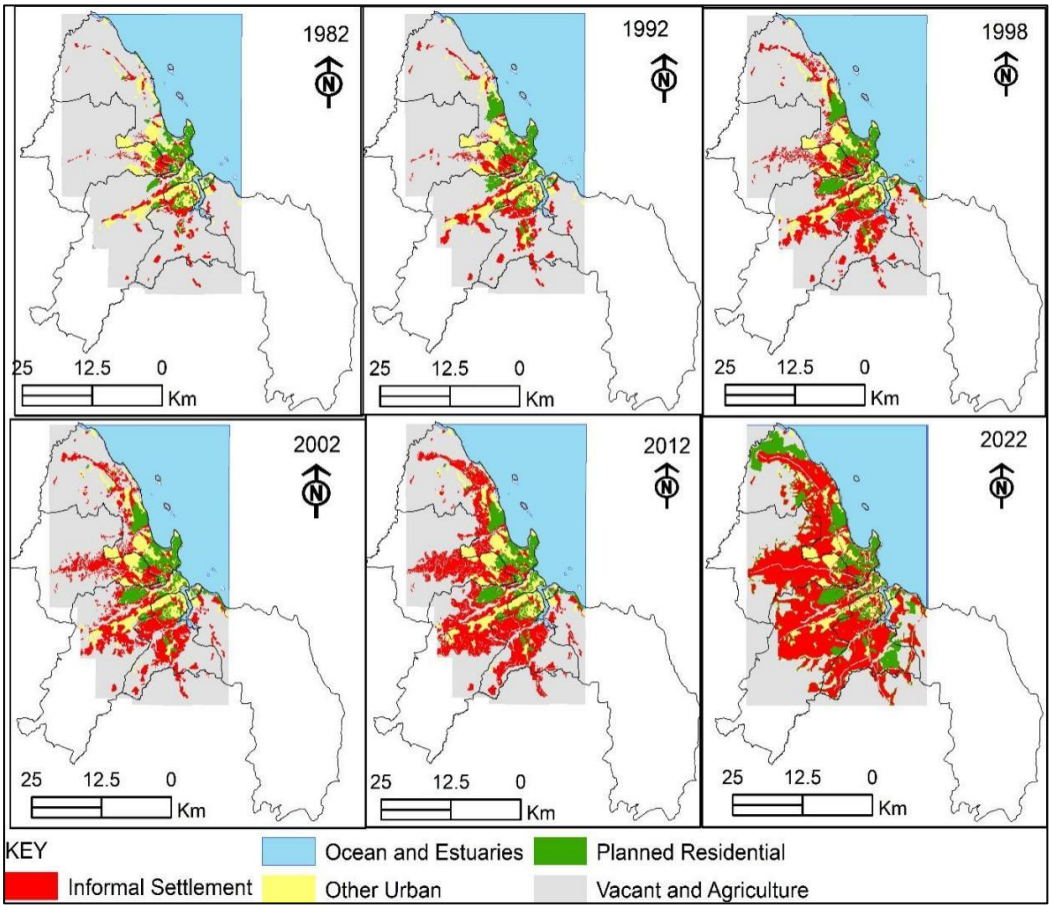

Figure 3: Spatial Distribution of Land Use in Dar es Salaam (1982–2022)

Source: Historical land use data (1982, 1992, 1998, 2002) obtained from the Dar es Salaam Land Use and Informal Settlement Dataset v1, available at SEDAC (https://sedac.ciesin.columbia.edu); simulated land use data for 2012 and 2022 adapted from Lindner (2010) using a Cellular Automata (CA) model.

Table 3: Land Use Change Detection (1982–2022)

Land Use Type	Area Coverage (km²)						Change From 1982– 2022	
	1982	*1992*	*1998*	*2002*	*2012*	*2022*	*km2*	*% increase*
Informal Settlement	51.89	81.92	138.70	171.95	273.73	378.56	326.67	629.53
Other Urban	73.46	80.81	83.55	86.71	76.34	80.82	7.37	10.03
Planned Residential	43.22	58.03	66.34	66.53	125.94	167.19	123.98	286.88
Vacant and Agriculture	810.69	758.57	690.71	654.00	510.69	363.75	-446.94	-55.13
Ocean and Estuaries	438.23	438.23	438.23	438.20	430.82	427.10	-11.13	-2.54
Total	**1417.48**	**1417.56**	**1417.53**	**1417.39**	**1417.53**	**1417.43**		

Figure 4 visually represents the net land-use changes in Dar es Salaam from 1982 to 2022, highlighting the areas where different land-use categories have either expanded or contracted. The most notable transformation is the significant expansion of informal settlements, which underscores the challenges associated with managing rapid urban development in the city.

