Ghana Journal of Geography

journal homepage: https://www.ajol.info/index.php/gjg/ https://journals.ug.edu.gh/index.php/gjg/

Spatial Patterns of Urban Expansion and Domestic Solid Waste Management in the Tamale Metropolis, Ghana

Zakaria Alhassan[1*] & Issaka Kanton Osumanu[2]

[1]Ndewura Jakpa Senior High/Technical School, Damongo, Savannah Region, Ghana.
[2]Department of Geography, Simon Diedong Dombo University of Business and Integrated Development Studies, Wa, Upper West Region, Ghana.

article info

Article history:
Received 25th September 2024
Accepted 18th November 2024
Published 31st December 2024

Keywords:
Infrastructure,
Land use,
Peri-urbanisation,
Population increase,
Waste generation.

abstract

The increase in population in the Tamale Metropolitan Area has resulted in rapid urbanization accompanied with poor services provision. This study examined the pattern of urban expansion and household solid waste management in the Metropolis. The study employed a mixed method involving 100 household respondents sampled conveniently to respond to questionnaires. The questionnaires were administered in four communities (Zoozugu, Manguli, Sakasaka and Aboabo) which were selected through stratified sampling. The questionnaires were supplemented by key informant interviews at the Tamale Metropolitan Assembly and Zoomlion Ghana Limited. The pattern of expansion of the Metropolis was studied by extracting built-up areas from satellite images for the years 2004, 2014 and 2022. The results indicated that the built area increased from 3,745.71 ha of land in 2004 to 5,697.45 ha of land in 2014 and from 5,697.45 ha in 2014 to 8,447.67 ha in 2022. The time series analysis of the urban expansion maps further showed linear growth and peri-urbanization in the area. The results from the questionnaires indicated that rural-urban migration is the root cause of expansion. It is shown that urban expansion has negatively affected household solid waste management in the metropolis because of the lack of infrastructure in response to the increase in population growth of the city.

© 2024 GJG Ltd. All rights reserved.

Introduction

Urban expansion, resulting mainly from people moving to and residing in cities and towns (Marzuki & Jais, 2020), results in the conversion of rural regions into cities and towns or peri-urban areas (UN, 2018). Although urbanization is seen as a distinct indicator of development and modernity, it also has drawbacks (Olaniyi et al., 2013; Marzuki & Jais, 2020). Urban environments provide a habitat for entrepreneurship and technological advances, and those are seen as the benefits of urbanization (UN, 2018). According to Marzuki and Jais (2020), urbanization has multiple effects on development's social, environmental, and economic facets. Urban sprawl, which has a cascading effect on people, modifies a location's land use and land cover over time, triggering a crucial negative influence on the environment (Osumanu & Akongbangre, 2020).

Urban expansion and population growth are closely related (Angel et al., 2011; Fuseini, 2016). Since 1950, the global population has increased more quickly (UN, 2019), resulting in the acceleration of urbanization between 1950 and 2018. The 414 million Africans who lived in cities in 2011 are expected to rise to 662 million by 2050 with the assumption that the urbanization trend will continue worldwide, especially in Africa and it sub regions (UN- Habitat, 2010). The expected speed of Africa's transition into the "urban age" is unheard of (Guneralp et al., 2018). The urban population of Africa is projected to triple from 395 million in 2010 to 1.339 billion in 2050, accounting for 21% of the estimated global urban population (UN, 2014). This unprecedented urban population increase has been attributed to migration or natural increase (Jenkins, 2013). Between 2000 and 2010, urban settlements with fewer than 300,000 dwellers accounted for 58% of Africa's urban growth (African Development Bank, 2016). The five areas where urban expansion is concentrated are the Nile River in Egypt; the West African coast along the Gulf of Guinea; the northern shores of Lake Victoria in Kenya and Uganda, extending into Rwanda and Burundi; the Kano region in northern Nigeria; and greater Addis Ababa, Ethiopia (Guneralp et al., 2018). Rapid urbanization has given rise to megacities. Some African cities have already grown to contain more than 10 million people. Currently, the continent is home to seven megacities: Lagos, Cairo, Accra, Kinshasa, Johannesburg-Pretoria, Nairobi, and Khartoum (Cobbinah et al., 2022). The increase in urbanization in Africa has had a negative impact on the environment already, including the contamination of priceless water systems and the decline in air quality, and as the demand for housing in urban areas consumes agricultural land and green space into built up (Guneralp et al., 2018; Abdulai & Osumanu, 2023).

The share of Ghana's urban population has risen quickly over time since the middle of the 20th century (Yankson and Bertrand, 2012). Greater Accra and Ashanti regions accounted for nearly half (47.8%) of the rise in the urban population, which increased from 12,545,229 (50.9%) in 2010 to 17,472,530 (56.7%) in 2021 (Ghana Statistical Service [GSS], 2021). The Greater Accra Region has the highest percentage of urban residents (91.7%), while the Upper East Region has the lowest percentage (25.4%). There are currently seven urbanized regions in Ghana - Greater Accra, Ashanti, Bono, Central, Bono East, Western, and Eastern (GSS, 2021). Such an expansion in urban areas describes how important towns and cities have become centers of population within the country's economy and society (Maleeks et al., 2002; Bhatta, 2010). The process of urbanization is dynamic and intricate. The transition from rural to urban forms is accelerated through alterations to the structural and functional features of the built environment (Castle & Crooks, 2006; Dahal et al., 2016; Sahana et al., 2018) including the generation and management of domestic solid waste (Osumanu, 2022).

The generation and management of solid waste is principally an urban phenomenon because there are fewer packaged goods, less food waste, and

* Corresponding author.
E-mail addresses: alhassanz190@gmail.com (Z. Alhassan).

http://dx.doi.org/10.4314/gjg.v16i4.1
© 2024 GJG. All rights reserved.

less manufacturing in rural areas. Urbanization and waste production have a favorable relationship, according to global trends (Jamir, 2021). The production of waste also rises along with urbanization, but it is suggested that global production of urban solid waste is growing faster than urbanization (Kosoe et al., 2022). The 220 million urban dwellers who made up 13% of the world's population in 1900 produced less than 300,000 tonnes of rubbish per day (including broken household items, ash, food waste, and packaging). By 2000, 2.9 billion people (49% of the world's population) were living in cities, producing more than 3 million tonnes of solid waste every day. This is expected to increase to twice that amount by 2025, which will be sufficient to fill a daily line of trash trucks 5,000 kilometers long (Hoornweg et al., 2012). Improper waste management degrades the urban environment and poses health hazards (Jamir, 2021). In order to maintain a healthy environment in metropolitan areas, attention must be paid to urban solid waste management along with urban expansion.

Remote sensing (RS) and Geographic Information Systems (GIS) are essential tools for evaluating and monitoring environmental effects because of their synoptic coverage and consistent use of spaceborne imagery (Basommi et al., 2015). Applications that have been used extensively to examine urban expansion include RS and GIS (Akongbangre, 2016; Osumanu et al., 2019; Osumanu & Akongbangre, 2020). Geographic information systems (GIS) and Remote Sensing data can be used to circumvent the limitations present in developing countries (Ndzabandzaba, 2015; Jamir, 2021). Data on land use and land cover, population density, and solid waste generation and management can all be recovered using RS in a range of spatial and temporal resolutions. Urbanization trends can be analyzed using GIS techniques, and future patterns can be forecasted (Simwanda et al., 2020; Jamir, 2021). Similarly, GIS can be used to analyse domestic waste generation and management trends in urban areas.

The rising population of Tamale Metropolitan Area (TMA) in northern Ghana led to urban sprawl and peri-urbanization (UN-HABITAT, 2008; United Nations Population Fund, 2007; Akongbangre, 2016) and urban poor infrastructure and service provision (Fuseini, 2016). Sustainable urbanization strategies must be adopted in order to overcome the challenges posed by rapid urbanization in the Metropolis. A number of researches in the Metropolis (Fuseini, 2016; Puopiel & Owusu-Ansah, 2014; Naab et al., 2013) are tilted towards achieving sustainable urbanization in TMA. In the midst of all these researches, very little is done on the pattern of urban expansion and how it affects domestic solid waste management. This study seeks to spatially examine the pattern of urban expansion and domestic solid waste management in Tamale Metropolitan Area. The study contributes by combining spatial and non-spatial data and techniques to analyse the relationship between urban expansion and domestic solid waste management.

Theoretical Perspective

The theoretical underpinning of this study is the self-generated urbanization theory. According to this theory, the emergence of urbanization requires the satisfaction of two separate conditions: the production of surplus goods that sustain people in non-agricultural activities and the achievement of a level of social development that enables large communities to successfully function on their own (Bodo, 2015; Lampard, 1965; Bodo, 2019). It is believed that these urbanization-causing changes happened at the same time as the first settlements in the Middle East began to form during the Neolithic era (Wheatley, 1971; Bodo, 2019). According to this view, people started migrating from the countryside to cities in search of manufacturing work (Childe, 1950). As a result, it was determined that industrialisation was the primary cause of the migration of people from rural to urban areas. According to historical evidence, no society could be characterized as urbanized prior to the industrial revolution in Great Britain in the twentieth century. After this time, the West started to industrialize quickly, and soon after that, the rest of the world's industrialization and urbanization raced through the previous century to the present day. According to this theory, urbanization results from industrialization. This idea has also been criticized for emphasizing rural-to-urban migration within counties as the cause of urbanization, given that other cities may also experience urbanization for reasons other than rural-to-urban migration (Davis, 1972; Pred, 1977).

Although this theory has been criticized for emphasizing rural-urban migration as the only factor contributing to urbanization, it is useful for research on urbanization in developing nations. Urbanization is mostly a result of rural-urban migration, which is a problem in Ghana and most developing nations. For instance, in Ghana, between 1948 and 1960, migration from rural regions was responsible for 98% of the urban expansion (Songsore, 1977; Naab et al., 2013). The argument that rural-urban drift is caused by industrialisation claims that this movement is typically motivated by a search for employment in cities and towns.

