



Determinants of Urban Green Spaces Change in Katsina, Northern Nigeria

Abubakar Sa'ad^{1*}, Lawal Abdulrashid¹, Yahaya Zayyana Ibrahim¹, and Hamidu Saadu²

¹Department of Geography, Umaru Musa Yar'adua University, Katsina, Nigeria

²Department of Biology, School of Science, Federal College of Education, Katsina, Nigeria

*Corresponding Author:

Email: abubakarsadm@gmail.com

Article Information

<https://doi.org/10.69798/96974867>

Copyright ©: 2026 The Author(s).

This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International (CC-BY-4.0) License, which permits the user to copy, distribute, and transmit the work provided that the original authors and source are credited.

Published by: Koozakar LLC. Atlanta GA 30350, United States.

Note: The views expressed in this article are exclusively those of the authors and do not necessarily reflect the positions of their affiliated organizations, the publisher, the editors, or the reviewers. Any products discussed or claims made by their manufacturers are not guaranteed or endorsed by the publisher.

Edited by:

Prof. José Mvuezolo Bazonzi 

Prof. Benjamin Mwadi Makengo 

Abstract

This study was poised to identify the factors contributing to changes in urban green spaces in the Katsina urban area. It utilized a mixed-methods approach, which included administering questionnaires, interviewing key stakeholders, organizing focus group discussions, conducting field observations, and maintaining a diary study. Data analysis assumed descriptive and inferential statistics. The findings indicated that urban spatial expansion urban expansion and population growth accounted for 82% of observed UGS decline, alterations in environmental and physical conditions, socio-economic transformations, and shifts in political and administrative structures were the primary factors driving changes in UGSs in Katsina. To this end, it is recommended that urban planning authorities in Katsina integrate population management, sustainable land-use policies, and environmental governance reforms to mitigate further loss of urban green spaces.

Keywords: Urban Green Spaces, Urban Expansion, Population Growth, Environmental Change, Katsina, Nigeria

INTRODUCTION

Urban Green Spaces (UGSs) are vital elements of sustainable urban environments, contributing significantly to the well-being and satisfaction of urban residents. These spaces not only enhance the aesthetic appeal of cities but also play a pivotal role in defining public spaces' character and functionality. In fact, national urban planning policies have increasingly recognized the importance of UGSs, integrating diverse local stakeholder needs for effective urban governance (Kimpouni *et al.*, 2020). Thus, the benefits provided by UGSs encompass vital ecosystem services and socio-economic advantages, making them indispensable for urban sustainability. They facilitate biodiversity conservation, enhance landscape beauty, improve air quality, and contribute to carbon storage (Semeraro *et al.*, 2021; Sa'ad, 2024).

The ecological benefits of UGSs are manifold. They play a crucial role in maintaining biodiversity and improving air quality, while also mitigating urban heat through vegetation (Hunter *et al.*, 2019; Sa'ad, 2024). Furthermore, UGSs serve important socio-cultural functions. They offer spaces for recreation and promote social interaction, thus enhancing public health by encouraging physical activity (Kimpouni *et al.*, 2020). Economically, UGSs provide resources such as food, timber, and medicinal plants, while also creating job opportunities in various sectors (Sa'ad, 2024).

Studies have shown that rapid urbanization of global populations poses significant threats to UGSs. As of 2014, 54% of the world's population resided in urban areas, a figure projected to soar to 70% by 2050 (Vargas-Hernández *et al.*, 2018). This urban expansion has often led to the degradation and loss of UGSs, for instance, a study in the United States between 1990 and 2010, revealed a loss of approximately 1.4 million hectares of UGSs due to urban development (Anguluri and Narayanan, 2017). In developing countries, particularly in many African cities, the situation is even direr, as UGSs have been substantially diminished to accommodate urban sprawl and other anthropogenic activities (Sa'ad, 2024). In Katsina,

In Nigeria and specifically in Katsina significant changes in UGSs have been observed over the past

decades (Sa'ad, 2024). The transformation of UGSs from the 13th century to 2020 has been shaped by several critical factors. Urbanization has accelerated, resulting in the conversion of green spaces into built environments, thereby reducing the availability of UGSs (Alabi, 2020). Additionally, ineffective urban planning and the lack of stringent land use regulations have further exacerbated the decline of these essential spaces (Bala *et al.*, 2022). Socio-economic pressures, including increasing population density and rising economic activities, have intensified land demand, leading to further encroachment on UGSs (Barau *et al.*, 2023). Despite the recognized significance and changes of UGSs, there remains a research gap regarding factors Influencing changes in UGSs, particularly in Katsina. Against this backdrop, this study aims to bridge this gap by examining the factors contributing to UGS changes in Katsina. Understanding these dynamics is crucial for informing effective urban planning and policy-making that prioritize green spaces, thereby enhancing the quality of life for urban residents.

LITERATURE REVIEW

Concept of Urban Green Spaces

This research adopts and modified Suligowski *et al.* (2021) definition, that is UGSs is undeveloped land that is partially or entirely covered with wetlands, grass, trees, shrubs, or other vegetation. According to Roy *et al.* (2012) UGSs come in a diverse range of types, structures, and shapes, ranging from public parks to green walls and cemeteries.

Studies on Factors Responsible for UGSs Changes

Several studies have investigated the factors contributing to changes in UGSs globally and locally (as shown in Table 2). This analysis can be categorized into three main driver themes: Physical Drivers, Socio-economic Drivers, and Political Drivers.

Physical Drivers

Rapid urbanization is a significant physical driver affecting UGSs worldwide. Salman *et al.* (2023) linked this phenomenon to the depletion of substantial portions of UGSs globally. In Asia, Nor *et al.* (2017) identified rapid urbanization as the primary factor responsible for UGS changes in three major cities: Kuala Lumpur, Manila, and Jakarta. Similarly, in Chattogram, Bangladesh,

Siddique and Uddin (2022) attributed the loss and fragmentation of UGSs to urbanization, primarily fueled by rural–urban migration. In Australia, Sushinsky *et al.* (2013) demonstrated that urban sprawl negatively impacts UGSs and directly affects the local bird population. Such findings highlight the physical consequences of rapid urban development on green spaces.

Socio-economic Drivers

Socio-economic factors also significantly influence UGS preservation and management. In Mumbai, Rahaman *et al.* (2021) examined how urban sprawl, coupled with a lack of enforcing regulations and financial mismanagement, undermines UGS conservation. Sara *et al.* (2018) further emphasized socio-economic challenges in suburban Stockholm, identifying critical issues such as limited property rights, inadequate strategic guidance for UGS management, competing interests from private landowners, and insufficient monitoring of completed projects.

In Africa, Girma *et al.* (2019) noted that construction activities led to a loss of approximately 1410.7 ha of UGSs in Sebeta town, Ethiopia, from 2003 to 2016, showcasing the socio-economic implications of urban development on green spaces.

Political Drivers

Political factors play a crucial role in the management and preservation of UGSs. For instance, in Kumasi, Ghana, Mensah (2015) linked climatic conditions, a lack of priority for UGSs, political instability, and urbanization pressure to the depletion of these spaces. In Enugu, Nigeria, Uchegbu (2017) highlighted the impact of low planning, oversight, lack of coordination, and public participation on the quality and availability of UGSs.

In Northern Nigeria, Zakka (2017) noted that outdated master plans and a lack of commitment from urban authorities contributed to declining UGSs. Similarly, Rikko *et al.* (2022) analyzed the depletion of UGSs in Jos, attributing it to an increase in built-up areas from 17.36% in 1990 to 44.99% in 2021, a trend exacerbated by political negligence.

