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Identification of flood-vulnerable communities and the factors contributing to flooding occurrences within the Tamale Metropolis of the Northern Region, Ghana

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Abstract
This study identified flood-vulnerable communities and the factors contributing to flooding occurrences within the Tamale Metropolis in the Northern Region, Ghana. A descriptive study design was used for this study. Secondary data was obtained from government institutions' who are responsible for flood prevention and management of flooding. These institutions included Town and Country Planning, Tamale, Ghana Meteorological Agency, Tamale and National Disaster Management Organisation (NADMO). Historical rainfall and flood data for the Tamale Metropolis spanning the past two decades (2000-2020) was used for this analysis. Also, time-series analysis was used to identify the pattern of rainfall and flooding in the Tamale Metropolis. Furthermore, once the patterns were identified, mapping flood-prone areas was conducted using geographic information system (GIS) software to map flood-prone areas within the Tamale Metropolis to create a comprehensive flood-prone map. The study revealed fluctuations in mean annual rainfall over the years, with the highest recorded mean annual rainfall in 2018 (298 mm) and the lowest in 2013 (152 mm). It also identified two main soil types in the Tamale Metropolis: Ferric Luvisols covering 162.65 km2 and Plinthic Luvisols covering 406 km2. The highest elevation in the area is 184.45 km2, while the lowest elevation is 42.94 km2. The study concluded Sakasaka, Taha, Kanvilla, Norrip village, Ghogu, Nyohni, Kunyilla, Zujung, Kaakpayili, Sishiagu, Jekeriyili, Lamashegu, and Kalpohim estate were more prone to flooding due to their low elevation. The study recommends that the metropolitan assembly should invest in infrastructure projects that reduce flood vulnerability, such as the construction of bridges, roads, and other transportation networks that can withstand flooding during the raining season.

Keywords: Flooding, Flood-Vulnerable Communities, Factors, Flooding Occurrence and Tamale Metropolis.

1.0 Introduction

Floods are a natural disaster that have occurred throughout history and continue to pose significant challenges to humanity. A flood is defined as an overflow of water onto normally dry land, usually caused by heavy rainfall, melting snow, or dam failure (Hrushikesh, Gururaj & Pathak, 2023). This phenomenon has devastating consequences, such as loss of life, destruction of infrastructure, displacement of populations, and long-term economic and environmental impacts (Glago, 2021; Onwuka, Ikekpeazu, & Onuoha, 2015). Floods occur in various forms, such as river floods, flash floods, coastal floods, and urban floods (Sowmya, John & Shrivasthava, 2015). River floods are the most common type and typically result from prolonged periods of heavy rainfall or snowmelt that cause rivers to exceed their capacity (Pomeroy, Stewart & Whitfield, 2016). Flash floods, on the other hand, occur suddenly and with little warning, often in mountainous regions or areas with poor drainage systems (Kieu & Van Tran, 2021). Coastal floods are caused by storm surges or tsunamis, while urban floods are a result of inadequate drainage systems in cities (Natarajan & Radhakrishnan, 2020). The global impact of floods is substantial, accounting for about 43% of all recorded natural disasters worldwide between 1998 and 2017 (Tembata et al., 2020). During the same period, floods affected over 2.3 billion people and caused more than 157,000 deaths globally (Ganguly & Cahill, 2020). The economic losses associated with flooding during the same period exceeded $662 billion (Kurt, 2023). However, the frequency and intensity of floods are expected to increase due to climate change. The adverse effects of climate change have led to rising global temperatures and more frequent and intense rainfall events, overwhelming existing infrastructure and natural drainage systems (Hassan, Yassine & Amin, 2022; Pradhan-Salike & Pokharel, 2017). In Africa, floods are a common occurrence due to the continent's diverse geographical features and climatic conditions (Alfieri et al., 2017). Heavy rainfall is the primary cause of flooding, leading to substantial flood risk, especially in regions lacking adequate water management infrastructure (Miller & Hutchins, 2017). Rapid urbanization further exacerbates the problem, as limited drainage capacity in urban areas results in water accumulation and subsequent flooding during periods of heavy rainfall. Deforestation also plays a role in increasing flood vulnerability in African countries by disrupting the natural balance of ecosystems and reducing the vegetation's ability to absorb excess water. This amplifies surface runoff and raises the likelihood of flooding (Gunnell et al., 2019). Consequently, floods in Africa have resulted in loss of life, displacement and homelessness, infrastructure damage, agricultural losses, and the spread of waterborne diseases (Mugambiwa & Makhubele, 2021). The general effects of floods in Africa have a direct implication on the flood situation in Ghana. Between 1991 and 2018, floods accounted for approximately 38% of all reported disasters in Ghana, with the Upper East, Upper West, Northern, and Volta regions being particularly prone to flooding (Ntim-Amo et al., 2022). In 2015, heavy rains caused severe flooding in Accra, resulting in over 150 deaths and the displacement of thousands of people. Moreover, floods have affected over 1.7 million people across the country annually, with an estimated cost of around $200 million in terms of infrastructure damage, loss of productivity, and emergency response efforts (myjoyonline.com, 2023).