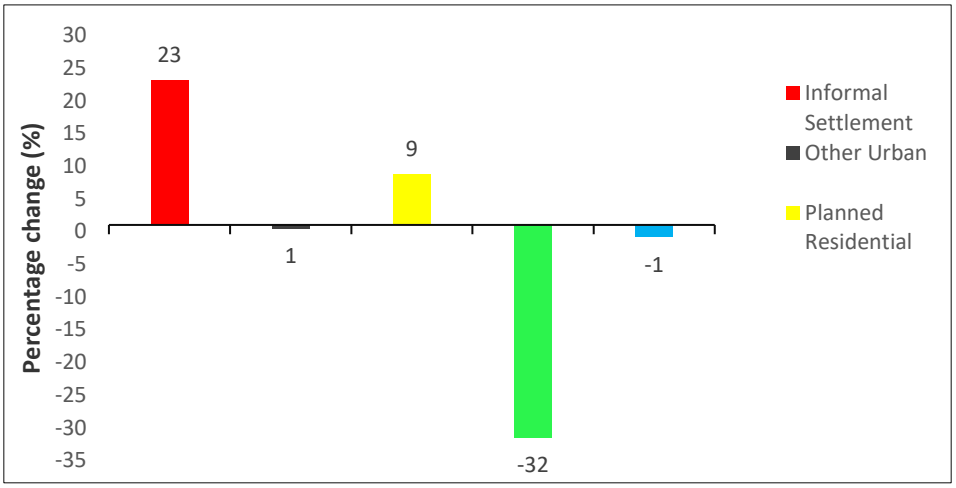

Figure 4: Net Land Use Change from 1982 to 2022

Source: Historical land use data (1982, 1992, 1998, 2002) obtained from the Dar es Salaam Land Use and Informal Settlement Dataset v1, available at SEDAC (https://sedac.ciesin.columbia.edu); simulated land use data for 2012 and 2022 adapted from Lindner (2010) using a Cellular Automata (CA) model.

3.4. Drivers of Informal Settlement Growth

The data collected from interviews with key informants revealed that challenges in urban planning primarily drive informal settlements. The primary issues identified were the lack of financial resources, political interference, failure to

formalize land ownership, poor coordination among stakeholders, and the lack of public awareness of urban planning processes. As people migrate to Dar es Salaam, they often clear land to establish new settlements, leading to changes in land use and land cover. One interviewee noted:

> *"Most of the plots are occupied by squatters. This area has become a squatter settlement because people moved to Buza…"* ***(Case 45, FGD, Mtaa Rrepresentative: Buza).***

Another respondent, when asked about changes in the land over the past 30 years, observed:

> *"Yes, there have been changes due to the presence of squatter groups."* ***(Case 11, FGD).***

Economic constraints drive people to seek cheap, un-surveyed, and unplanned plots, accelerating the development of informal settlements, as explained by two interviewees:

> *"Low-income levels lead people to search for affordable plots and build informal settlements."* ***(Case 7, Interview, Community Development Officer, Ubungo Municipal Council).***

> *"The prevalence of squatters is due to the lack of planning and surveying of many areas."* ***(Case 17, Interview, Town Planner Officer, Ubungo Municipal Council).***

Similarly, another participant remarked:

> *"Land use changes began in 1997 when people started buying plots for residential purposes, as they were available at lower prices."* ***(Case 39, FGD, Mtaa Vice Chairman, Kijichi Ward).***

The mind map in Figure 5 is a visual representation of the primary sources, coded for the theme of 'Unawareness' and 'Formalization Failure'. It illustrates the interconnected factors driving land cover transformations in the city.

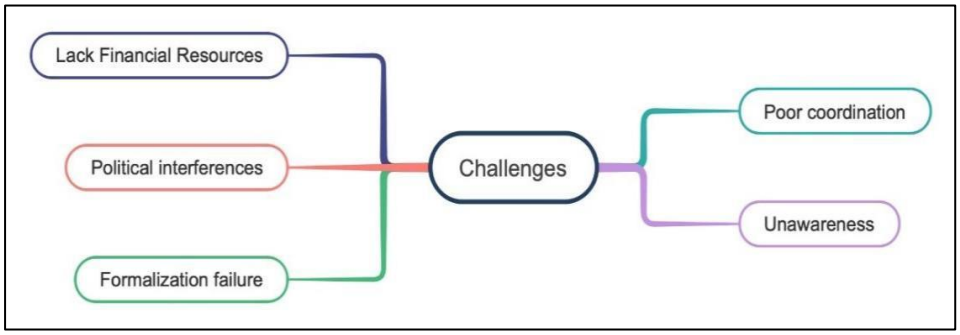

Figure 5: A Mind Map Illustrating Challenges in Urban Planning, Focusing on Unawareness and Formalization Failure.