METHODOLOGY

Study Area

This study was conducted in Katsina an ancient northern Nigerian town located about 40km to the country's border with Niger republic. Katsina urban area is the capital city of Katsina. It covers roughly 23, 938 km² in total area (Google Earth, 2019; Mashi *et al.*, 2020). It is situated between Longitude 7° 34'30"E and 7° 39'0" East of the Greenwich Meridian and Latitude 12° 54'0"N and 12° 58'30" North of the Equator. The location of Katsina urban area in Nigeria is shown in Figure 1. The Katsina urban area encompasses portions of the Katsina and Batagarawa local government areas, divided into five (5) wards managed by traditional rulers known as Wakili. This region was selected for study due to its historical richness in UGSs, significantly influenced by European contributions. Located in the Sahel, Katsina faces environmental challenges such as rapid urbanization, desertification, deforestation, and climate change, making it a relevant case for analyzing UGS decline in Nigeria.

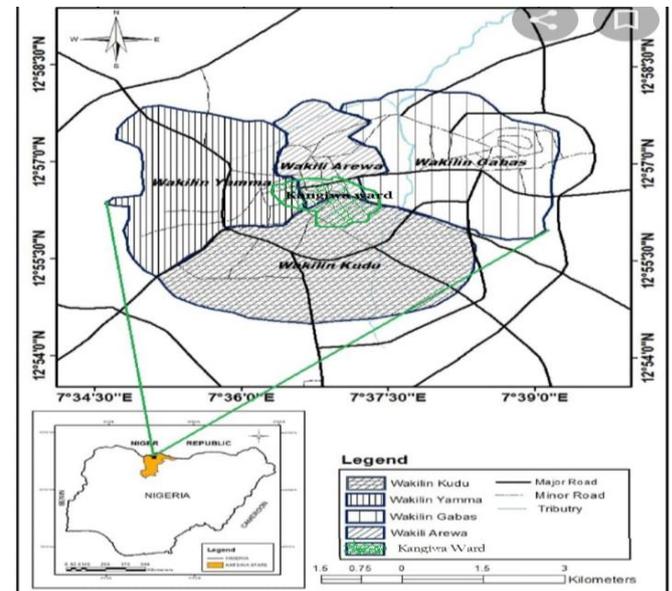


Figure 1: Study area showing wards in Katsina Urban Area

Source: Adapted from Mashi *et al.* (2020)

Climate

The climate is characterized by a long dry season from November to March, with temperatures averaging 30-35°C, and a shorter wet season from April to October, peaking in rainfall and humidity during July and September. Long-term data indicate an average annual rainfall of about 750 mm, with low humidity levels during dry periods

influenced by Harmattan winds (NiMeT, 2022; Jande et al., 2020; Mashi et al., 2020; Godstime et al., 2018).

Soil and Vegetation

Katsina's soil comprises crystalline rock and weathered materials vital for agriculture. The region's vegetation represents the Sudan savanna, home to drought-resistant species such as Acacia (Abdulrasheed, 2012; Godstime, 2018).

Drainage

The primary drainage systems are the Ginzo and Tille streams, which have been compromised by urban development, resulting in flooding issues (Usman, 1981; Ladan, 2022; Mohammed and Hamisu, 2015).

Land Use

Urban growth driven by population increase has significantly altered land use, converting green spaces into residential and commercial areas, including new neighborhoods and markets (Danbuzu et al., 2014; Dabo and Yunus, 2020; Muhammad et al., 2022).

Economic Activities

Agriculture is the cornerstone of Katsina's economy, with farmers growing crops like millet and sorghum, complemented by livestock rearing. Agro-processing and local markets play crucial roles in enhancing agricultural value and providing employment (Abubakar and Abdurrahman, 2018; Umar et al., 2018).

Population and Settlement

The Hausa and Fulani are the predominant ethnic groups, engaged in agriculture and livestock herding, respectively. Population growth is driving urban sprawl, leading to the conversion of UGSs into developed areas and placing additional stress on natural resources (Zayyana, 2010; Umar et al., 2018).

Data Collection

This section presents how data were collected, collated, evaluated and interpreted as outlined by Abubakar (2012). With a projected population of 453,580 in Katsina (2021), a sample size of 783 was determined, resulting in 800 distributed. A mixed-methods approach was employed, involving the use of questionnaires, interviews with key

informant interviews, focus group discussions, field observations, a diary study, and review of historical documents. (Barau et al., 2023). Previous research supports the use of both qualitative and quantitative methods for comprehensive insights (Simon, 2015). Quantitative data underwent sorting, coding, and analysis utilizing the Statistical Package for Social Science (SPSS) Version 23 (Akinyode, 2018). The findings were presented using Stacked Bar Charts to illustrate the frequency distribution of responses, and the Chi-square (χ^2) test was employed to determine the association between socio-demographic variables of respondents and the variables under consideration (Lester et al., 2020).

RESULTS AND DISCUSSION

Demographic Characteristics of the respondents

This section presents various socio-economic characteristics of respondents, including age, gender, marital status, education, occupation, income, residency, land tenure, and building permits (Table 2). The largest group of respondents (30.6%) lived in Wakilin Kudu ward, with fewer in Wakilin Yamma (20.3%) and Wakilin Gabas (19.9%); Kangiwa ward had the least representation (9.47%) due to its three districts. Males comprised 66% of participants, reflecting cultural norms that limit female engagement (Umar et al., 2019). Men's greater reliance on urban green spaces (UGSs) contributes to their depletion, aligning with Yu et al. (2020). Age Distribution: Most respondents (24.3%) were aged 37-47, followed by 48-58 years (22.9%) and 26-36 years (17.8%). The younger respondents are more likely to utilize UGSs for recreation, highlighting the importance of these spaces (Simon, 2015). The lack of UGS restoration correlates with younger demographics, contrasting with Lu et al. (2022), which found older adults more influential in UGS mental restoration. Marital Status: About 70.4% of respondents were married, but this status did not significantly impact UGS restoration efforts. This contrasts with findings from Su et al. (2022) in Beijing, where married individuals showed stronger environmental values. Education: About 38% of respondents had tertiary education, with 36.0% having completed secondary education. Historical educational trends in Katsina support these findings (Ladan, 2022).