Tamale, characterized by a Sahelian climate, experiences an extended period of low rainfall and a shorter duration of increased rainfall between May and September (Chagomoka et al., 2018). This makes Tamale more vulnerable to flooding during the rainy season. However, the phenomenon of flooding in Tamale is worsened by urbanization and population growth. The rapid growth of the city's metropolitan area has led to increased housing and infrastructure needs, resulting in the invasion of open spaces and natural watercourses (Mensah, Gough & Simon, 2018). The exponential population growth and unregulated urbanization have put significant pressure on the city's drainage infrastructure, exacerbating the problem of flooding. Insufficient stormwater management in various parts of the city leads to water pooling on roadways, residential areas, and agricultural land during intense rainfall (Kaur & Gupta, 2022). This not only inconveniences the local population but also causes property damage and agricultural losses. In the long term, floods have far-reaching consequences. They displace communities, hamper economic development and recovery by destroying infrastructure such as roads, bridges, and buildings, increase poverty levels, and lead to social unrest (Islam et al., 2016). Additionally, floods carry pollutants and contaminants, posing risks to public health and the environment (Crawford et al., 2022). In response to these persistent flooding issues, both local and national governments have implemented various flood adaptation strategies to mitigate the adverse effects on livelihoods. This study therefore seeks to identify flood-vulnerable communities and the factors contributing to flooding occurrences within the Tamale Metropolis in the Northern Region, Ghana.

2.0 Methodology

The study was conducted in the Tamale Metropolis. The Tamale Metropolitan was formalized through the enactment of a legislative instrument (L.I. 2068). Tamale serves as both the

Metropolitan Capital and the Regional capital of the Northern Region. The Tamale Metropolis is classified as one of the 16 Metropolitan, Municipal, and District Assemblies (MMDAs) within the Northern Region. The Metropolis is situated in the middle region of the Region. The Metropolis is situated within the geographical coordinates of latitude 9º16 and 9º34 North, and longitudes 0º36 and 0º57 West (GSS, 2022). The main objective of this study is to identify flood-vulnerable communities and the factors contributing to flooding occurrences within the Tamale Metropolis of the Northern Region, Ghana. A descriptive study design was used for data collection. Secondary data was obtained from government institutions' who are responsible for flood prevention and management of flooding. These institutions included Town and Country Planning, Tamale, Ghana Meteorological Agency, Tamale and National Disaster Management Organisation (NADMO). Historical rainfall and flood data for the Tamale Metropolis spanning the past two decades (2000-2020) was used for this analysis. Also, time-series analysis was used to identify the pattern of rainfall and flooding in the Tamale Metropolis. Furthermore, once the patterns were identified, mapping flood-prone areas was conducted using geographic information system (GIS) software to map flood-prone areas within the Tamale Metropolis to create a comprehensive flood-prone map.