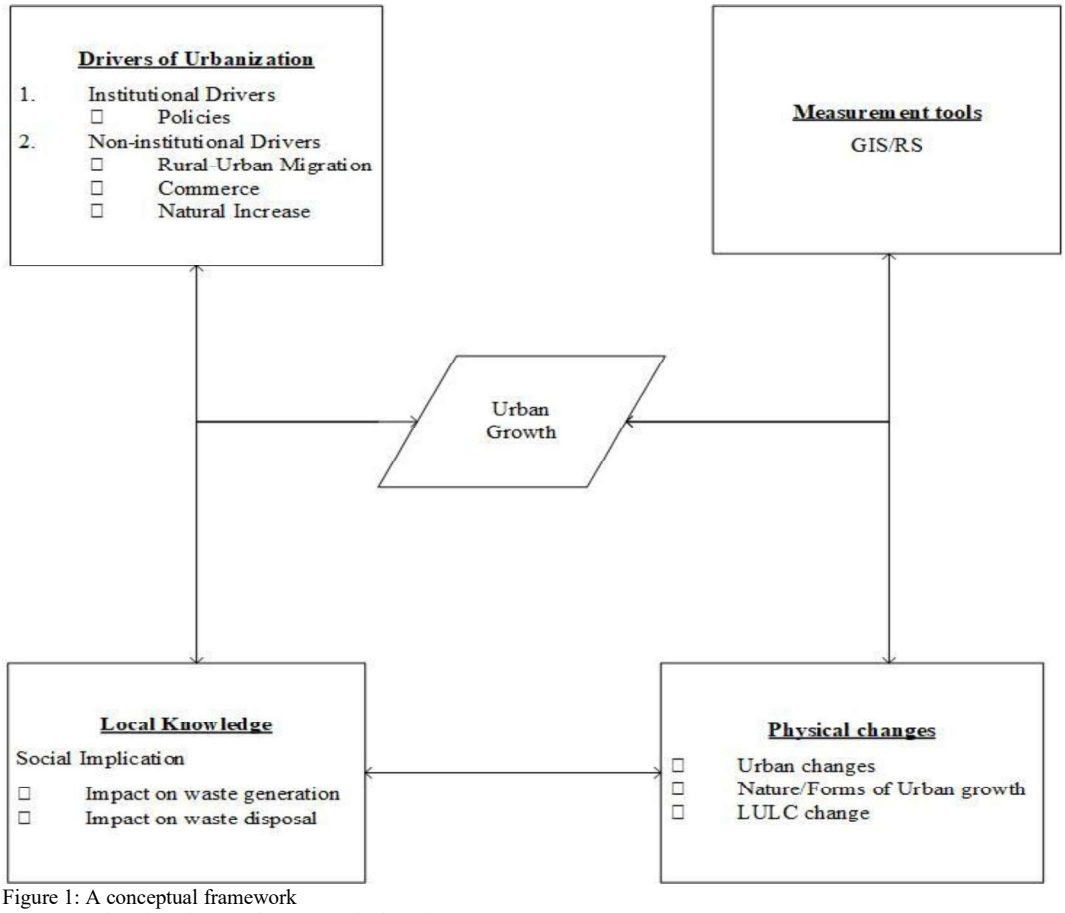

Figure 1: A conceptual framework
Source: Author, based on Koti (2013) and Akongbangre (2016).

Institutional and non-institutional factors (Figure 1) both play significant roles in urban expansion (Hu, 2013). Institutional drivers relate much to government policies such as reclassification of settlements, making settlements regional and district capitals, housing reforms, etc. Non-institutional drivers are those that are less informed by policies, for instance, rural-urban migration, market demand, etc. Urban expansion is both a demographic and physical phenomenon. As a physical process, urban expansion is about the expansion of urban land cover, which is usually measured using GIS tools, while as a demographic process, it refers to the increase in urban population driven by both institutional and non-institutional factors. In order to have a comprehensive knowledge of urban expansion and how it impacts domestic solid waste management, there is the need to seek local knowledge on drivers of urban expansion and social impacts. The use of Participatory Geographic Information Science (PGIS) in this study allowed for the integration of local knowledge into conventional GIS to analyze the spatial patterns of urban expansion and domestic solid waste management in the Tamale Metropolis. Local actors are able to communicate their understanding of the physical environment by analyzing items, connections, and problems (Minang, 2003; Akongbangre, 2016).

Martials and Methods

The study context

Tamale was founded as a colony in 1907 (Staniland, 1975). It was separated from the West Dagomba District to create the Tamale Municipal District in 1988, at which point it was constituted as a district. By means of Legislative Instrument (LI) 1801 of the Local Government Act of 1993 (Act 462), it was granted a metropolitan status in 2004. The capital of the northern region, Tamale, also serves as the capital of the Tamale Metropolitan Area. The study area is located between latitudes 9°16'N and 9°34'N and longitudes 0°34'W and 0°57'W (Figure 2). Its overall area is 922 km^2 (GSS, 2010). It is roughly in the middle of the Region, bounded to the north-west by Sagnarigu Municipality, to the east by Mion District, to the south by East Gonja District, and to the south-west by Central Gonja District. A total of 374,744 people live in the Metropolis, with 185,051 (49.4%) males and 189,693 (50.6%) females (GSS, 2021). This represents around 16.2% and 1.2% of the regional and national populations respectively (FOA, 2022). Generally speaking, the Tamale Metropolis, which rises to a height of around 180 meters above sea level, is a component of the Voltain Sandstone Basin. The terrain is mostly rolling, with a few isolated hills.

Data acquisition

This study used both primary and secondary data. Primary data were gathered through key informant interviews, disseminated questionnaires, and observations of the urban patterns in a few chosen communities within the Metropolis. A total of 100 questionnaires were administered conveniently and key informant interviews were granted through purposive sampling to officials of Tamale Metropolitan Assembly and Zoomlion Ghana in Tamale. Secondary data used in this study include shapefiles for roads, rivers, settlements, and the metropolitan boundary of the Metropolis. Satellite images were obtained from the United States Geological Survey Department. Combining spatial and non-spatial data sources (Figure 3) guaranteed that findings from the examination of empirical data gathered from the field interacted with concepts from theory (Creswell, 2003; Toku, 2018).