Table 1: Respondents' Demographic Characteristics

Demographic	Kangiva (n = 57)		Wakilin Gabas (n = 120)		Wakilin Yamma (n = 122)		Wakilin Arewa (n = 119)		Wakilin Kudu (n = 184)		Total (N = 602)	
	Frg.	%	Frg.	%	Frg.	%	Frg.	%	Frg.	%	Frg.	%
GENDER												
Male	48	7.97	82	13.62	88	14.62	65	10.80	116	19.27	399	66.3
Female	9	1.50	38	6.31	34	5.65	54	8.97	68	11.30	203	33.7
AGE												
15 to 25 Years	4	0.66	21	3.49	7	1.16	7	1.16	32	5.32	71	11.8
26 to 36 Years	7	1.16	28	4.65	17	2.82	21	3.49	34	5.65	107	17.8
37 to 47 Years	15	2.49	33	5.48	27	4.49	33	5.48	38	6.31	146	24.3
48 to 58 Years	21	3.49	26	4.32	39	6.48	24	3.99	28	4.65	138	22.9
59 to 69 Years	9	1.50	9	1.50	21	3.49	22	3.65	27	4.49	88	14.6
70 to 80 Years	0	0.00	2	0.33	9	1.50	10	1.66	17	2.82	38	6.3
Above 80 Years	1	0.17	1	0.17	2	0.33	2	0.33	8	1.33	14	2.3
MARITAL STATUS												
Single	7	1.16	20	3.32	13	2.16	10	1.66	40	6.64	90	15.0
Married	45	7.48	92	15.28	85	14.12	84	13.95	118	19.60	424	70.4
Divorced	3	0.50	3	0.50	18	2.99	12	1.99	10	1.66	46	7.6
Separated	2	0.33	1	0.17	0	0.00	5	0.83	3	0.50	11	1.8
Widowed	0	0.00	4	0.66	6	1.00	8	1.33	13	2.16	31	5.1
HIGHEST EDUCATIONAL LEVEL												
In formal	6	1.00	11	1.83	14	2.33	14	2.33	24	3.99	69	11.5
Primary	5	0.83	27	4.49	14	2.33	12	1.99	31	5.15	89	14.8
Secondary	26	4.32	47	7.81	40	6.64	42	6.98	62	10.30	217	36.0
Tertiary	20	3.32	35	5.81	54	8.97	51	8.47	67	11.13	227	37.7
MAIN OCCUPATION												
Civil Service	26	4.32	28	4.65	44	7.31	36	5.98	54	8.97	188	31.2
Personal Business	25	4.15	67	11.13	43	7.14	38	6.31	85	14.12	258	42.9
Corporate	3	0.50	9	1.50	11	1.83	20	3.32	19	3.16	62	10.3
Others	1	0.17	13	2.16	14	2.33	7	1.16	15	2.49	50	8.3
Unemployed	2	0.33	3	0.50	10	1.66	18	2.99	11	1.83	44	7.3
AVERAGE MONTHLY INCOME												
Less than N30,000	13	2.16	25	4.15	20	3.32	24	3.99	38	6.31	120	19.9
N30,000 to N59,000	12	1.99	40	6.64	38	6.31	34	5.65	36	5.98	160	26.6
N60,000 to N89,000	17	2.82	25	4.15	10	1.66	29	4.82	30	4.98	111	18.4
N90,000 to N119,000	7	1.16	14	2.33	9	1.50	14	2.33	29	4.82	73	12.1
N120,000 and Above	8	1.33	16	2.66	45	7.48	18	2.99	51	8.47	138	22.9
RESIDENCY												
Less than 5 Years	3	0.50	7	1.16	17	2.82	8	1.33	13	2.16	48	8.0
5 to 9 Years	10	1.66	19	3.16	18	2.99	20	3.32	28	4.65	95	15.8
10 to 14 Years	17	2.82	27	4.49	20	3.32	23	3.82	39	6.48	126	20.9
15 to 19 Years	13	2.16	41	6.81	28	4.65	29	4.82	42	6.98	153	25.4
20 Years and Above	14	2.33	26	4.32	39	6.48	39	6.48	62	10.30	180	29.9
LAND TENURE												
Family land	29	4.82	54	8.97	64	10.63	64	10.63	91	15.12	302	50.2
Purchased	24	3.99	56	9.30	36	5.98	34	5.65	59	9.80	209	34.7
Allocation	0	0.00	4	0.66	7	1.16	2	0.33	28	4.65	41	6.8
Others	4	0.66	6	1.00	15	2.49	19	3.16	6	1.00	50	8.3
LAND PERMIT												
No	49	8.14	71	11.79	86	14.29	83	13.79	135	22.43	424	70.4
Yes	8	1.33	49	8.14	36	5.98	36	5.98	49	8.14	178	29.6

Source: Fieldwork (2020)

However, despite a well-educated population, UGS depletion persists, as shown in Simon (2015). Occupation: The majority (42.9%) were in private business, followed by civil service (31.2%). The occupational status did not influence UGS restoration, contrary to Home *et al.* (2012) who found a connection between occupation and UGS engagement. Income: Most respondents (26.6%) earned ₦30,000 - ₦59,000 monthly, indicating moderate socioeconomic status. Lower-income residents typically live in areas with depleted UGSs, while higher-income residents positively influence UGS restoration (Simon, 2015). The current findings differ from Panno *et al.* (2017), which linked higher well-being and income to UGS engagement. Residency: Nearly 30% had lived in Katsina for over 20 years, yet this long residency did not correlate with UGS conservation, echoing Simon (2015). Land Tenure: Half owned family lands, but many built without permits (70.4%), which negatively impacts UGS preservation due to non-compliance with regulations. This contrasts with Pietrzyk-Kaszyńska *et al.* (2017) who found that formal land tenure enhances UGS valuation in Polish cities.

Factors influencing changes in UGSs

Three sets of factors were identified based on the questionnaire survey, interviews, FGDs and observations: physical, socioeconomic, and political.

Physical factors contributing to UGS depletion

The survey identified four key physical factors affecting UGSs in Katsina: high temperatures, poor soil quality, pests and diseases, and drought (Figure 2). Notably, 85% of respondents acknowledged that thermal regime (high temperatures) significantly impact UGSs, which aligns with Katsina's predominantly hot and dry climate. Respondents noted that the soil dries out quickly, limiting their ability to cultivate plants. Previous research supports this, indicating that Katsina experiences a typical tropical climate characterized by high heat and aridity (Ladan, 2022; Mashi *et al.*, 2020; Mmaduabuchi *et al.*, 2020). Historically, colonial green belt initiatives successfully established protected UGSs around the old GRA, aided by nearby forest reserves (Maxlock, 1967). However, there is clear evidence of climate change, leading to a decline in UGSs and vegetation cover.

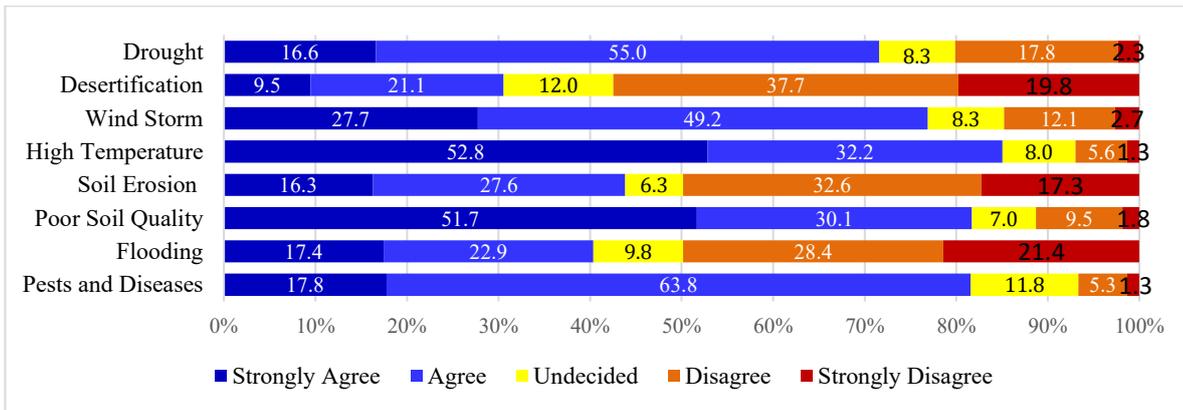


Figure 2: Physical factors Influencing Changes in UGS

Source: Author Analysis (2022)

Additionally, 81.8% of respondents indicated that spatial or ecological implications negatively affect plant growth.

This finding was consistent with previous studies that classify Katsina's soil as Typical Alfisols, which are loose and sandy, resulting in low water retention and acidity (Sani et al., 2019). Healthy vegetation typically requires fertile soil with high organic matter to thrive and resist erosion. Over 81.6% of respondents acknowledged that biotic stress (pests and diseases) significantly impact UGS in Katsina. These issues increase the costs associated with developing and maintaining UGS. The Food and Agriculture Organization (FAO, 2021) indicates that around 100 insect species harm trees in both planted and natural forests across Africa. In West Africa, the shoot borer is a notable pest affecting young trees and seedlings in nurseries (Mostafa et al., 2022). Suleiman (2016) also identified insect pests affecting cultivated vegetables in Katsina.

Conversely, 57.5% of respondents dismissed land degradation (desertification) as a major factor affecting UGS changes, noting its limited impact in certain areas. Although desertification has adversely affected UGS in places like Kukar-Geza and Ambadas, previous studies highlight its broader effects, with Verón et al. (2018) stating that over 40% of global land is affected. Nwokocho (2015) described desertification in northern Nigeria as a complex crisis, while Saulawa et al. (2018) emphasized its negative impact on greenery and agricultural land in Katsina. Regarding soil loss (erosion), nearly half (49.9%) of respondents disagreed that it significantly contributes to UGS

changes. However, discussions indicated that soil erosion harms UGS development by destroying topsoil. Areas such as Dutsen-Amare and Korama-Nayalli are reportedly affected by water erosion. Jiao et al. (2009) found that soil erosion destabilizes plant communities in Northern China, while Ladan (2022) noted that Katsina faces multiple environmental challenges, including soil loss (erosion) and desertification, which threaten UGS.