3.0 Results and Discussion

3.1 Identify flood-vulnerable communities and the factors contributing to flooding occurrences within the Tamale Metropolis

This section identifies the various communities in the Tamale Metropolis that are highly prone to flood. The areas prone to flooding within the Tamale Metropolis are shown using maps and satellite images. The Tamale Metropolis, located in the northern region of Ghana, is a rapidly urbanizing area that has experienced perennial flood issues. Flooding in this area has a significant impact on social services, infrastructure, and the local population. Thus identification of flood-prone areas in Tamale Metropolis is very important to this study as it serves for the development of fold risk maps and early warning systems for the people of the Tamale Metropolis. Generally, in the Tamale Metropolis areas that are highly prone to flooding are Sakasaka, Taha, Kanvilla, Norrip village, Ghogu, Nyohni, Kunyilla, Zujung, Kaakpayili, Sishiagu, Jekeriyili, Lamashegu and Kalpohim estate (GSS, 2022). These areas are vulnerable to flooding due to their low-lying nature and the heavy downpours that occur in these areas. In accessing the flood-prone areas in the Tamale Metropolis, topography, geology and hydrological variables were considered. In this study, the topography, geology and hydrological variables are geology (soil type), topography (slope, elevation, and land use land cover) and hydrology (drainage density, flow accumulation, rainfall and total wetness index).

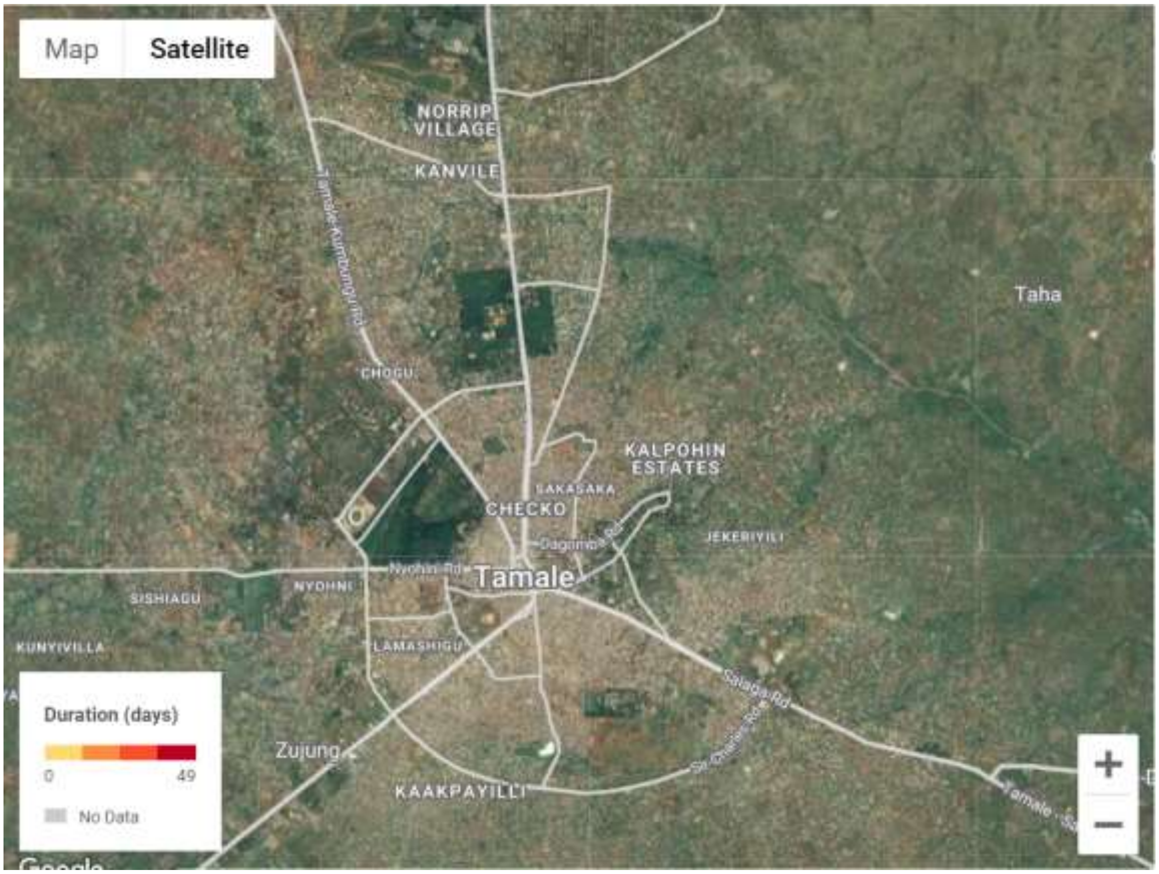

Figure 4.1: Satellite image of flood prone areas in Tamale Metropolis

Source: Authors own construct from www.earthmap.net, (2023)