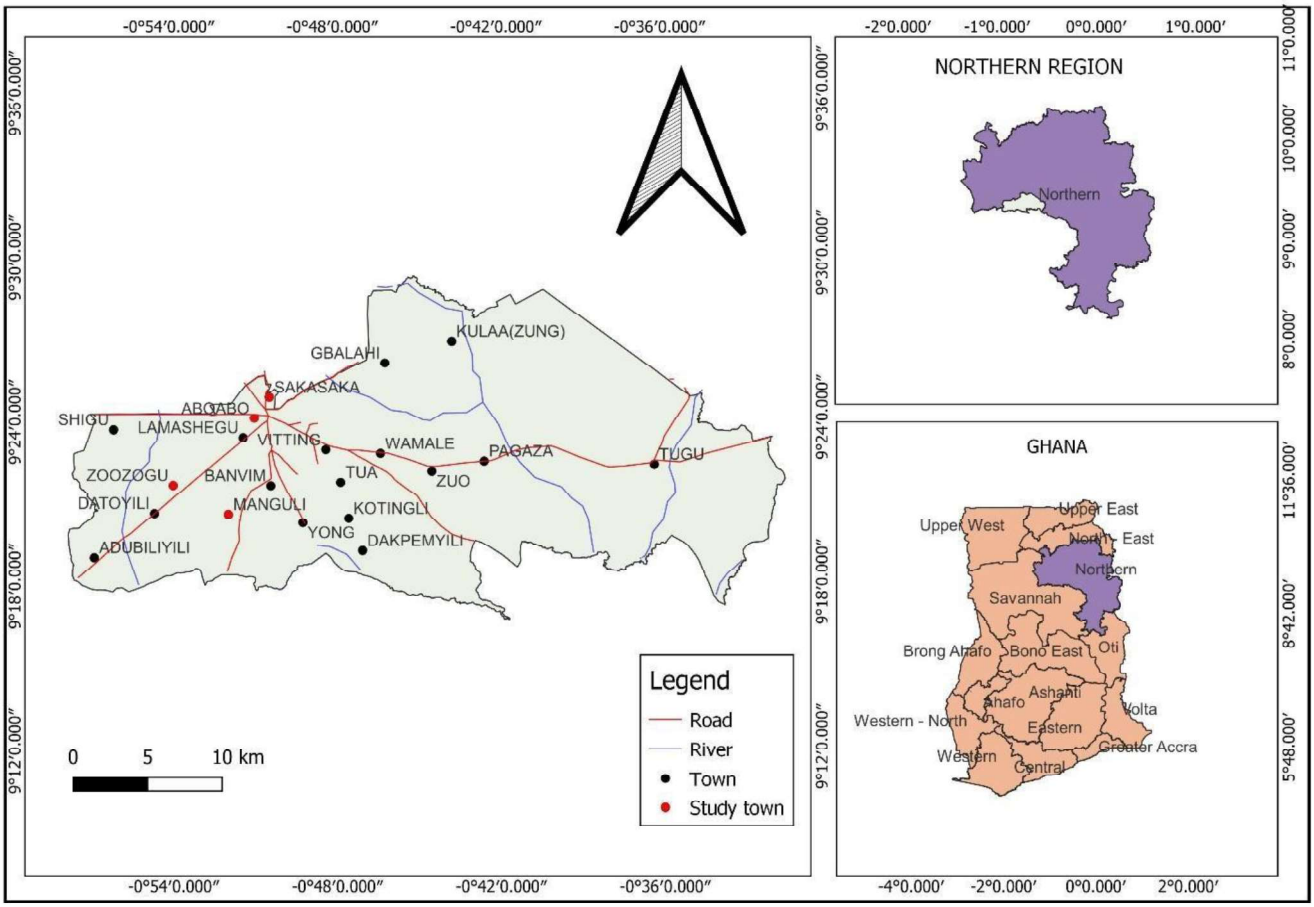

Figure 2: Tamale Metropolis highlighting study communities

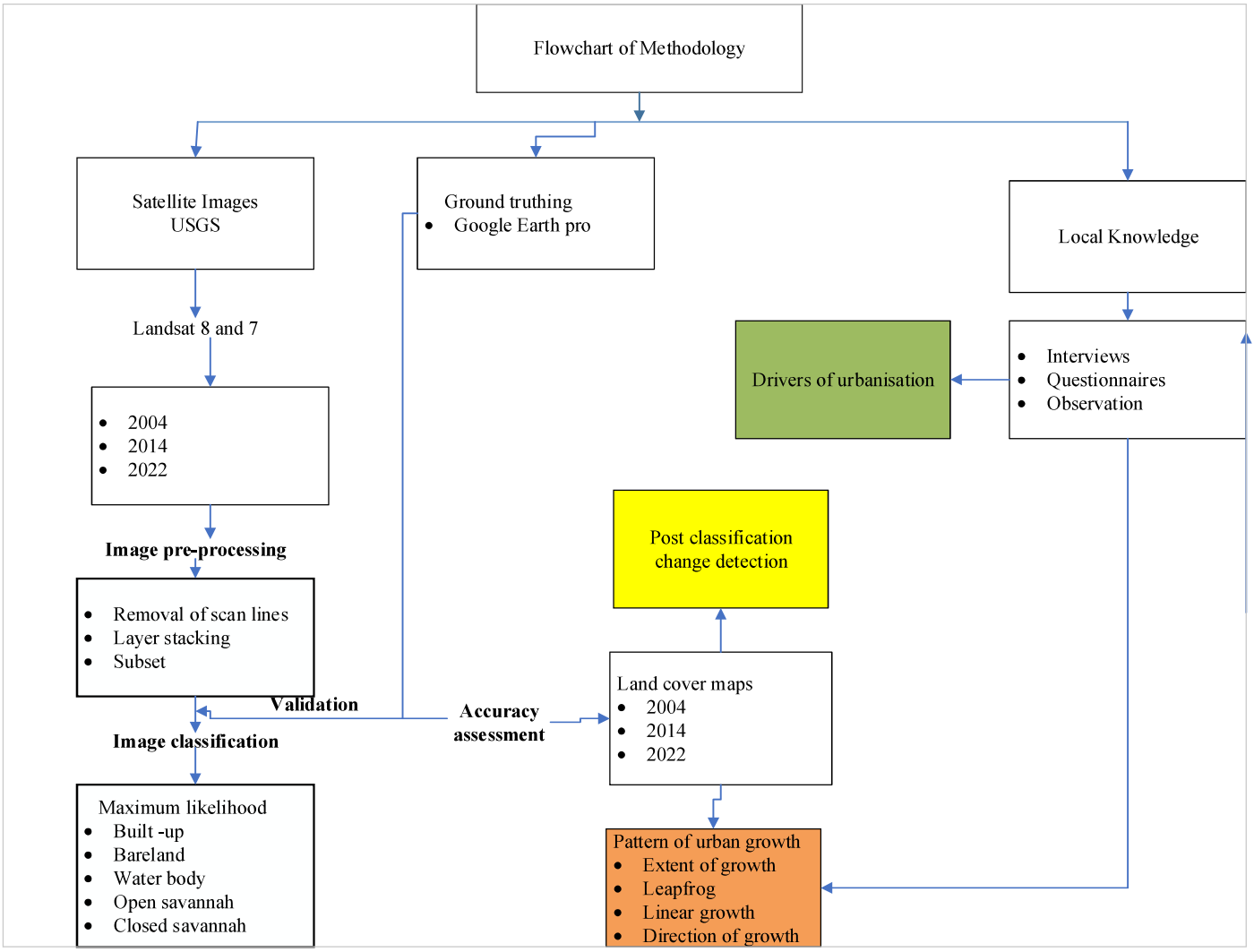

Figure 3: Flowchart of methodology

Urban expansion

The large continuous zone of built-up in Tamale Metropolis for the years 2004, 2014 and 2022 were digitized into polygons to represent the urban areas of the Metropolis (Figure 4). The areas of the polygons were computed and it indicated that the urban area of Tamale has been increasing. It increased from 3,605.274 ha of land in 2004 to 5,571.58 ha in 2014 representing a 54.5% increment in the urban area. Between 2014 and 2022, the urban area increased from 5,571.58 ha to 9,342.84 ha with a percentage increase of 67.7. The percentage increase in the urban extent between 2014 and 2022 posits that Tamale is expanding at a faster rate and this is in line with the findings of Gyasi et al. (2014), Fuseini et al. (2017) and Sulemana and Yiran (2018).

This massive expansion became visible after the area attained the status of a metropolis. The population of the new metropolis began to grow at a faster rate due to high fertility, low mortality and high net-migration (Yahaya, 2022). Sulemana and Yiran (2018) noted that population growth causes an increase in the need for physical infrastructure, such as homes, schools, hospitals, businesses, and roads. The urban area will grow spatially as a result of the development of this infrastructure. Another factor that causes the expansion of the urban area is Tamale's strategic location in the Northern Region with a market potential for local commodities from the agricultural and commercial sectors of the other districts in the Region (GSS, 2010). In addition, the region stands to benefit from markets in the West African Region from nations like Burkina Faso, Niger, Mali, and the northern half of Togo. The central location of the Metropolis attracts a lot of businesses into the area which has led to the establishment of business within the Central Business District (CBD), forcing indigenous settlers within the urban core to resettle in the fringes to bring about urban expansion.

In order to have a detailed understanding of the extent of expansion in the Metropolis, the satellite images of the area for the various years were classified into built-up and non-built-up areas. The built-up refers to the houses and other structures whilst the non-built-up includes bare land, Open Savannah, Closed Savannah and water bodies (Figure 5). The built-up area of Tamale grew in size and compactness from 2004 to 2022. The built-up radiates from the urban core to other parts of the Metropolis. This confirms Fuseini's (2014) findings that the pattern of growth in Tamale Metropolis is a radial expansion. Sulemana and Yiran (2018) also made similar observations in the Metropolis and attributed the cause of this type of growth to the topography of the area.

Tamale has grown to encompass a number of villages that were located within an 18 km radius of its inner core. This is evidenced in the results of 2004 and 2022 maps (Figures 5 and 6). The 2004 result shows clearly the urban core and its nearshoring villages separated by open spaces usually used for agriculture. Some of the villages include Manguli, Yong, Taha, Tua, and Zoozugu. This is in line with Gyasi et al. (2014) and Tegegne (2002), as cited in Toku (2018), who made the claim that urban growth is an unforeseen event that causes the displacement of nearby rural farming villages. As the city continues to grow, due to population growth, it expanded to merge with those villages giving it both rural and urban characteristics and this is term as leapfrog growth/peri-urbanisation which can be observed in the 2022 results. One of the respondents at Zoozugu, a peri-urban community had this to say:

"*… there use to be a clear boundary between this town and Dungu, but now, you can see that Dungu has expanded to merge with this town and this town is growing to merge with Datoyili. Because of the establishment of University for Development Studies (UDS) a lot of people are building here just to be close to the university.*"

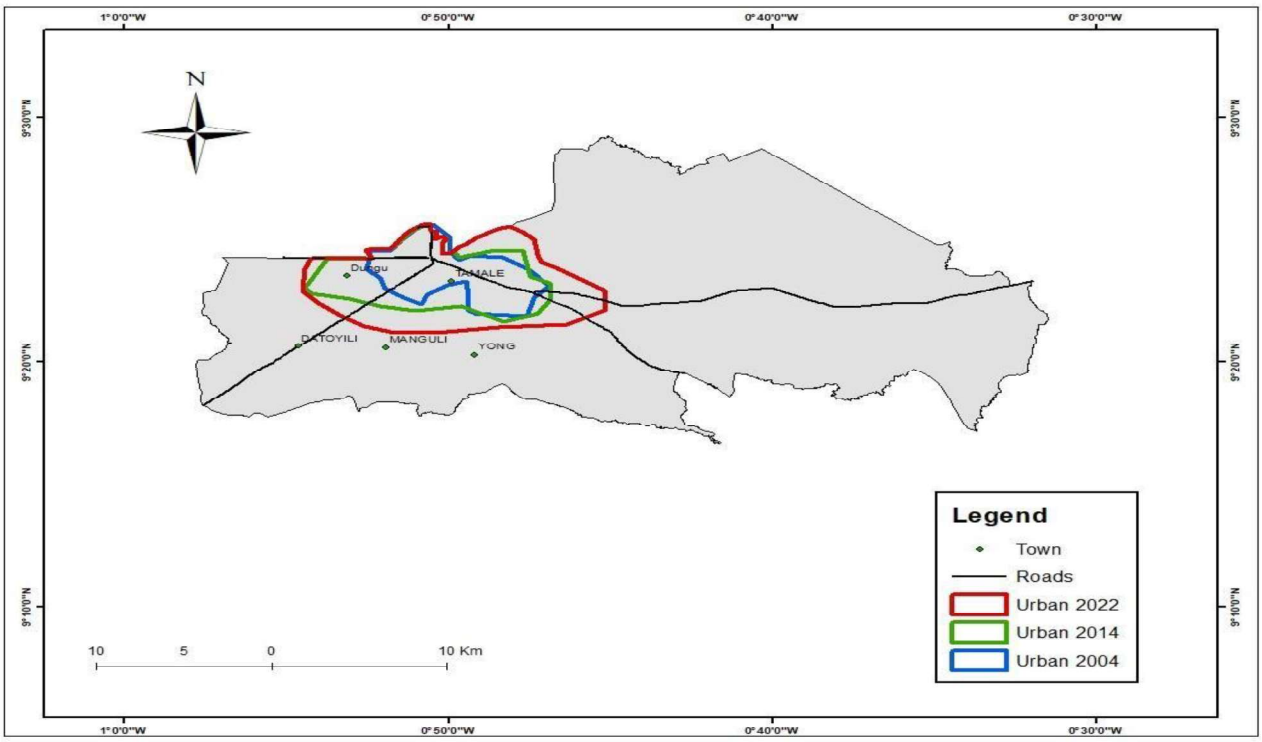

Figure 4: Extent of Tamale 2004, 2014 and 2022

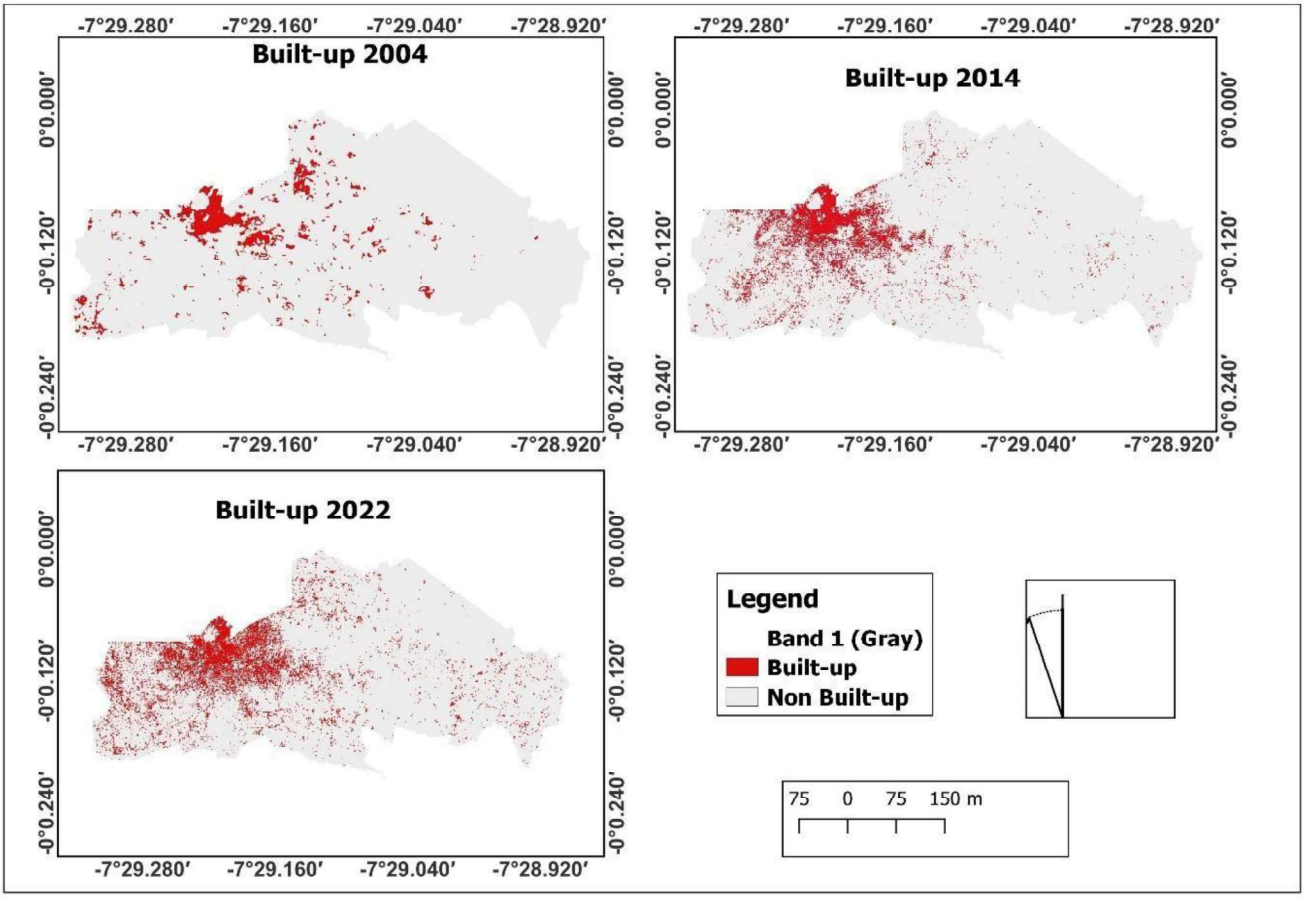

Figure 5: Built up area of Tamale in 2004, 2014 and 2022

The location of UDS, Tamale Campus at Dungu in Tamale south, has attracted a lot of real estate development leading to the emergence of peri-urban communities such as Zoozugu, Kamonayili, Datoyili and Gunayili (Figure 7).