Chi-square (χ^2) analysis highlighted significant differences in perceptions based on socio-demographic factors regarding physical influences on UGS. The influence of drought varied significantly by residential district ($p = 0.001$), gender ($p = 0.002$), and land tenure ($p = 0.001$). Similar patterns were observed for wind storms, desertification, flooding, and soil erosion. Notably, neighborhood variation had the most substantial impact on perceptions of physical factors affecting UGS, followed by land tenure type. Gender also influenced opinions on drought and wind storm impacts.

Urban Governance Implications: Weak urban governance often fails to implement effective environmental policies that could mitigate these physical challenges. For instance, the lack of investment in irrigation systems or soil management practices can lead to further degradation of UGS. **Spatial Planning:** Inadequate spatial planning may neglect the integration of green infrastructure, such as parks and urban forests, which could help combat the adverse effects of climate. Properly designed green spaces can enhance local biodiversity and improve

microclimates, but without strategic planning, these benefits are lost

Socio-economic factors contributing to UGS depletion

This section presents survey respondents' views on how socio-economic factors affect UGS in Katsina (Table 3 and Figure 4). Over half agreed that eight socio-economic factors significantly influence UGS development. Notably, 87% reported that negative public attitudes undermine UGS

preservation. Respondents noted a lack of community involvement in tree planting and a tendency to blame the decline of UGS on loss of community cohesion and a belief that the government should handle all responsibilities. For example, past initiatives, like the European Economic Community's provision of free tree seedlings, were undermined by pressures to clear UGS for safety concerns.

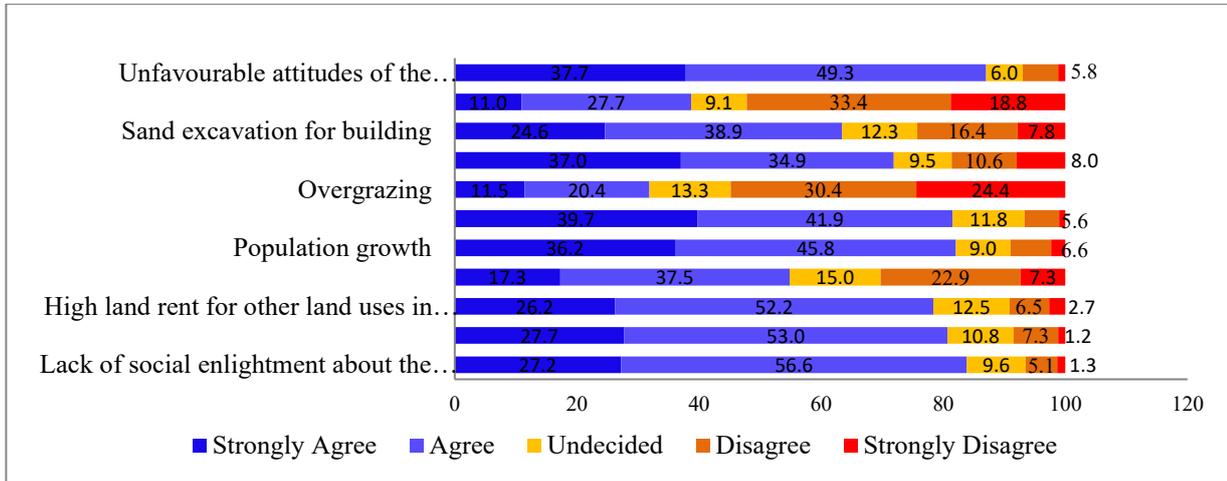


Figure 3: Socioeconomic Factors Influencing Changes in UGS Depletion in Katsina
Source: Authors Analysis (2022)

Observations indicate failures in UGS restoration and preservation policies. Previously, there was an annual tree planting campaign, which has since ceased. While UGSs are now included in planned developments (e.g., in Kofar-Kaura and Goruba), the planning authority does not enforce UGS reservations in informal markets, leading to further depletion. Despite increased awareness about the importance of preserving UGS through various channels, the lack of penalties for environmental violations exacerbates the issue.

Previous studies in Africa support the findings on UGS degradation. Mensah (2015) noted a lack of public commitment to UGS protection in Kumasi, where many shrubs and lawns were destroyed for commercial purposes. This finding mirrors the situation in Nairobi, Kenya, as reported by Makworo and Mireri (2011), where public parks were similarly compromised. Such negative behaviors stem from insufficient public involvement in UGS maintenance, contradicting principles of environmental sustainability that

advocate for preserving natural spaces to support ecosystem services vital for human well-being (Jennings et al., 2019; Semeraro et al., 2021). Conversely, Bonilla (2013) found that public commitment has successfully conserved parks in various Mexican municipalities.

In Katsina, over 83% of respondents indicated that a lack of social awareness regarding UGS benefits influenced its decline. Interviews revealed that the public often undervalues vegetation, primarily seeing it as a source of fruits, firewood, and animal fodder. This lack of enlightenment hinders recognition of UGSs as revenue sources and vital for sustainable living. Furthermore, there is insufficient education on UGS preservation in schools and communities. Kabir (2021) linked environmental decline in Dhaka and other Bangladeshi cities to similar issues of public awareness. Ladan (2015) emphasized that many remain unaware of the role of vegetation in mitigating climate change and other urban

environmental challenges, viewing trees mainly as fuel sources (Djibril et al., 2012; Mensah, 2015).

Additionally, 82% of respondents believe that population growth negatively impacts Katsina's UGSs, as urbanization increases demand for housing and commercial spaces, often at the expense of green areas. For example, residences replaced Kofar Durbi UGS and Lambun Sarkin Fada in Kofar Marusa. Public officials noted that rising populations lead to urban sprawl, squatter settlements, and greater demand for firewood, which collectively contribute to UGS decline. These observations align with earlier research linking urbanization to substantial UGS loss. The United Nations (2018) and Kuddus et al. (2020) forecast that urban populations will grow by 70% by 2050, exacerbating UGS destruction. Migration and high birth rates drive this urbanization (Mensah, 2015). Mhawish and Saba (2016) found that population increases historically altered land use in the Wadi Ziqlab catchment, resulting in a 42% decline in land cover. Furthermore, Varas-Hernandez et al. (2018) predicted significant urban population growth, indicating that existing UGSs will become increasingly inadequate due to expanding populations.

Most respondents (81.6%) indicated that the changes in UGSs in Katsina are largely driven by increased building construction. This finding corroborates interviewees' claims that much of the land used for construction is repurposed from farms, gardens, or other UGSs. The discussions highlighted that the lack of security measures in nearby UGSs has led to criminal activities, including drug use and illicit trade, prompting public outcry for their preservation. However, instead of addressing these security issues, the government has reclassified UGSs, converting areas like the Kabukawa Forest Reserve into urban developments. Furthermore, new government buildings and road constructions have substantially diminished the green areas in Katsina, adversely affecting the microclimate and contributing to the urban heat island effect.

Moreover, Ametepey and Ansah (2014) found that construction activities in Ghana significantly impact vegetation and biodiversity. Other studies identified infrastructural projects as primary causes for UGS loss (Puplampu and Bofo, 2021). Additionally, 80.7% of respondents acknowledged

that poverty and unemployment contribute to UGS changes. The informal land market often values land beyond the reach of poorer residents, leading to the destruction of UGSs without alternatives. The absence of law enforcement further pressures farmers to sell their land. Interestingly, nearly half of the respondents (54.8% and 52.2%) did not view overgrazing and hunting as significant factors in UGS changes, aligning with interviewee observations about limited grazing and hunting areas. This aligns with UN-Habitat (2017), which identified poverty as a key driver of green space loss in Africa.