Source: Field data: 2022

4. Discussion

4.1 LULC Change Dynamics

The results of this paper highlight significant changes in land use and land cover (LULC) in Dar es Salaam over nearly three decades. The rapid expansion of agricultural land and built-up areas, coupled with the drastic reduction in forestland and bushland, reflect global urbanization trends in developing cities where rapid population growth exerts pressure on natural landscapes (Abebe et al., 2019; Johnson et al., 2022).

The increase in agricultural land from 24% in 1995 to 33.58% in 2024 (a 9.58% increase) demonstrates a shift in land use priorities, likely driven by the need to feed a growing urban population. Concurrently, the expansion of built-up areas, particularly informal settlements, underscores the ongoing challenges of managing urban sprawl. The increase in built-up land by over 330km² (nearly 20% change) illustrates the city's struggle to control urban development, as further evidenced by the dramatic decline in natural vegetation cover (Smith Fawzi et al., 2020).

Moreover, the substantial reduction in forest and bushland between 1995 and 2009 underscores the impact of urban growth and its broader environmental implications. The loss of over 374km² of bushland could lead to decreased biodiversity, altered hydrological cycles, and increased susceptibility to environmental disasters, such as flooding and soil erosion (John, 2020). Addressing these ecological consequences through urban planning is essential to ensure long-term sustainability.

4.2 Drivers and Spatial Patterns of the Expansion of Informal Settlements

The rapid expansion of informal settlements in Dar es Salaam presents a pressing urban challenge. According to the land use change analysis (1982–2022), informal settlements increased by 630%, far exceeding the growth of planned residential areas. This disproportionate expansion reflects a growing demand for affordable housing driven by rural-to-urban migration, which the formal planning system has struggled to accommodate. Figure 3 and Table 3 clearly illustrate the spatial spread and magnitude of this transformation. The expansion primarily occurred on the periphery of the city—toward the north, south, and west—indicating a pattern of outward urban sprawl.

Furthermore, Figure 4 highlights net land use changes, showing a consistent decline in vacant and agricultural lands coinciding with the spread of informal settlements. The overlapping data confirm that the growth of informal settlement is strongly linked to the conversion of former agricultural land; signifying unregulated land acquisition and housing development. As one interviewee remarked:

> "*Many city dwellers have low incomes, which forces them to seek affordable, unsurveyed, and unplanned plots, thereby accelerating the growth of informal settlements.*" ***(Field Interview, 2022)***

The key drivers of this expansion include ineffective urban planning, inadequate financial resources, and the failure to formalize land and provide sufficient infrastructure. Political interference and poor coordination among stakeholders further hinder the city's ability to manage its informal growth. Additionally, the lack of awareness regarding the requirements of building permits contributes to disorderly construction. Also, complex formalization processes make it challenging to integrate informal settlements into the urban fabric, as noted by Lugakingira et al. (2020).

Likewise, poor collaboration—among government agencies, communities, and other stakeholders—hinders the development of effective urban planning strategies. Political interference exacerbates these issues and impedes progress toward addressing the expansion of informal settlements. These governance and land use challenges perpetuate the growth of informal settlements, worsening overcrowding, inadequate infrastructure, and social inequality.

Informal settlements pose severe social, economic, and environmental challenges. They often lack essential services—such as water, sanitation, and electricity—resulting in poor living conditions. Situated in vulnerable areas—such as in floodplains—these informal settlements increase the risk of disasters during extreme weather events (Abebe et al., 2019). Also, residents living in these areas mostly lack formal land tenure, and thus are particularly vulnerable to forced eviction and economic insecurity.

This article aligns with previous research by John (2020) and Smith Fawzi et al., (2020), who identified rapid rural-to-urban migration, and insufficient affordable housing, as the primary drivers of the growth of informal settlements. The challenges of ineffective urban planning and political interference resonate with the findings of Magina and Kombe (2020), Peter and Yang (2019), and Uısso et al. (2023). Moreover, the finding on poor stakeholder collaboration is consistent with the observations of Worrall et al. (2017). Addressing these issues requires a comprehensive approach; including enhancing awareness of building regulations, streamlining formalization processes, improving stakeholder coordination, and minimizing political interferences.