The major roads in Tamale, including the Tamale-Kumasi trunk road, Tamale-Salaga and Tamale-Yendi roads attract a lot of human settlements along (Figure 8), because the roads are fertile grounds for businesses and also provide easy access to electricity and transportation. This finding is in contrast with Fuseini's (2016) finding that urban growth in Tamale is more radial than growth along major routes. However, Akongbangre (2016) states clearly that Wa has often developed along transportation corridors. Mention can also be made of towns like Datoyili, Gunayili, Kamonayili and Zoozugu as towns that grew along the Tamale-Kumasi Road. It can be observed in Figure 8 that towns like Vitting, Wamale and Zuo are all developing along the Tamale-Yendi route. Anane (2022) states that the availability of electricity and waterlines along key arterial highways has contributed to the current trend for roadside dwelling among peri-urban people. Akongbangre (2016) agrees to this by stating that, the majority of residential facilities are located adjacent to roads, which makes it simple to access transportation and supports the growth of business operations.

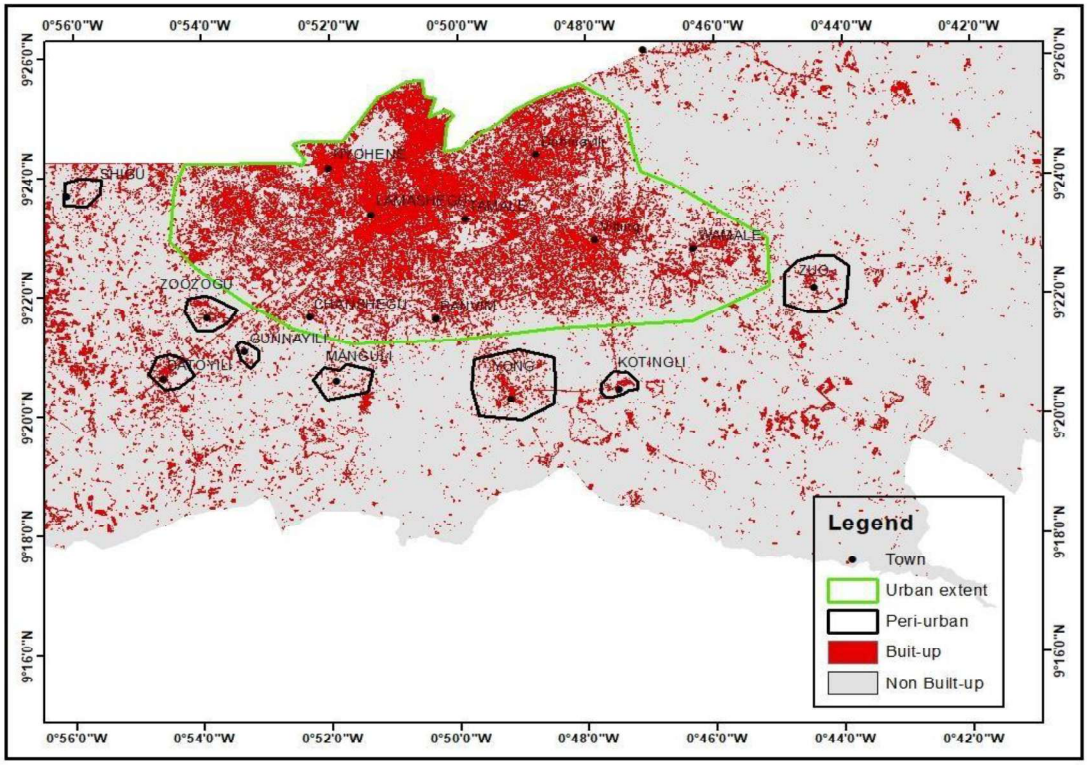

Figure 6: Peri-urban areas in Tamale Metropolis, 2022.

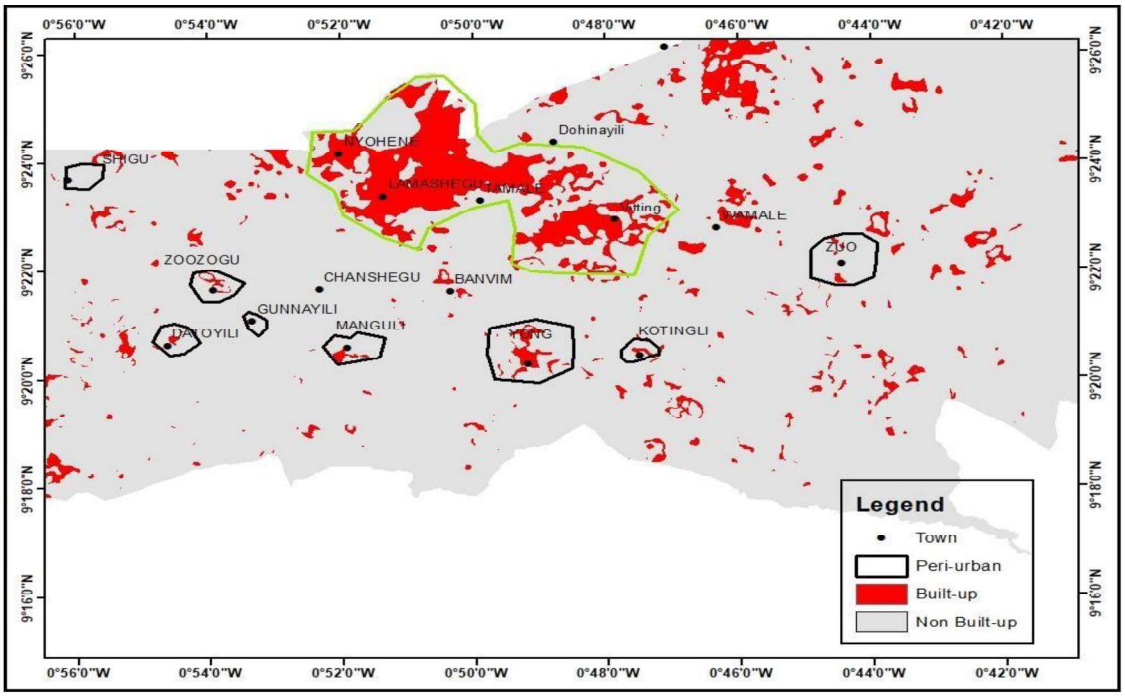

Figure 7: Peri-urban areas in Tamale Metropolis, 2004

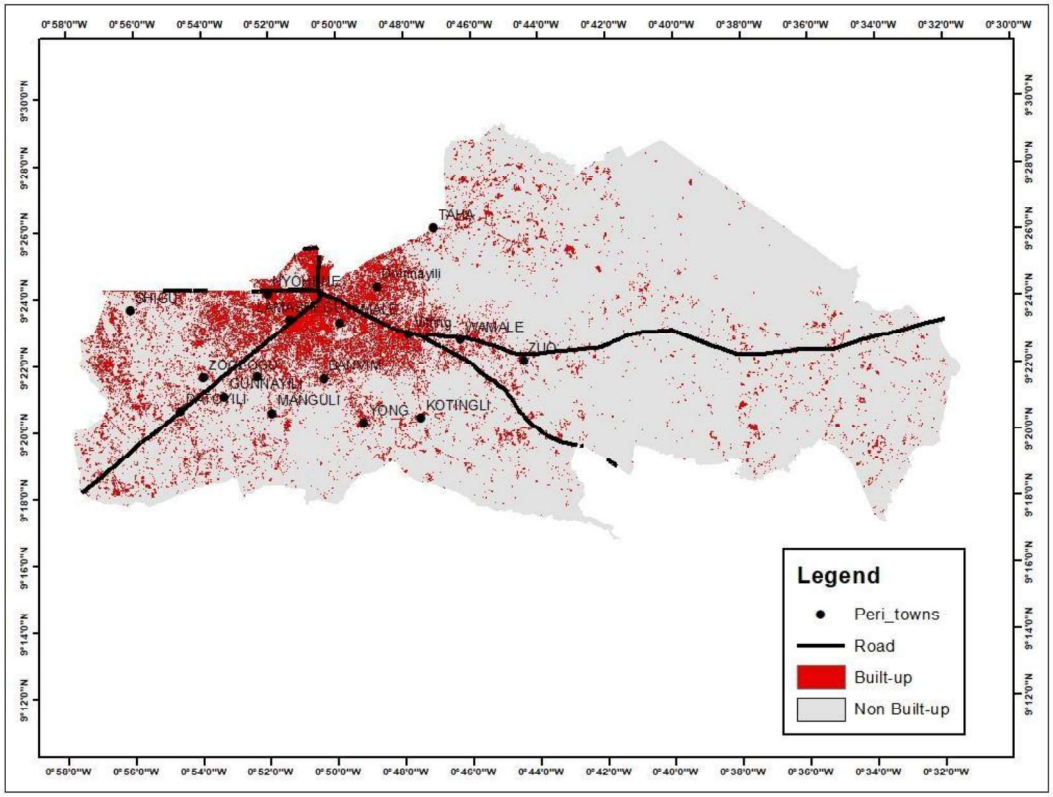

Figure 8: Linear growth in Tamale Metropolis

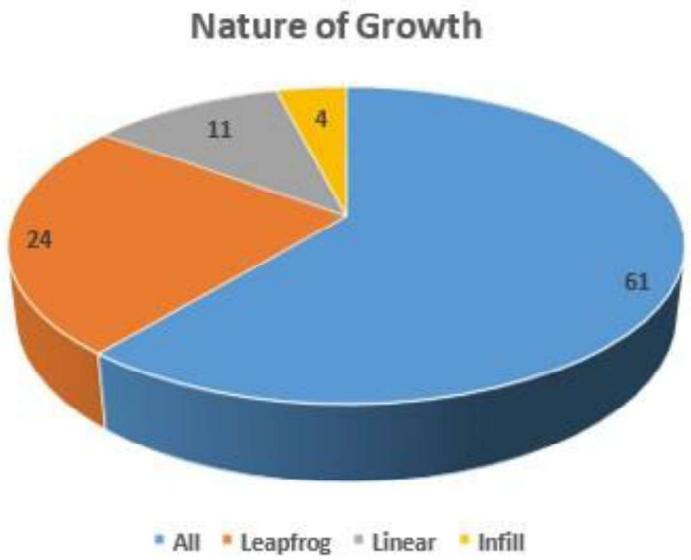

Figure 9: Responses to the nature of urban expansion in Tamale Metropolis

Respondents' reactions to the nature of urban expansion are presented in Figure 9, which reveals that 4% were of the view that urban growth in the Metropolis is the infill type, 11% believed that the growth is linear, 24% thought the growth is leapfrog and the remaining respondents (61%) said that all the three forms of growth can be found in the Metropolis. A respondent from Aboabo, within the urban core said that:

"... the growth can be seen towards the nearby villages. It is also growing along major routes like the Tamale-Kumasi Road. The empty spaces within town are also used to build stores and other structures for commercial purposes."