A Chi-square (χ^2) analysis revealed that socio-demographic factors—such as residential neighborhood, occupation type, and land tenure—significantly influence perceptions of UGS changes. Differences in respondents' districts and educational levels also correlated with views on population impact.

Notably, living in different neighborhoods was the most influential factor affecting perceptions, followed by land tenure differences. The duration of residency and educational level also played significant roles in shaping opinions on socio-economic factors influencing UGS changes in the area.

Environmental Behaviour

This misunderstanding contributes to increased tree cutting and degradation of UGS, as individuals may not feel a personal investment in these areas. Additionally, rapid population growth intensifies the demand for housing and commercial space, leading to the clearing of green areas.

Economic Pressures

The reliance on UGS for resources like firewood, coupled with the high costs of alternative fuels, drives further deforestation. Economic pressures often overshadow environmental considerations in decision-making, leading to unsustainable exploitation of these areas.

Political factors influencing changes in Katsina UGS

This section discusses respondents' views on how political factors impact the changes in UGS in Katsina town, highlighting significant findings (Table 3 and Figure 4). A notable 83.7% of

participants agree that a primary political issue hindering UGS development is the lack of political will to protect these spaces. Interviewees connected this lack of will to bureaucratic delays, insufficient security for designated UGS areas, and reliance on outdated planning regulations. While planning schemes and laws are crucial for managing urban growth and enhancing residents' quality of life, there are few UGSs formally recognized in Katsina's layouts and master plans. Even designated areas for parks and reserves have often been compromised by other land uses. For example, substantial portions of land intended for

UGSs or forest reserves in the Goruba layout and other areas no longer exist. This issue is not unique to Katsina; similar challenges have been identified in various African cities. Appiah-Opoku et al. (2023) note comparable problems in Lagos, while Halima (2022) and Simon (2015) report declining green cover due to urban expansion in Kano and Ibadan, respectively. Furthermore, in Addis Ababa, about 300 hectares planned for UGSs remain undeveloped (Sa'ad, 2024). Gaikwad et al. (2019) emphasize that many public parks in developing nations exist only on paper.

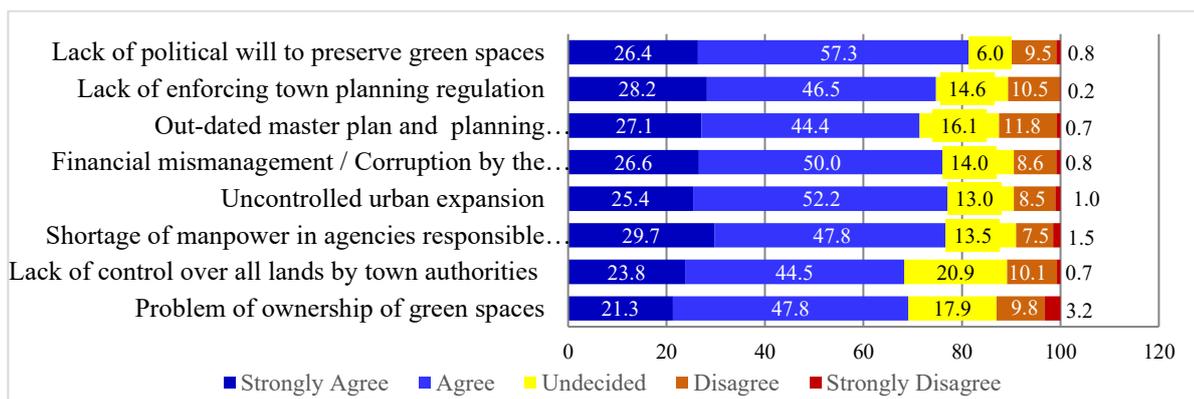


Figure 4: Political Factors Contributing to UGS Depletion in Katsina

Source: Authors Analysis (2022)

The development of UGS in Africa is hindered by prolonged bureaucratic procedures, favoritism, and nepotism among planning authorities. Research by Arku et al. (2016) indicates that obtaining building permits in some Nigerian cities can take over a year, involving 32 steps. In Lagos, officials at the Federal Housing Unit have delayed permit approvals (Girma et al., 2019). Additionally, the misuse of funds intended for urban greening projects has further undermined UGS development. For instance, donor funding for Harare's Ecological Zones was misappropriated, halting progress (Mamvura, 2022). In Ghana and Cameroon, the bureaucratic processes for securing development permits are lengthy, averaging two and seven years, respectively (Mensah, 2015). In Katsina, the government has been reluctant to secure UGS, particularly tree plantations, which are increasingly associated with criminal activities. This has led local communities to urge the government to clear or develop these areas. Poor coordination among government agencies and limited citizen involvement have also contributed to the

ineffective reservation and protection of UGS. The lack of security for these spaces has deterred public use, mirroring findings in Ghana, where urban parks are inadequately protected (Mensah, 2015). For example, Kumasi Children's Park has become unsafe at night due to criminal activity (Narh et al., 2020), and many UGSs in Kenya lack security personnel (Gallaher, 2017).

Furthermore, outdated planning regulations in Katsina are a barrier to UGS development. The Max Lock Master Plan from 1967 has not been updated and is no longer applicable due to the town's growth. Violations of this master plan have occurred even before its scheduled expiration. This aligns with findings from UN-Habitat (2017) and Dekki et al. (2017), which indicate that many African countries rely on obsolete master plans for urban management. The outdated nature of these plans has led to significant losses of UGS, as seen in Abuja, where a 1970s master plan continues to guide development. An empirical study by Simon (2015) found that 52.8% of respondents felt that

relying on such master plans was ineffective for urban recreation planning in Ibadan, highlighting the lack of stakeholder involvement in their development.

About 77.6% of respondents believe that uncontrolled urban expansion is a key factor in the decline of UGSs in Katsina. Urbanization poses significant challenges, especially after the establishment of Katsina State in 1987, which accelerated population growth and environmental changes. Notable urban developments have replaced important UGSs, such as Lambun Sarkin Fada and the new State Government House. During the colonial era and shortly after independence, the Katsina Emirate effectively managed UGSs, leading to lower encroachment rates.

Comparatively, traditional chiefs in several African nations maintain tighter control over UGSs, enhancing preservation efforts (Holt et al., 2019). Informal land subdivision exacerbates UGS depletion, with private real estate development often neglecting UGS provisions (Adegun, 2021; Enoguanbhor, 2022). Recent studies indicate that built-up areas in Katsina increased by 82.4% from 1999 to 2009 and more than doubled (136.3%) from 2009 to 2019, while vegetation declined by 4.0% and 33% in the same periods. This trend aligns with findings from other urban areas in Africa and the USA, where urbanization has led to significant UGS loss (Saghir & Santoro, 2018; Tiando et al., 2021; Mensah, 2015; Anguluri & Narayanan, 2017).