4.3 Consequences of Inadequate Urban Planning

Inadequate urban planning in Dar es Salaam has resulted in severe and interconnected issues that threaten the city's sustainability, and the well-being of its residents. Key challenges include environmental and air pollution, gender-based violence (GBV), disease outbreaks, poor road infrastructure,

proliferation of informal industries, and shortages of open spaces and social services. The study revealed that 27 out of 39 participants identified land use and land cover (LULC) changes as the primary contributor to environmental pollution. In unplanned settlements, inadequate sewage and waste management have led to contamination, deforestation, biodiversity loss, and increased flooding. Furthermore, urban sprawl has exacerbated rising temperatures and air pollution from various sources. One interviewee pointed out the rapid growth of informal industries in settlements, which has resulted in significant air and water pollution, particularly in the Keko area.

> *"The rise of these informal industries has contributed to increased environmental pollution in the Keko area."* ***(Interview, Case 35, Land Surveyor from Temeke Municipal Council).***

Furthermore, 8 out of 13 participants in KIIs and FGDs indicated that rapid urbanization—characterized by overcrowding, unsanitary conditions, and insufficient healthcare services—has directly contributed to the increase in gender-based violence (GBV) and disease outbreaks. The expansion of informal businesses—including those providing sexual services—further compounds the health and safety challenges. Disease outbreaks are primarily attributable to poor waste management and inadequate sewage management. As previously mentioned, the lack of proper solid waste disposal systems leaves areas unclean; thereby fostering conditions conducive to outbreaks of diseases, such as cholera and typhoid. One interviewee highlighted this issue, stating,

> *"There is an outbreak of epidemic diseases such as cholera and diarrhoea"* **(Case 20, Interview, DCC, Town Planner).**

Besides, poor road infrastructure, coupled with the expansion of informal settlements, have led to increased conflicts and environmental degradation; further complicating the provision of essential social services. During the FGDs, participants highlighted the challenges posed by inadequate road network infrastructure in squatter settlements, and the difficulties in implementing road development plans. This problem stems from unplanned housing construction that fails to incorporate the necessary road infrastructure. One participant remarked on inadequate road networks, saying:

> *"There is no planning and insufficient road width pathways"* ***(Case 13, FGD, Mtaa Representative, Mbezi Ward)***.

The word cloud generated from the NVivo analysis presented in Figure 6 highlights key concepts related to environmental and air pollution factors. Terms such as 'environment', 'waste', 'air', 'solids,' 'pollution', and 'temperature' are displayed in large font sizes and positioned in the centre of the figure, indicating that the study participants frequently mentioned these as they discussed the consequences of land use and land cover changes.