The findings clearly demonstrate a large increase in the urban land cover of the city, as seen by growth in peri-urban areas and in-fill construction within urbanized districts.

Urban development is seen to the west and east of Tamale Metropolis and very little growth towards the south (see Figure 10). The growth towards the east is influenced by the Target Residential Area where a lot of the high-income earners in the Metropolis resettle. Sulemana and Yiran (2018) attributed the growth in the east to north-east to regular enhanced water supply and distribution to the city's neighborhoods. The presence of the Tamale-Yendi Road and the Tamale-Salaga Road in the eastern part of Tamale has also contributed to that growth. There are a number of educational institutions such as Vitting SHTS, Tamale Girls SHS and Anbariya SHS which serve as growth poles in the eastern part of Tamale.

The growth towards the west can be mainly attributed to the numerous educational institutions in the location. These areas have the education ridge, Tamale Technical University and, by extension, Nyankpala Campus of UDS. Sulemana and Yiran (2018) also acknowledged the growth in the western part of Tamale Metropolis in their work by stating that in Tamale's western to northwestern part, there are active human settlements. It has been noted that the growth in the south-western part of the Metropolis became intense after the establishment of UDS Tamale Campus in 2007 in that area (Fuseini, 2017; Sulemana and Yiran 2018). The northwestern part is closer to the education ridge where there is an agglomeration of educational institutions. Sulemana and Yiran (2018) attributed the rationale behind the settling closer to educational facilities to the fact that water supply in educational institutions extends to the neighborhoods around them. The Savelugu-Nanton, Kumbungu, and Tolon Districts have all been affected by expansion in the northern, northwestern, and western parts of the Metropolis respectively (Farvacque-Vitkovic et al., 2008), while the East and Central Gonja Districts are quickly being encroached on by expansion in the southern and southwestern parts of the Metropolis (Fuseini, 2016).

Drivers of urban expansion

Respondents mentioned the following as the drivers of urban expansion in the Tamale Metropolis: rural-urban migration, natural population increase, government policies and increase in commerce (Figure 11). The results reveal that 66% of the respondents agreed that urban growth within the Metropolis is as a result of rural-urban migration, 23% of them said it is due to natural population increase, 8% associated the phenomenon to commerce and 3% attributed it to government policies. This is similar to the findings of the Ghana Statistical Service (2010) that Tamale's population growth is mostly the consequence of immigration.

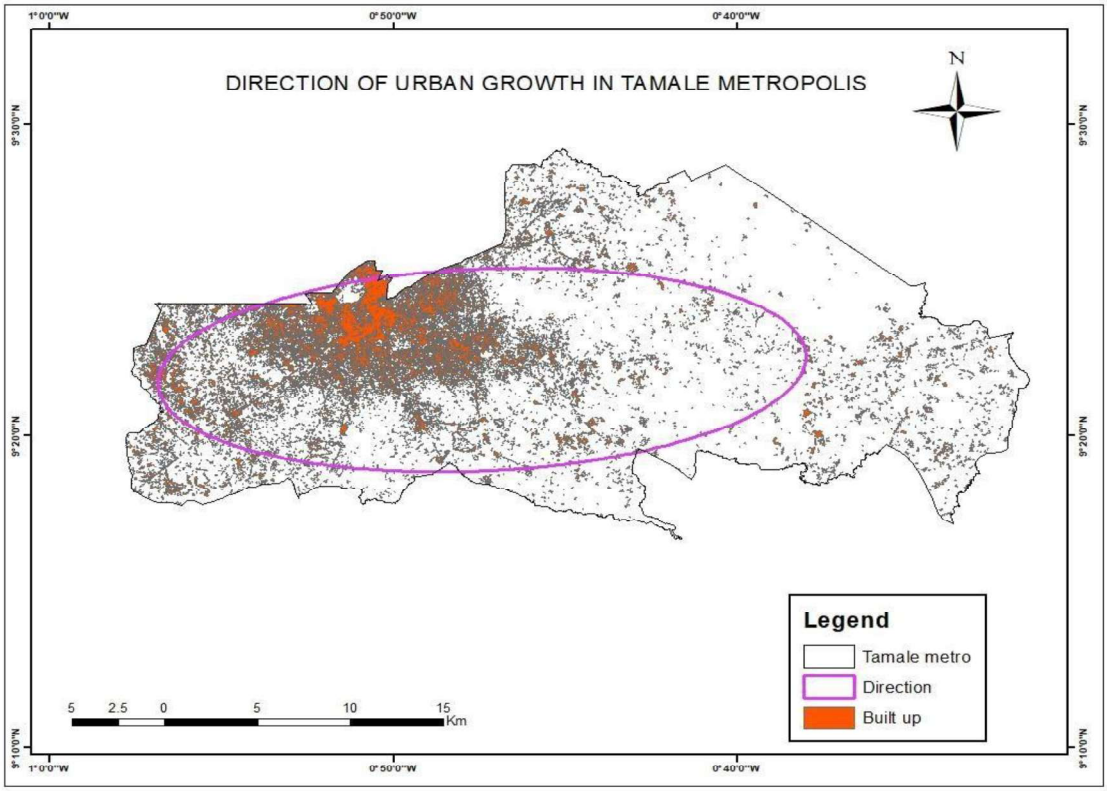

Figure 10: Direction of urban expansion in Tamale Metropolis

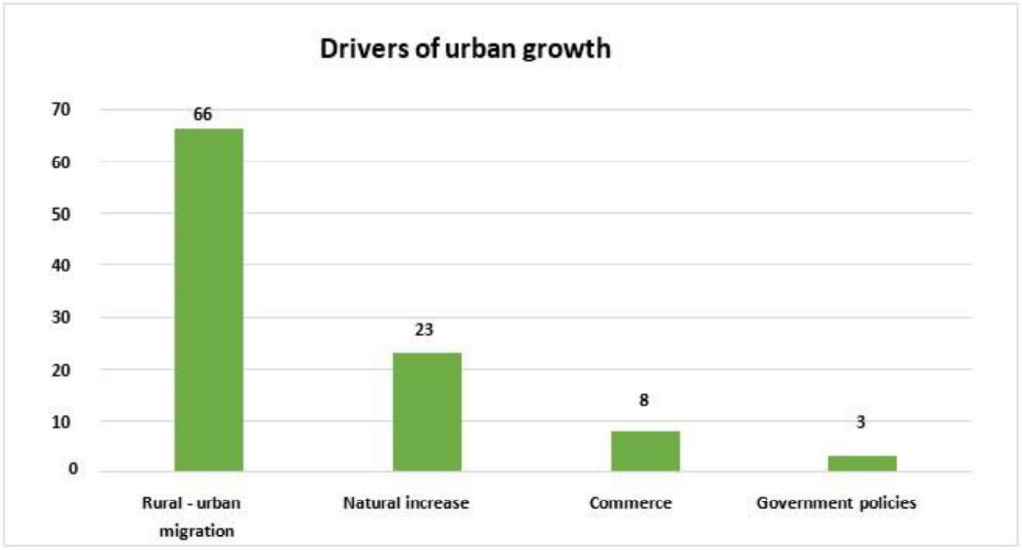

Figure 11: Drivers of urban expansion in Tamale Metropolis

A respondent said that:

"*Tamale is now home to strangers. Majority of us are not indigenes of this town and as we move in, we try finding land to build which in turn expands the city.*"

On natural increase, a female respondent had this to say:

"*I think that the growth of Tamale is because we are giving birth to many people, so houses that could accommodate a family will not be able to if they give births. So, some of the members will have to relocate and build and that I think is the cause of the growth of Tamale.*"

It is widely accepted that urban expansions are driven by population growth as people will need to put up more structures to compensate for such increases. Additionally, factors like natural increase and rural-urban migration affect population growth. For instance, the United Nations Department of Economic and Social Affairs (2017), argues that positive net migration has been responsible for population growth in developed regions of the world. Ashraf et al. (2013) strongly argue that fertility is a major influencing factor of population growth. This indicates that the factors that affect the population of an area invariable affect expansion of such areas. The drivers of urban expansion identified by this study are similar to those established by Kosoe et al. (2018) in a similar study within the same study area that rapid population growth, characterized by increased rural-urban migration and natural increase between 2000 and 2018 contributed to demand for land for residential and related activities leading to an increase in the built-up area.

Impact of urban expansion on land use/land cover change

Due to the diverse uses of land in the Tamale Metropolis, there have been some changes in the land's cover. According to the data, the major land cover in Tamale is open savannah, which consists of grassland, farms, and scattered trees (Figure 12). This land cover is the first cover that is usually converted to other land uses because it is easier to clear and convert. About 68% of the Metropolis' total land area was covered by this land cover in 2004. In 2014, it rose to 76.31%, and in 2022, it marginally rose to 78.79%. Only when the closed savanna vegetation is transformed by elements like wildfires and the collection of fuel wood, among other things, can this land cover increase (Akongbangre, 2016). The closed savannah land cover, on the other hand, decreased from 17.12% in 2004 to 4.36% in 2014 before slightly increasing to 22% in 2022. Bare land showed another intriguing variation in land use or cover as 8.28% of the total land area was made up by bare ground in 2004, but that percentage rose to 10.34% in 2014 and then dropped drastically to 2.39% in 2022. This was so because the 2022 image was downloaded in the wet season, and so much of the land appeared green and there were a lot of wet surfaces, but the other two images were downloaded in the dry season.

The steady decrease of the "blue" color, which indicates water, is evident when looking at the land cover composite map. In 2004, there were more water bodies in the Metropolis, which made up 0.63% of the total land area. It severely dropped to 0.19% in 2014 before marginally rising to 0.48% in 2022. This is because the 2022 image was downloaded in the wet season. Finally, unlike other land use patterns that fluctuated, the Metropolis' built-up area grew during the time period. In 2004, the built-up area covered about 3745.71 ha, representing 5.78%. It increased to 5697.45 ha, representing 8.80%, and further increased to 8447.67 ha, representing 13.04% of the total land cover. The expansion of built-up areas is a sign that the urban region is encroaching on other types of land cover. This explains why closed savannah experienced negative growth of -8262.72 ha between 2004 and 2014. The change in the closed savannah has led to the positive change of 5257.35 ha in open savannah from 2004 to 2014 and about 1609.11 ha from 2014 to 2022. This, by extension, also influenced bare land, which increased by 1336.5 ha from 2004 to 2014 (see Figure 13 and Table 1).