Table 3: Association between Respondents’ Socio-demographic Variables and Political Factors Contributing to UGS Depletion

Political Factors	Statistic	Socio-Demographic Variables									
		Ward	Age	Gender	Marital Status	Edu. Level	Occup.	Avg. Income	Resid.	Land Tenure	Land Permit
		df	16	24	4	16	12	16	16	16	12
Lack of political will to preserve green spaces	χ^2	122.176	27.998	9.556	65.532	16.490	25.709	17.558	22.456	32.733	3.821
	p	0.000*	0.260	0.049*	0.000*	0.170	0.058	0.350	0.129	0.001*	0.431
Lack of enforcing town planning regulations	χ^2	77.477	25.712	13.393	25.892	25.852	26.347	9.737	37.453	20.210	7.213
	p	0.000*	0.368	0.010*	0.056	0.029*	0.049*	0.880	0.002*	0.063	0.125
Out-dated master plan and planning ordinance / regulations	χ^2	96.167	29.272	1.352	19.501	21.053	14.165	8.608	37.969	29.710	10.325
	p	0.000*	0.210	0.853	0.244	0.050	0.586	0.929	0.002*	0.003*	0.035*
Financial mismanagement / Corruption by the government officials	χ^2	34.552	25.710	9.553	15.336	20.240	21.425	20.540	21.092	19.838	11.636
	p	0.005*	0.368	0.049*	0.500	0.063	0.163	0.197	0.175	0.070	0.020*
Uncontrolled urban expansion	χ^2	62.743	16.377	16.960	16.102	8.641	22.275	12.641	16.049	14.833	8.666
	p	0.000*	0.874	0.002*	0.446	0.733	0.135	0.699	0.450	0.251	0.070
Shortage of manpower in agencies responsible for urban green space management	χ^2	86.472	23.759	10.854	32.075	10.369	47.387	21.129	18.521	38.880	8.169
	p	0.000*	0.475	0.028*	0.010*	0.584	0.000*	0.174	0.294	0.000*	0.086
Lack of control over all lands by town authorities	χ^2	40.986	26.874	1.030	23.487	7.891	23.864	26.021	9.982	11.359	12.505
	p	0.001*	0.310	0.905	0.101	0.794	0.093	0.054	0.868	0.498	0.014*
Problem of ownership of green spaces	χ^2	18.657	24.049	0.430	16.915	11.114	18.618	25.460	25.683	17.873	3.804
	p	0.287	0.459	0.980	0.391	0.519	0.289	0.062	0.059	0.120	0.433

Source: Authors Analysis, (2022); *Significant at $p < 0.01$

Furthermore, 77.5% of respondents cited personnel shortages in UGS management agencies as a crucial factor in UGS changes. Interviewees noted that insufficient funding and resources hinder effective enforcement of development regulations. Similar findings were reported in other African cities, where inadequate resources limit UGS

management (Simon, 2015; Mensah, 2015). Additionally, 76.6% of respondents attributed UGS depletion to corruption and financial mismanagement among government officials, including neglecting to enforce development controls and approving illegal constructions. These observations align with previous studies

highlighting the misuse of funds intended for UGS initiatives (Costa & Patrício, 2020; Mensah, 2015). Chi-square analysis indicated significant differences in perceptions based on socio-demographic variables, such as residential area, gender, marital status, and land tenure. Notably, living in different districts significantly influenced opinions on the factors affecting UGS changes. Gender differences were the second most significant, followed by land tenure and marital status, while educational level impacted perceptions of only one political factor.

Urban Governance

The presence of informal land markets and unregistered vendors creates a legal ambiguity that undermines efforts to protect UGS. Weak enforcement of land-use regulations further exacerbates this issue, as the lack of political commitment results in inadequate staffing and financial mismanagement in relevant agencies.

Spatial Planning

The failure to update urban master plans to reflect current realities leads to a disconnect between growth needs and environmental sustainability. This misalignment allows for unchecked development that encroaches on UGS, diminishing their availability and ecological functions.

Summary of the Findings

The study identified:

- Physical factors challenges, such as high temperatures, sandy soils that dry quickly, and inadequate rainfall, which hinder vegetation growth. Prolonged dry seasons further exacerbate the impact of pests and diseases on plants.
- Socioeconomic factors challenges, regarding public perceptions which greatly affect UGS management, with many residents believing that the government alone is responsible for their maintenance. This misunderstanding, coupled with a lack of awareness about the importance of UGSs, leads to increased tree cutting. Rapid population growth heightens demand for housing and commercial space, resulting in more clearing of UGSs. Economic pressures, such as the need for firewood and the high cost of alternative fuels, contribute to further deforestation.

- Political factors, including challenges such as: Ineffective urban planning, characterized by outdated master plans and the misuse of planning regulations, has led to uncontrolled urban expansion. Informal land markets and unregistered vendors undermine UGS preservation. Additionally, inadequate staffing and financial mismanagement in relevant agencies reflect a lack of political commitment to protecting these vital spaces.

Strategies for Improvement

To address the decline of UGSs, several strategies can be implemented:

Firstly, addressing physical challenges requires for:

- High Temperatures: Use heat-tolerant plants and protective measures like mulching.
- Soil Quality: Conduct soil tests to guide plant selection and improve nutrient levels with fertilizers.
- Drought: Introduce drought-resistant species and efficient irrigation methods.
- Soil Erosion: Utilize cover crops and deep-rooted trees to stabilize soil.

Secondly, addressing socio-economic challenges require: Community engagement by improving public attitudes through education and community involvement, such as providing free tree seedlings, is essential. Urban planning should prioritize the integration of UGSs, employing smart green city strategies. Sustainable construction practices and environmental assessments are critical for protecting existing green spaces. Job creation and training in sustainable practices can engage communities in UGS restoration.

Finally, addressing political challenges requires:

- Political will: Enforcing urban planning regulations and involving communities in UGS discussions.
- Increasing Manpower: Enhancing staffing in public agencies and collaborating with NGOs.
- Improving Worker Conditions: Promoting transparency and accountability in government operations.
- Enforcing Regulations: Strictly implementing town planning regulations to prevent UGS encroachment.

CONCLUSION

The depletion of UGSs in Katsina is driven by three main factors. Physical factors include high temperatures, which can be mitigated with urban cooling solutions like tree canopies and green roofs, as well as poor soil quality that can be improved through organic fertilizers and land management. Sustainable pest and disease management, alongside efficient water systems for drought conditions, is also necessary. Socio-economic factors involve negative public attitudes that can be addressed through awareness campaigns promoting UGS benefits, the need for UGS preservation in urban planning due to population growth, and the enforcement of zoning laws to protect existing green spaces amidst increased construction. Lastly, political factors such as insufficient political will impede UGS protection, making it vital to advocate for supportive policies and funding. Developing an urban growth strategy that includes designated green areas can help manage urban expansion. Implementing these strategies is crucial to counter the depletion of UGSs in Katsina. By tackling these persistent challenges holistically, cities can work towards preserving their green spaces for future generations.

RECOMMENDATIONS

Considering these findings, the following recommendations are proposed to address the factors influencing changes in Katsina's UGSs: Assess the impacts of the changes in UGSs. Create a comprehensive plan for the restoration and preservation of UGSs.