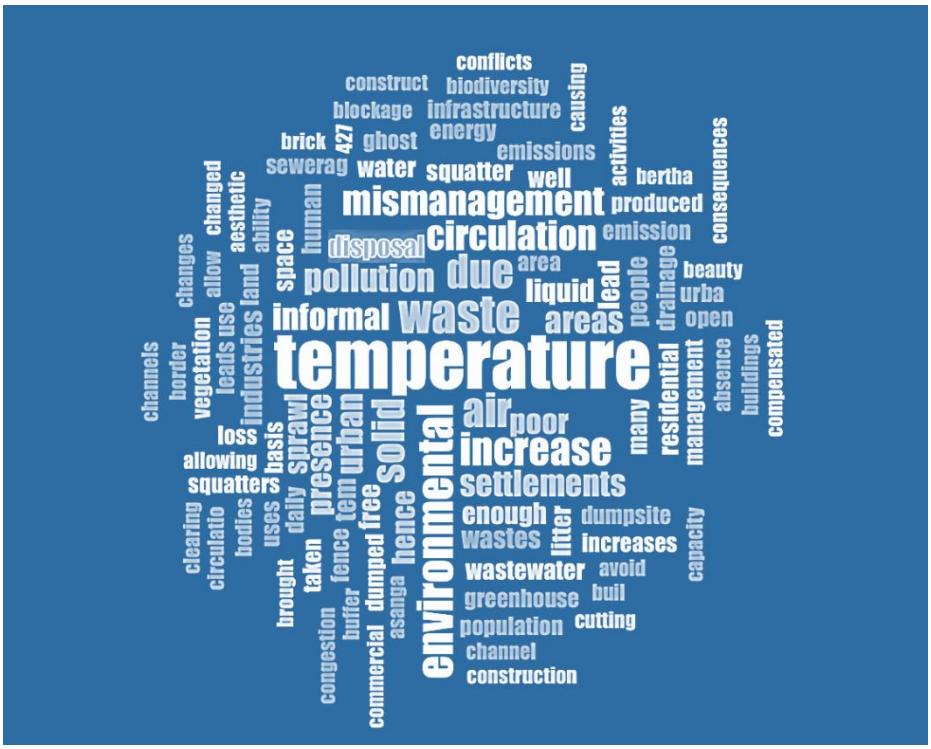

Figure 6: A Word Cloud for Environmental and Air Pollution Node

Source: Field Data (2022)

These findings underscore the urgent need for comprehensive urban planning strategies that address the multifaceted impacts of land use and land cover (LULC) changes on the environment, public health, and infrastructure. Effective coordinated planning is crucial to mitigate these adverse effects and build a sustainable and resilient urban future for Dar es Salaam.

4.4 Implications for Urban Planning and Policy

The findings of this study highlight the need for a more integrated and proactive approach to urban planning in Dar es Salaam. The rapid expansion of both formal and informal urban areas demands improved coordination between urban planners, government agencies, and local communities (Johnson et al., 2022). It is imperative that the city prioritizes formal land tenure, and invests in infrastructure to accommodate its burgeoning urban population.

Policy interventions should concentrate on managing urban sprawl through effective zoning regulations and formalizing land tenure in informal settlements. Furthermore, policies must aim to preserve the remaining forestland and bushland to mitigate the environmental repercussions of urban

cities. Urban planners should integrate climate resilience into development strategies to safeguard the city against environmental risks such as flooding, which may be intensified by the loss of natural vegetation and the proliferation of impervious surfaces in built-up areas (Abebe et al., 2019).

Similarly, initiatives to manage informal settlements should prioritize enhancing access to basic services and infrastructure. Such efforts should not only improve the living conditions of urban residents, but also contribute to the overall sustainability of the city. Adopting a more participatory approach that involves communities in the planning process can promote greater cooperation and minimize the risk of political interference (Terdoo, 2024).

Moreover, efforts to manage informal settlements should focus on improving access to basic services and infrastructure, thereby enhancing the living conditions of urban residents, and contributing to the city's overall sustainability. A more participatory approach that engages communities in the planning process can foster greater cooperation and reduce the risk of political interference (Fawzi et al., 2020).

4.4 Limitations

While this study offers insights into land use changes and the expansion of informal settlements, it has limitations due to the unavailability of high-resolution data, and the reliance on secondary sources for stakeholder interviews. Future research could utilize higher-resolution satellite imagery and incorporate primary data collection methods, such as household surveys, to gain a deeper understanding of the social dynamics within informal settlements. Moreover, the lack of recent land use data has necessitated the use of simulated data, which may have introduced uncertainties in the findings. Addressing these limitations in subsequent studies will improve the accuracy and reliability of the insights into urban development and settlement patterns.

5. Conclusion and Recommendations

This study presented a comprehensive assessment of the expansion of informal settlements and land use and land cover (LULC) changes in Dar es Salaam from 1995 to 2024, integrating geospatial analysis with qualitative insights from key informant interviews and focus group discussions. The findings reveal profound transformations in the city's landscape, characterized by significant increases in agricultural and built-up areas; as well as considerable declines in forest, bushland, and grassland cover. Notably, informal settlements expanded by over 600% between 1982 and 2022, far exceeding the growth of planned residential areas; and revealing the uncontrolled nature of urban sprawl on the city's periphery.

The expansion of informal settlements is driven by financial constraints, political interference, ineffective land formalization, limited stakeholder coordination, and low public awareness of planning regulations. These factors collectively contribute to extensive environmental, social, and economic challenges; including deforestation, biodiversity loss, increased flood risk, gender-based violence, disease outbreaks, and persistent urban poverty.

To address these challenges, a multifaceted and integrated urban planning strategy is required. This should involve increased financial investment in infrastructure and planning, a more substantial political commitment to enforce long-term land use policies, streamlined formalization processes, enhanced institutional coordination, and improved public awareness of urban planning regulations. By implementing such measures, Dar es Salaam can move towards a more sustainable, inclusive, and resilient urban future. The study highlights the importance of adopting spatially informed and participatory planning frameworks that address the governance, environmental, and social aspects of informal settlement growth.

Data Availability

The data supporting this study's findings are available upon request from the corresponding author [OS].

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