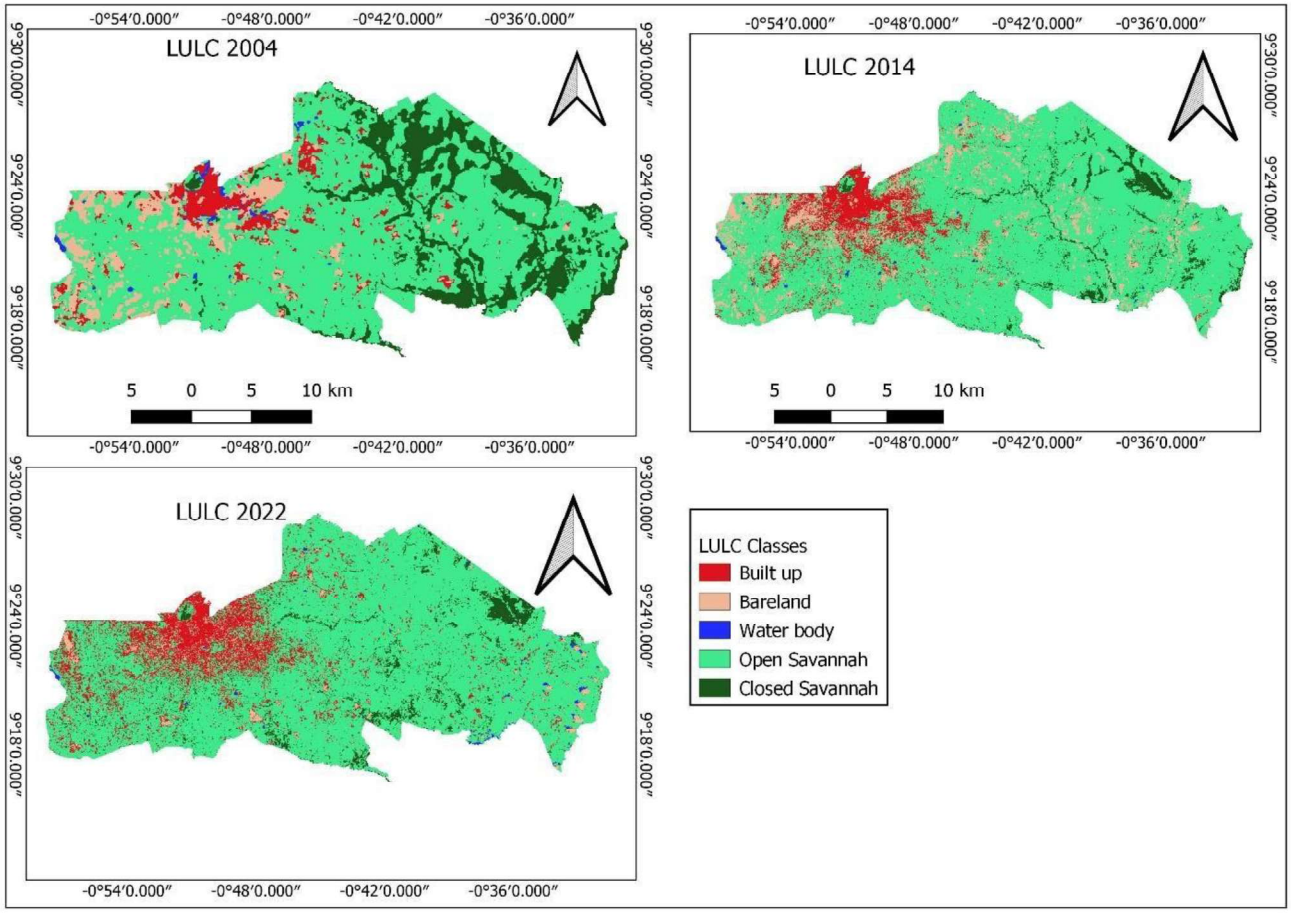

Figure 12: Land use/land cover maps of Tamale Metropolis for 2004, 2014 and 2022

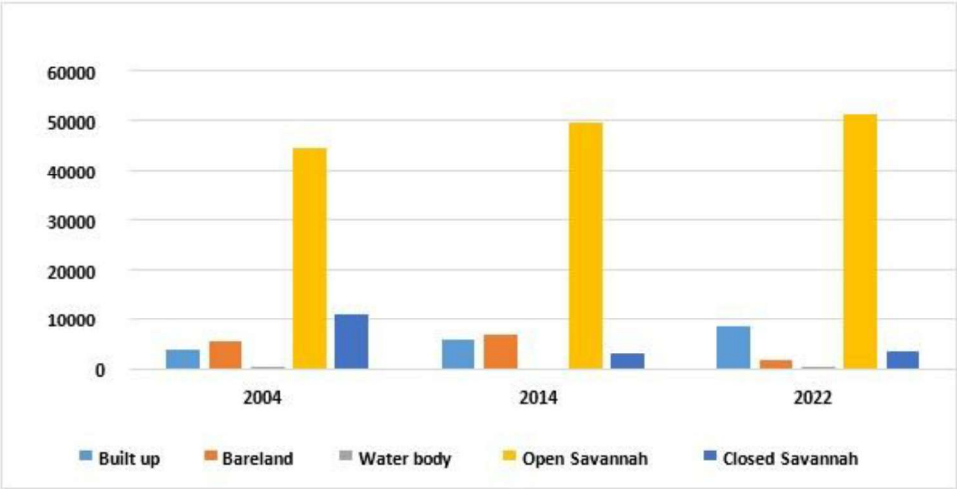

Figure 13: Land cover sizes for the years 2004, 2014 and 2022

Table 1: Land use/land cover change in Tamale Metropolis from 2004 to 2022

	2004 to 2014			2014 to 2022		
Land cover	Ha	Ha	Difference	Ha	Ha	Difference
Built-up	3745.71	5697.45	1951.74	5697.45	8447.67	2750.22
Bare land	5362.92	6699.22	1336.3	6699.22	1545.12	-5154.1
Water body	405.27	122.4	-282.87	122.4	311.94	189.54
Open Savannah	44166.78	49424.13	5257.35	49424.13	51033.24	1609.11
Closed Savannah	11087.82	2825.1	-8262.72	2825.1	3430.53	605.43

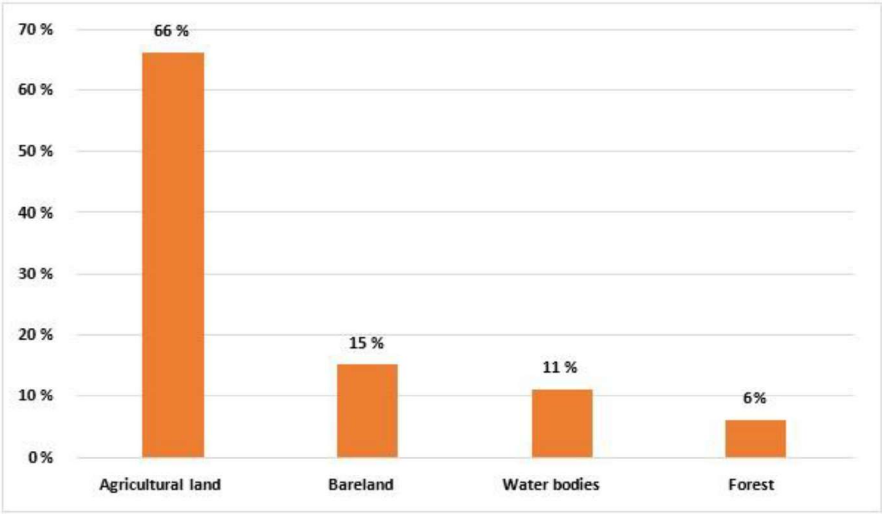

Figure 14: Responses on the effects of urban growth on land cover

The responses concerning the major land cover affected by urban expansion in the study area indicates that 66% of respondents said agricultural land use is the main land cover that has been affected by urban growth in the Metropolis. Additionally, 15% of the respondents named bare land as the dominant land cover affected by urban expansion, 11% named water bodies as the dominant land cover affected by urban growth, and 8% named forests as the dominant land cover affected by urban growth in the Metropolis (Figure 14). This insinuates that the dominant land cover affected by urban growth in the Metropolis is agricultural land use, which is part of the open savannah land cover (Osumanu & Ayamdoo, 2022). This land cover is the dominant land cover in the Metropolis and appears to have increased from 2004 to 2022. The positive change in this land cover is also because previous agriculture lands are converted to build-up, which increases the demand for agriculture land. A respondent had this to say:

"…where we are now were farm lands of people meaning we have taken over peoples' farmlands. But it does not mean that farmlands have reduced. Since there are still bushes ahead, they move there to clear the bush and farm. It is just that most of them are not able to go far."

This suggests that farm lands, for that matter open savannah lands cover, are not reducing rather they are expanding at the expense of the closed savannah land cover.

Domestic solid waste generation and management

The form of waste generated in urban and peri-urban areas of Tamale Metropolis were almost similar (Table 2). Out of the total respondents in the urban area, 96% of waste generated was solid and the remaining 4% was liquid waste. In the peri-urban areas, 88% of the waste generated was solid and the remaining 12% was liquid. This indicates that, the Metropolis needs to have more solid waste handling facilities. Polythene material emerged as the most common solid waste generated in urban (Aboabo and Sakasaka) and peri-urban (Manguli and Zoozugu) areas. This means that there is little difference in the type of waste produced in urban and peri-urban settings. This is due to the peri-urban areas gradually acquiring urban characteristics, resulting in the rise in the consumption of packaged goods there. A key informant at Zoomlion Ghana Limited, Tamale, said that:

"The major form of waste generated within the TMA is solid waste. That is why it is common to see a lot of polythene and rubbish around. Our headache, when it comes to waste management in the Metropolis, is solid waste."

Table 2: Types of waste generated in Tamale Metropolis

Community	Solid	Liquid (%)
Sakasaka	25	0
Aboabo	23	2
Manguli	21	4
Zoozugu	23	2
Total	92	8

Waste storage is a very important element of waste management. Consequently, the various ways by which households stored their wastes was inquired and the findings showed that 5% of respondents in peri-urban areas stored their wastes in closed containers, 15% did so in open containers and the remaining did not store any waste at all. Most households in the peri-urban areas burn their wastes in their backyards or in front of their houses, indicating that a good number of them did not store their wastes. This supports Issahaku et al.'s (2014) finding that some households within Tamale Metropolis lacked dedicated waste storage systems. Therefore, after being collected in the home, waste was just dumped at a disposal site, which causes littering in certain homes. In addition to mice that scavenge through the garbage piles that are typically left by the roadside in search of food, uncovered pile of wastes frequently attracts animals like dogs, goats, and sheep (Oteng-Ababio, 2011; Boateng et al., 2016). In both urban and peri-urban environments, this leads to the breeding of mosquitoes that spread diseases like malaria (Oteng-Ababio, 2011; Boateng et al., 2016). These effects would be severe in the urban areas because that is where there is much generation of wastes. A respondent at Manguli said that:

"... I do not allow my wives to leave rubbish in the house, and if I see any rubber, I personally burn it and the first thing my wives do in the morning is to sweep and burn the rubbish and it is done daily. I personally do not like dirt and that is what I have used to train my wives."