REFERENCES

- Abdulrasheed, L. (2012). Farmers Indigenous Knowledge of Land Degradation and Conservation Measures in the Nigeria Sahel. PhD Dissertation, the University of Abuja, Nigeria.
- Abubakar, I. (2012). Households' Coping Strategies with Unsatisfactory Urban Services in a Planned City of Developing Countries: A Case Study of Abuja, Nigeria. PhD Dissertation, the Florida State University, USA.
- Abubakar, L.S (2020). Dikko Dynasty: 100 years of the Sullubawa Ruling House of 1906-2006.
- Abubakar, U. L., and Abdurrahman, A. (2018). An Assessment of Public Health Economy in Katsina State. Health Econ Outcome Res Open Access, 4 (160), 2.
- Adegun, O. B., Ikudayisi, A. E., Morakinyo, T. E., and Olusoga, O. O. (2021). Urban green infrastructure in Nigeria: A review. Scientific African, 14, e01044.
- Akiyode, B. F. and Khan, T. H. (2018). Step by step approach for qualitative data analysis. *International Journal of Built Environment and Sustainability*. 5 (3), 163-174.
- Alabi, M. O. (2020). Sustainable urban form and challenges of open space utilization, Akure, Nigeria as a case study. *International Journal of Urban Sustainable Development*. 12 (3), 328-339.
- Ametepey, S. O. and Ansah S. K. (2014). Impacts Of Construction Activities On The Environment: The Case Of Ghana. *Journal of Construction Project Management and Innovation*. 4 (S1): 934-948.
- Anguluri, R., and Narayanan, P. (2017). Role of green space in urban planning: Outlook towards smart cities. *Urban Forestry and Urban Greening*. 25, 58-65.
- Appiah-Opoku, S., Manu, K. K., Asibey, M. O., and Amponsah, O. (2023). Tragedy of urban green spaces depletion in selected sub-Saharan African major cities. *Journal Africsn Studies Development*. 15, 46-61
- Arku, G., Mensah, K. O., Allotey, N. K., and Addo Frempong, E. (2016). Non-compliance with building permit regulations in Accra-Tema city-region, Ghana: exploring the reasons from the perspective of multiple stakeholders. *Planning Theory and Practice*. 17 (3), 361-384.
- Bala W. Jafun A. Mohammed U. A.Yina P. I. (2022). University Students' Perceptions and Use Of Campus Green Spaces At Gombe State University, Gombe State, Nigeria FUDMA. *Journal of Sciences*. 6 (1), 42645 – 2944.
- Barau, A. S., Abubakar, I. R., Kafi, K. M., Olugbodi, K. H., & Abubakar, J. I. (2023). Dynamics of negotiated use of public open spaces between children and adults in an African city. *Land Use Policy*. 131, 106705.
- Bonilla, M. H. (2013). The significance and meanings of public space improvement in low-income neighbourhoods 'colonias populares' in Xalapa-Mexico. *Habitat International*. 38: 34 - 46.
- Costa, C. S., and Patrício, C. (2020). The production of public open spaces and the deliberate exclusion of undesirables.
- Dabo, M. Z., and Yunus, S. (2020). Road transport information system: a panacea for road transport facility management in Katsina local government, Katsina state, Nigeria. *FUDMA journal of sciences*. 4 (2), 466-477.
- Danbuzu, L. A. S., Tanko, A. I., Ibrahim, U. A., & Ahmed, M. (2014). Spatial distribution of solid waste collection points using GIS approach in urban Katsina, Katsina State, Nigeria. *American Journal of Engineering Research*. 3 (7), 107-116.
- Dekki, C., Khullar, A., Koike, H., Lo, S. T. T., and Zenteno-Bueno, S. (2017). A youth perspective on the New Urban Agenda. *International Development Planning Review*. 39 (4), 362-366.
- Djibril, C., Coulibaly, A., Wang, X., & Ousmane, D. (2012). Evaluating green space use and management in Abidjan City, Cote D'Ivoire. *International Journal of Economics and Management Engineering*, 2(3): 108-116.
- Enoguanbhor, E. C. (2022). Geospatial Assessments of Urban Green Space Protection in Abuja City, Nigeria. *Eximia*, 5(1), 177-194.
- FAO, 2021. The State of Food and Agriculture 2021. Making agrifood system more resilience and stress. Rome, FAO. <https://www.fao.org>.

- Gaikwad, A., and Shinde, K. (2019). Use of parks by older persons and perceived health benefits: A developing country context. *Cities*. 84, 134-142.
- Gallaher, C. M. (2017). Regreening Kibera: How urban agriculture changed the physical and social environment of a large slum in Kenya. *Global urban agriculture*, (pp. 171-183). Wallingford UK: CABI.
- Google Earth Professional (2019). satellite image of Katsina Urban Area. 30 meters Spatial resolution. Retrieved from <https://earthexplorer.usgs.gov>.
- Halima A. I. (2022). Declining Urban Greenery in Kano Metropolis, Nigeria *AFRIGIST Journal of Land Administration and Environmental Management*. 2 (1), 1-13.
- Hassan, A. and Yakubu, I.B (2010). Socio economics factors influencing Household energy use in Katsina metropolis. *Journal of Social Management Studies*. 13 (1), 15-16.
- Holt, E. W., Lombard, Q. K., Best, N., Smiley-Smith, S., and Quinn, J. E. (2019). Active and passive use of green space, health, and well-being amongst university students. *International journal of environmental research and public health*. 16 (3), 424.
- Home, R., Hunziker, M., & Bauer, N. (2012). Psychosocial outcomes as motivations for visiting nearby urban green spaces. *Leisure sciences*. 34 (4), 350-365.
- Hunter, R. F., Cleland, C., Cleary, A., Droomers, M., Wheeler, B. W., Sinnett, D., ... and Braubach, M. (2019). Environmental, health, wellbeing, social and equity effects of urban green space interventions: A meta-narrative evidence synthesis. *Environment international*, 130, 104923.
- Jande, J. A., Godwin N. N., and Mohammed, M. (2020). Prediction of Land Use Change in Katsina-Ala through a Geospatial Approach. *Journal of Agriculture and Sustainability*. 13 (1), 20-23.
- Jennings, V., and Bamkole, O. (2019). The relationship between social cohesion and urban green space: An avenue for health promotion. *International journal of environmental research and public health*. 16 (3), 452.
- Jiao, J. Houyuan Zou, Yanfeng Jia, Ning Wang (2009). Research progress on the effects of soil erosion on vegetation *Acta Ecologica Sinica* 29 (2), 85-91.
- Kabir, H., Maple, M., and Usher, K. (2021). The impact of COVID-19 on Bangladeshi readymade garment (RMG) workers. *Journal of Public Health*. 43 (1), 47-52.
- Kimpouni, V., Nzila, J. D. D., Watha-Ndoudy, N., Kokolo Bilongo, E. C., Yallo Mouhamed, S., Kampe, J. P., and Louembe, D. (2020). Sociocultural and ecological dynamics of green spaces in Brazzaville (Congo). *International journal of ecology*. 20 (20), 1-12.
- Kuddus, M. A., Tynan, E., & McBryde, E. (2020). Urbanization: a problem for the rich and the poor. *Public health review*. 4(1), 1-4.
- Ladan, S. I. (2022). Assessment of Environmental Challenges Posed by Ponds in Katsina City, Northern Nigeria. In *Proceedings of the Sustainable Research and Innovation Conference* (pp. 86-92).
- Lester, J. N., Cho, Y., and Lochmiller, C. R. (2020). Learning to do qualitative data analysis: A starting point. *Human Resource Development Review*, 19 (1),
- Liu, W., Zhao, H., Sun, S., Xu, X., Huang, T., & Zhu, J. (2022). Green space cooling effect and contribution to mitigate heat island effect of surrounding communities in Beijing metropolitan area. *Frontiers in Public Health*, 10 , 870403
- Makworo, M., and Mireri, C. (2011). Public open spaces in Nairobi City, Kenya, under threat. *Journal of Environmental Planning and Management*. 54 (8), 1107-1123.
- Mamvura, Z. (2022). Reconstituting the cultural geography in Zimbabwe: Place renaming in Zimbabwe's 'New Dispensation'. *Geopolitics*. 27 (3), 972-994.
- Mashi, S. A. Inkani, A. I., Oghenejeabor, O and Asanarimam, A. S. (2020). Community perception, response and adaptation strategies towards flooding risk in a traditional African city. *Natural Hazards*. 103, 1727-1759.
- Max Lock Group of Consultancy (1967). North Kaduna State Sub-Regional Study Survey and Planning Reports for Kaduna State Government and Kaduna Master plan.
- Mensah, A. C. (2015). Sustaining urban green spaces in Africa: a case study of Kumasi Metropolis, Ghana (Doctoral dissertation, University of Birmingham).
- Mensah, C. A., Antwi, K. B., Eshun, J. K., and Baidoo, P. (2017). Towards sustainability: Overcoming the physical barriers to urban green spaces in Kumasi, Ghana. *Ghana Journal of Geography*. 9 (2), 125-150.
- Mhawish, Y. M. Saba, M. (2016). Impact of Population Growth on Land Use Changes in Wadi Ziqlab of Jordan between 1952 and 2008. *International Journal of Applied Sociology*. 6 (1): 7-14.
- Mmaduabuchi, A. S., Bello, Y., and Yaro, A. (2020). Determination of Factors Responsible for the Change in Vegetal Cover in Katsina Town. *FUDMA. Journal of Sciences*. 4 (3), 636-644.
- Mohammed A, Hamisu I. (2015). Environmental implication of devastated urbanized river and drainage improvement design for Ginzo channel in Katsina town, Katsina state, Nigeria. *Katsina. Journsl of Natural Applied Science*. 4:16–24.
- Mostafa, S., Wang, Y., Zeng, W AND Jim, B (2022). Plant responses to herbivory wounding, and infection. *International Journal of Molecular Science*. 23 (13), 7031.
- Muhammad, G. U., Maulan, S., Yusof, M. J. M., and Ibrahim, R. (2022). Typology And Ownership of Rural Open Spaces In Semi-Arid Regions: A Case of Katsina State, Nigeria. *International Journal on Sustainable Tropical Design Research and Practice*. 15 (1) 122-124.
- Narh, S. N., Takyi, S. A., Asibey, M. O., and Amponsah, O. (2020). Garden city without parks: an assessment of the availability and conditions of parks in Kumasi. *Urban Forestry and Urban Greening*, 55, 126819
- NiMeT (2022). The Nigerian Meteorological Agency. Nnamdi Azikiwe International Airport Road, Abuja, Climate Report on Katsina.
- NPC (2009). National Population Commission. Federal Republic of Nigeria. Official Gazette. Vol. 96.
- Nwokocho, C. (2015). Effect of desertification on environmental management in Northern Nigeria. *Arabian Journal of Business and Management Review*. 3 (6), 5
- Panno, A., Carrus, G., Lafortezza, R., Mariani, L., & Sanesi, G. (2017). Nature-based solutions to promote human resilience and wellbeing in cities during increasingly hot summers. *Environmental Research*, 159. 249-256.
- Pietrzyk-Kaszyńska, A., Czepkiewicz, M., and Kronenberg, J. (2017). Eliciting non-monetary values of formal and

- informal urban green spaces using public participation GIS. *Landscape and Urban Planning*. 160, 85-95.
- Puplampu, D. A., and Boafo, Y. A. (2021). Exploring the impacts of urban expansion on green spaces availability and delivery of ecosystem services in the Accra metropolis. *Environmental Challenges*. 5. 100283.
- Rahaman, S., Jahangir, S., Haque, M. S., Chen, R., and Kumar, P. (2021). Spatio-temporal changes of green spaces and their impact on urban environment of Mumbai, India. *Environment, development and sustainability*, 23, 6481-6501.
- Rikko, L. S., Pwajok, N. R. 1, Namo, J. A. and Habila, S. K (2022). Depletion of Urban Green Spaces in Jos Metropolis, Nigeria Sahel. *Journal of Geography, Environment and Development*. 3 (2), 67-77.
- Ros, M., Pascual, J. A., Hernández, M. T., and García, C. (2009). Long-term effects of revegetation on composition and activities (including transcription) of fungal communities of a semi-arid soil. *Biology and fertility of soils*. 45. 435-441.
- Roy, S., Byrne, J., and Pickering, C. (2012). A systematic quantitative review of urban tree benefits, costs, and assessment methods across cities in different climatic zones. *Urban forestry and urban greening*, 11 (4), 351-363.
- Sa'ad, A. (2024). Examining the changes in UGSs and a framework for restoration measures in katsina urban area: Ph.D Dissertation, Umaru Musa Yar'adua University, Katsina, Nigeria.
- Saghir, J., and Santoro, J. (2018, April). Urbanization in Sub-Saharan Africa. In Meeting Challenges by Bridging Stakeholders. Washington, DC, USA: Center for Strategic and International Studies.
- Salman, A., Haque, A., Rahman, M., Rabby, M. J., Hossen, S., Halder, P., and Evan, R. I. (2023). NDVI-based Analysis of Green Space Decline and Air Quality in Dhaka: Implications for Sustainable Development Goals. *Environmental and Earth Sciences Research Journal*, 10 (2).
- Sani, L, S. Pantami, S. Sani, A, M. (2019). Evaluation Of Soil Physical Properties at Jibia Irrigation Project, Katsina State, Nigeria. *Fudma Journal of and Agricultural Technology* 5 (1), 231-243.
- Sara K., Berit B. and Antoinette W. (2018). Planning for green qualities in the densification of suburban Stockholm opportunities and challenges, Department of Sustainable Development, Environmental Sciences and Engineering, KTH Royal Institute of Technology, Stockholm, Sweden; *Journal of Environmental Planning and Management*. 67 (14), 2613-2635.
- Saulawa, B. G., Julius, A., Michael B., Kwesi, D., Bothepha, M. (2018) Impact of Desertification on Livelihoods in Katsina State, Nigeria *Journal of Agriculture and Life Sciences*. 5 (1), 27-29.
- Semeraro, T., Scarano, A., Buccolieri, R., Santino, A., and Aarreaara, E. (2021). Planning of urban green spaces: An ecological perspective on human benefits. *Land*. 10(2), 105.
- Siddique, S., and Uddin, M. M. (2022). Green space dynamics in response to rapid urbanization: Patterns, transformations and topographic influence in Chattogram city, Bangladesh. *Land Use Policy*. 114, 105974.
- Simon, R. F. M. (2015): Prevalence and Usage of Open Recreational Spaces in Ibadan, Southwest Nigeria Ph.D in Architecture, Covenant University, Canaan Land, Ota, Ogun State, Nigeria.
- Suleiman, M. (2016). Survey of some insect pests of cultivated vegetables in Ajiwa irrigation site of Katsina State, Nigeria. *Intern. J. Innov. Sci. Eng. Technol*, 3, 156-160.
- Suligowski, R., Ciupa, T., and Cudny, W. (2021). Quantity assessment of urban green, blue, and grey spaces in Poland. *Urban Forestry and Urban Greening*, 64, 127276.
- Sushinsky, J. R., Rhodes, J. K., and Possingham H. P. (2013). How should we grow cities to minimize their biodiversity impact
- Tiando, D. S., Hu, S., Fan, X., and Ali, M. R. (2021). Tropical coastal land-use and land cover changes impact on ecosystem service value during rapid urbanization of Benin, West Africa. *International Journal of Environmental Research and Public Health*. 18 (14), 7416.
- Uchegbu S. N (2017). The impact of open space conversion on the socio-economic Development of Enugu Urban Nigeria.
- Umar, K.G, Yusuf, D.A and Ahmed, A (2019). The practice of Hausa traditional Architecture Toward conservation and restoration of spatial morphology, and techniques.
- Umar, N. K., Sulaiman, A. M., Giwa, S. M., and Sulaiman, A. Y. (2018). Spatio-Temporal Analysis of Urban Expansion in Katsina Local Government Area, Katsina State, Nigeria. *Sokoto Journal of Social Sciences*. 8 (2), 95-106.
- UN-Habitat (2017). Global report on human settlements 2009: Planning sustainable cities. London: Earthscan.
- United Nations. (2018): The sustainable development Goals report 2018. New York: United Nations.
- Usman, Y. B. (1981). The Transformation of Katsina 1400-1883: The Emergence and Overthrow of the Sarauta System and Establishment of the Emirate. PhD Thesis, Ahmadu Bello University, Zaria Nigeria.
- Vargas-Hernández, J. G. Pallagst, K. Zdunek-Wielgołask, J. (2018). Urban green spaces Varna, G and Tiesdell, S.(2010): Assessing the Publicness of Public Space: The Star Model of Publicness, *Journal of Urban Design*. 15. 575-598.
- Verón, R, Santiago Lisandro J Blanco, Marcos A Texeira, J Gonzalo N Irisarri, José M Paruelo (2018). Desertification and ecosystem services supply: The case of the Arid Chaco of South. *America Journal of Arid Environments*. 159, 66-74.
- Zakka, S.D. (2017). Urban Greenery a pathway to Environmental Sustainability in Sub Saharan Africa: A Case of Northern Nigeria Cities. *International Journal of Built Environment and Sustainability*. 4 (3), 38-40,
- Zayyana, Y. I. (2010). Some Aspects of Urban Farming in Urban Katsina, Katsina State. An Unpublish M.Sc thesis, Bayero University Kano.