In the urban areas, 42% of the respondents stored their wastes in waste bins but 17% of them used other closed containers, 27% used open containers (see Plate 1) and 8% used polythene bags for waste storage. It was observed that the high-wealth households and middle-wealth households in both the peri-urban and urban areas were those using waste bins provided by Zoomlion Ghana Limited while the low-wealth households used containers that were not covered because they are not able to afford the price of Zoomlion Ghana Limited's waste bins. This finding is in harmony with Issahaku et al.'s (2014) finding that most residents in low class residential areas cannot afford waste bins and must instead use old buckets and pans, many of which are left uncovered and expose residents to communicable diseases. The high- and middle-class residential areas can afford customized waste bins. Osumanu (2007) in a similar study also states clearly that compared to medium- and low-wealth households, those with high incomes kept their waste in closed containers. This was confirmed by a key informant at Zoomlion who indicated that:

"Apart from the partnership with government, Zoomlion provides waste bins to households at a fee. These waste bins are emptied through truck visits and also at a cost. Some households feel it is costly and prefer to use their own means of waste storage."

Plate 1: An opened waste storage container in one of the urban areas

Waste bins are generally used to store and, by extension, sort waste. Sorting of waste is very important when it comes to waste management (Kosoe et al., 2022). The majority (41%) of respondents in urban areas claimed that they did not sort their waste, while only 9% said they did so at the household level. Conversely, 42% of the respondents in the peri-urban areas said they do waste sorting while 8% of them said they did not do waste sorting. One reason that may account for this difference in waste sorting is the respondents' understanding of waste sorting. It was observed that the peri-urban areas had limited waste sorting due to the non-separation of solid wastes from liquid wastes. Here, because the home surroundings are not concrete surfaces, they easily pour away liquid waste which sips into the ground. With solid wastes, households gather and burn them. In the urban areas, households understood waste sorting as the separation of liquid waste, plastic waste, soils and food wastes. A key informant was of the view that:

"It will be difficult to practice waste sorting because to do waste sorting, you need not less than four waste bins at the household level and also you need not less than four communal containers at each vantage point. So, it will be very costly to practice waste sorting."

About 40% of the respondents in the urban areas disposed their wastes in communal containers to be further transported to the landfill in the Metropolis at Gbalahi, a suburb of Tamale and 12% disposed their wastes through truck visits by Zoomlion Ghana Limited. In addition, 14% of the respondents disposed their wastes in open drains and the remaining 34% disposed theirs on illegal dumpsites. The reason for the disposal of wastes in drains and unapproved dumpsites could be associated with inadequate skip containers. This is in tandem with Boateng et al.'s (2016) finding that the primary method of solid waste collection in urban areas is communal container collection. It is against this that Sumaila (2019) suggests that land use planners must make provisions in building plans for the placement of community containers and ensure adherence to these arrangements. Both Zoomlion Ghana Limited and the Metropolitan Assembly are responsible for providing these communal containers. The lack of collection of these communal containers leaves the urban area piled high with uncollected solid waste, especially in urban areas where a significant amount of waste is produced every day.

In an earlier study, Puopiel and Owusu-Ansah (2014) indicated that the acceptable skip to population ratio of 1:700 (as shown by ZoomLion) was not met in the low-class residential zones, where the skip ratio to the population was 1:9,378. This indicates that the average population a skip served exceeded the standard maximum population a skip was intended to have served by 13 times. According to Zoomlion, the number of skips provided for the Metropolis is 50 which is far less for the Metropolis considering its population. This could result in people disposing wastes in illegal dump sites, drains and forests. For example, in Aboabo, one of the urban communities, waste is disposed in an unproved dumpsite near the Aboabo forest (see Plate 2). The location contains a portion of the Metropolis' market, which suggests that a lot of rubbish will be produced there even though there are no many skips available. The results of Sumaila (2019) confirmed that the Metropolis lacks sufficient disposal containers to handle its waste. The respondents who used the dumpsites indicated that the sites were not maintained very well and for that matter the sanitation around was not good and could be dangerous for their health, indicating that they are aware of the health risks posed by this method of waste disposal.

Plate 2: An unapproved waste dumping site at Aboabo

Another factor to which the disposal of waste in drains and unapproved dumpsite in the urban areas can be associated with, is the irregularity of emptying of skip containers when they are full. In this regard, 75% of the respondents complained that the containers were not emptied regularly. This is in consonance with Amoah and Kosoe's (2014) findings that the timely collection of communal waste containers whenever they are full, has been a major problem for waste collection and transportation, and this has potential public health ramifications. A respondent in Sakasaka intimated that:

"Sometimes, we have to carry our wastes to nearby communities like Gumbihini and Warizihi to dispose them. Other times too, we are left stranded when the skips in those areas are full. So, we end up disposing our wastes in a drain or places we are not supposed to dispose waste."

A key informant at TaMA also reiterated this by stating that:

"One of the impacts of urban growth in the Metropolis is the increase in the quantum of waste generated. This puts pressure on the existing communal containers since new ones are not added to the stock."

The absence of skips in the peri-urban areas forces households to dispose their wastes by either burning, burying or dumping in the bush (Figure 15). About 76% of the respondents in these areas affirmed that they disposed their waste by burning them at small dumpsites in front of their houses. Another 14% of the respondents disposed their wastes by burying and the remaining 10% disposed their wastes by throwing them in the bush. This finding supports Boateng et al.'s (2016) observation that the majority of investments made in solid waste management go to urban populations at the expense of peri-urban and rural communities, despite the fact that the country's overall solid waste management status is poor.

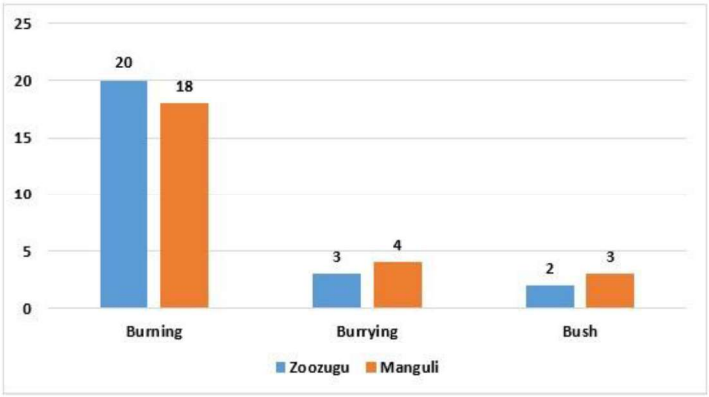

Figure 15: Methods of waste disposal in peri-urban areas

Respondents in the urban areas were clear in the views of the impact of urban expansion on household solid waste management that with an increase in population, there is a corresponding increase in the quantum of waste generated and so the need for more skips to compensate for that. At the peri-urban areas, respondents indicated that their population was increasing and they are also assuming urban characteristics so their quantum of waste generated had increased and, thus, they needed community containers since they did not have any. A respondent in one of the peri-urban communities said that:

"…our member of parliament built us a toilet facility without commissioning it so it is left to rot. We were hoping that when it is commissioned, we will get a communal container there. When you say you will not leave polythene around and burn it, the next day you will find the polythenes flying around your surroundings. But if we have a communal container, we can all send our rubbish there for onwards disposal at the landfill."

The overlay of household waste disposal methods on the land use land cover map for the year 2022 (Figure 16) suggests that households in the peri-urban areas are able to gather rubbish in front of their houses or the backyards because there is a lot of green spaces representing open savannah, which provides them with more space to gather, burn, bury or dispose wastes in the bush.

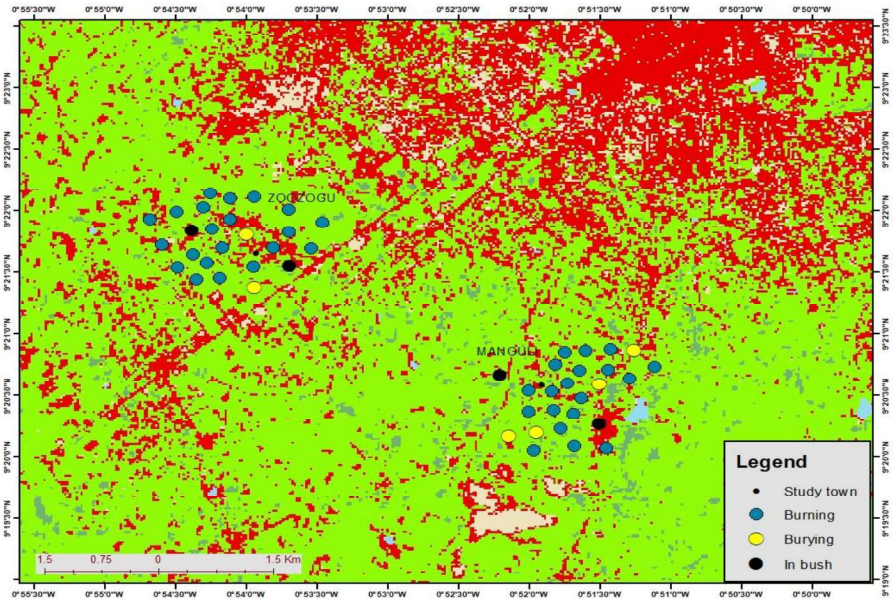

Figure 16: Overlay of methods of solid waste disposal in the per-urban areas on lu/lc 2022

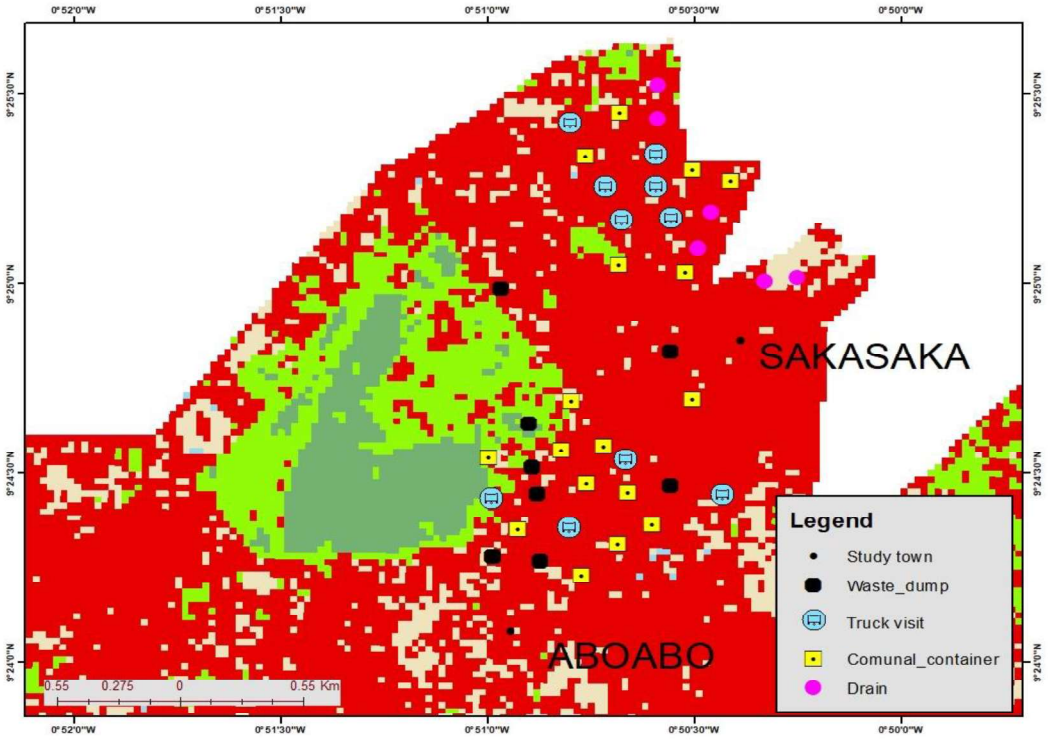

Figure 17: Overlay of methods of solid waste disposal in the urban areas on lu/lc 2022

Conclusion

This study has shown that GIS is a crucial tool for research in the spatial aspects of urbanization. It enables the use of satellite multi-date images to illustrate the many problems of urban development. With the aid of GIS and RS technologies including overlays, image analysis, and geo-statistics, this study was able to map out urban areas and produce maps of the land cover and related that with household solid waste management practices in the study area. Tamale Metropolis's demographic growth has resulted in the geographic expansion of its urban areas. The Metropolis urbanized area increased from 3,605.274 hectares in 2004 to 9,342.84 hectares in 2022. Linear growth and peri-urbanization were two manifestations of this expansion. The city's major routes are where you can see the city's rapid expansion since they provide business opportunities and easy access to electricity and water. Towns such as Manguli, Yong, Taha, Tua, and Zoozugu which were rural in 2004 have now been fast approached by the urban core thereby giving it a mixture of urban and rural characteristics. The infrastructure deficit to compensate the growing population and expansion of the Metropolis and the accompanying increase in household solid waste generation has created solid waste management problems in the area. While the urban areas are challenged with inadequate communal containers for waste collection, the peri-urban communities have to resort to burning, burying or disposal in bushes of solid waste due to the non-availability of proper waste collection mechanisms. With the continuous expansion of the Tamale Metropolis, it will definitely encounter some problems among which household solid waste management is a major one. There is therefore, the need to put mechanisms in place to control sprawling in the Metropolis in order to curtail rapid expansion. There is the need for the Tamale Metropolitan Assembly to collaborate with Zoomlion Ghana Limited to increase the number of communal containers in the Metropolis to help reduce the pressure on existing communal containers and to give the peri-urban areas the chance to dispose their waste properly.

Conflicts of Interests

The authors declare that they have no conflicts of interest.

Reference

Abdulai, I. A., & Osumanu, I. K. (2023). How urbanisation shapes availability of provisioning ecosystem services in peri-urban Ghana. *International Journal of Urban Sustainable Development*. 15:1, 282-298, DOI: 10.1080/19463138.2023.2267518

African Development Bank. (2016). *African Economic Outlook 2016: Sustainable Cities and Structural Transformation*. African Development Bank. Retrieved from https://www.afdb.org/en/documents/document/african-economic-outlook-2016-89452

Agbola, T. (2004). *"Readings in Urban and Regional Planning"* Published by Macmillan Nigeria Limited, Ibadan, Oyo State, Nigeria. Pp. 179

Akongbangre, J. N. (2016). *Urban Transition of Wa Town from 1986 To 2016: A Gis Perspective.* Unpublished master's thesis, UDS, Wa. www.udsspace.uds.edu.gh

Kosoe, E. A., Cobbinah, P. B., & Akongbangre, J. N. (2021). Spatial expression of climate change in rapidly urbanising city of Tamale, Ghana. In *Sustainable urban futures in Africa* (pp. 228-246). Routledge.

Anane, G. K., (2022). *Continuity in transition: spatial transformation in peri-urbanisation in Kumasi*. https://doi.org/10.21203/rs.3.rs-1677351/v1

Basommi, P. L., Guaan, Q. and Cheng D. (2015). Exploring Land use and Land cover change in the mining areas of Wa East District, Ghana using Satellite Imagery. *Open Geosci. 1*:618–626.

Bhatta, B., (2010). Analysis of urban growth pattern using remote sensing and GIS: a case study of Kolkata, India. *Int. J. Remote Sens. 30* (18:20), 4733–4746.

Cobbinah, P. B., Erdiaw-Kwasie, M. O. and Basson, M. (2022). *Deconstructing Africa's Urban Space: Sustainable Development and Spatial Planning Challenge.* DOI: 10.4324/9781003181484-1**.** Department of Economic and Social Affairs, Population Division.

Farvacque-Vitkovic, C., Eghoff, C., Raghunath, M. and Boakye, C. (2008). *Development of the Cities of Ghana: Challenges, priorities and tools.*

Fuseini, I. (2014). *Land use competition: Its implication for food security in peri-urban Tamale, Ghana.* Saarbrücken: Lambert Academic Publishing.

Fuseini, I. (2016). *Urban governance and spatial planning for sustainable urban development in Tamale, Ghana.* Unpublished dissertation, Stellenbosch University.

FOA, (2022). *Environmental And Social Impact Assessment (Esia) For Tamale Metropolitan Area Sub-Projects*. Savannah Agriculture Value Chain Development Project (SADP).

Ghana Statistical Service (GSS), (2010). *Population and Housing Census – Tamale Metropolitan Assembly.*

Ghana Statistical Service (GSS), (2021). *Population and Housing Census - Analysis of District and Regional Data of Tamale Metropolitan Assembly*.

Guneralp, B., Lwasa, S., Masundire, H., Parnell, S. and Seto, C. K. (2018). Urbanization in Africa: challenges and opportunities for conservation. *Environment Research Letters*. https://doi.org/10.1088/17489326/aa94fe.

Gyasi, E.A., Fosu, M., Kranjac-Berisavljevic, G., Mensah, A.M., Obeng, F., Yiran, G.A.B and Fuseini, I. (2014a). *Building urban resilience: Assessing urban and peri-urban agriculture in Tamale, Ghana.* United Nations Environment Programme (UNEP), Nairobi, Kenya.

Hu,R. (2013). Drivers Of China's Urbanisation and Property Development. *Australasian Journal of Regional Studies,19*, (2) 156-180.

Jamir, C., (2021). Urbanization and Solid Waste Generation in Urban Longleng District of Nagaland: Present Practices and Future Challenges. *International Journal of Business, Technology, and Organizational Behavior*. 1(5) 348-362.

Jenkins, P. (2013). *Urbanization, Urbanism, and Urbanity in an African City: Home Spaces and House Cultures*. Palgrave Macmillan.

Kosoe, E. A., Osumanu, I. K., & Diawuo, F. (2022). *Connecting solid waste management to sustainable urban development in Africa.* In P. B. Cobbinah & M. Addaney (eds.) Sustainable urban futures in Africa (pp. 285-306). London and New York: Routledge. DOI: 10.4324/9781003181484-14

Maleeks, Y. A., Aliyu, A. O., Bala, A., Isiaka, A. U. and Atta, K. Z. (2021). Spatio-Temporal Evaluation of Urban Growth of Zuru Metropolis, Nigeria. *Nigerian Journal of Environmental Sciences and Technology (NIJEST).* Vol 5, No. 2, pp 456 – 467. https://doi.org/10.36263/nijest.2021.02.0293

Marzuki, A. and Jais, A. S. (2020). Urbanisation and The Concerns for Food Security In Malaysia. *Journal of the Malaysian Institute of Planners,* vol.18 Issue 3. Pp. 202 – 217.

Naab, F.Z., Dinye, R.D. and Kasanga, K.R. (2013). *Urbanisation and its impact on agricultural lands in growing cities in developing countries: A case study of Tamale in Ghana*. 2(2):256–287.

Osumanu, I. K. (2022). Urban environmental management and governance: towards a conceptual framework. In K. Peprah, I. K. Osumanu, R. Aabeyir, & J. B. B. Sumani (eds.). *Environment and resource management in Ghana* (pp. 9-28). Accra: Woeli Publishing Services.

Osumanu, I. K., & Akomgbangre, J. N. (2020). A growing city: patterns and ramifications of urban change in Wa, Ghana. *Spatial Information Research,* 28, 523–536. DOI 10.1007/s41324-020-00313-1.

Osumanu, I. K., Akongbangre, J. N., N-Yelkabo, G. T., & Owusu-Sekyere, E. (2019). From patches of villages to a municipality: time, space, and expansion of Wa, Ghana. *Urban Forum*, 30, 57–74.

Osumanu, I. K., & Ayamdoo, E. A. (2022). Has the growth of cities in Ghana anything to do with reduction in farm size and food production in peri-urban areas? A study of Bolgatanga Municipality. *Land Use Policy*, 112, 105843. DOI: 10.1016/j.landusepol.2021.105843.

Rimal, B., Sloan, S., Keshtkar, H., Sharma, R., Rijal, S., and Shrestha, U. B. (2020). Patterns of Historical and Future Urban Expansion in Nepal. *Remote Sensing* 12, 628; doi:10.3390/rs12040628.

Sahana, M., Hong, H. and Sajjad, H. (2018) Analyzing urban spatial patterns and trend of urban growth using urban sprawl matrix: A study on Kolkata urban agglomeration, India. *Science of the Total Environment.* https://doi.org/10.1016/j.scitotenv.2018.02.170.

Seto, C. K., Güneralpa, B. and Hutyrac, R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Sustainability: vol. 109, no. 40*.

Staniland, M. (1975). *The lions of Dagbon: Political change in northern Ghana. Cambridge*: Cambridge University Press.

Sulemana, N. and Yiran, G.A. B. (2018). *Urbanization and Smallholder Livelihood Security in Africa: A Case Study of Coping Strategies of Peri-urban Dwellers in Tamale.* Rural and urban linkages.

Tew, Y. L., Tan, M. L., Samat, N. and Yang, X. (2019). Urban Expansion Analysis using Landsat Images in Penang, Malaysia (Analisis Pengembangan Bandar menggunakan Imej Landsat di Pulau Pinang, Malaysia). *Sains Malaysiana* 48(11): 2307–2315. http://dx.doi.org/10.17576/jsm-2019-4811-02.

Toku, A. (2018*). Urban Expansion and Its Effect On Peri Urban Agriculture In The Wa Municipality Of Ghana.* Unpublished Thesis, UDS, Wa. www.udsspace.com.

Un Habbitat (2018). *Solid Waste Management In Cities*. United Nations Human Settlements Program, Kenya.

UNDESA. (2014). *World urbanisation prospects: The 2014 revision, highlights (ST/ ESA/SER.A/352).* UN

United Nation (2018). *World Urbanization Prospects: The 2018 Revision*. United Nations Department of Economic and Social Affairs/Population Division.

United Nations, Department of Economic and Social Affairs, Population Division (2019). *World*

United Nations, Department of Economic and Social Affairs, Population Division (2019). *World Population Prospects 2019.*

Yahaya, A. (2022). Population Growth in the Tamale Metropolis: A Blessing Or a Curse to Housing. *Ghana Journal of Development Studies*, Vol. 19 (2)

Yankson, P. W.K. and Bertrand, M. (2012). *The Mobile City of Accra Urban Families, Housing and Residential Practices.* Council for the Development of Social Science Research in Africa DAKAR. Imprimerie Graphi plus, Dakar, Senegal.