3.2 Mean annual rainfall pattern of Tamale Metropolis

Analyzing the data on mean annual rainfall for the Tamale Metropolis, as presented in Figure 4.2, reveals discernible trends and patterns. Generally, an increase in rainfall in a given area is associated with a higher incidence of floods (Olanrewaju, Ekiotuasinghan & Akpan, 2017). Figure 4.3 displays the distribution of mean annual rainfall across different categories, namely, very low, low, medium, high, and very high. Notably, the low category constitutes the largest proportion, as depicted in Figure 4.3. Nevertheless, Figure 4.2 demonstrates that there have been fluctuations in mean annual rainfall over the years. The highest recorded mean annual rainfall occurred in 2018, with a value of 298 mm, while the lowest was observed in 2013, with a value of 152 mm. Overall, the mean annual rainfall in the Tamale Metropolis has exhibited a general upward trend over the past twenty-seven years. The variability in mean annual rainfall has significant implications for flooding in the Tamale Metropolis. Higher mean annual rainfall, as observed in 2018 leads to increased water accumulation and potential flooding, since the Tamale Metropolis drainage systems are not adequately equipped to handle such volumes of water. This increase in rainfall, along with rising temperatures, has led to higher water discharge and increased flooding in the flood-prone zones of the metropolis. However, lower mean annual rainfall, such as that seen in 2013 resulted in reduced flooding risk in the area.

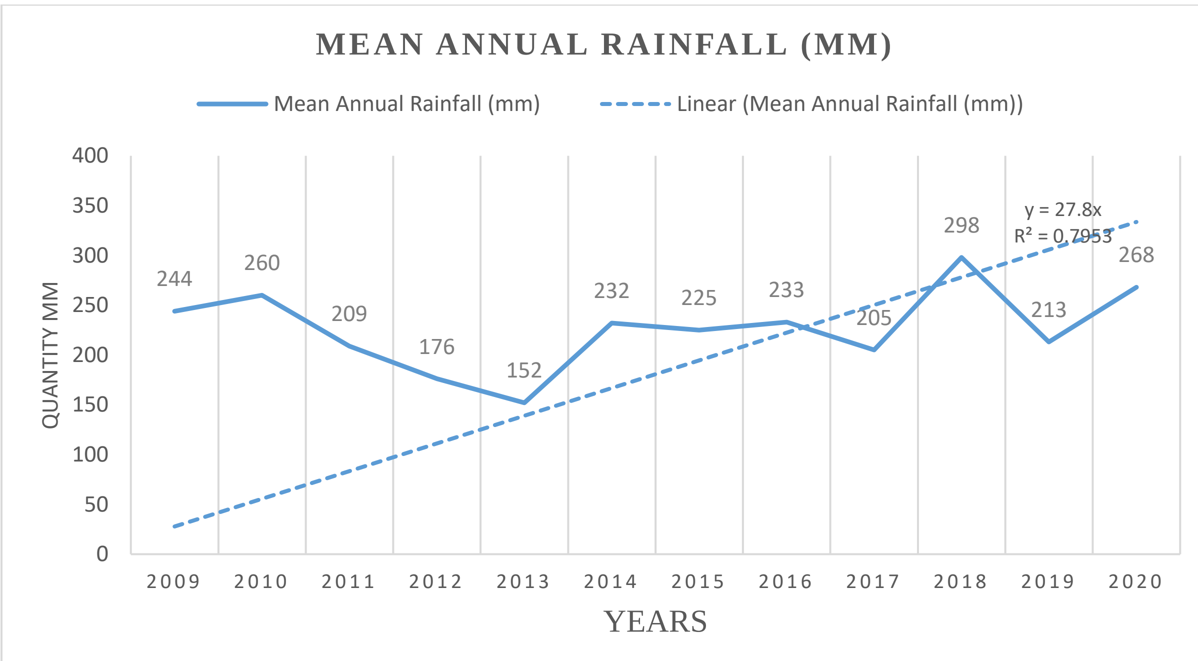

Figure 4.2: Mean annual rainfall

Source: www.climate-data.org (2023)

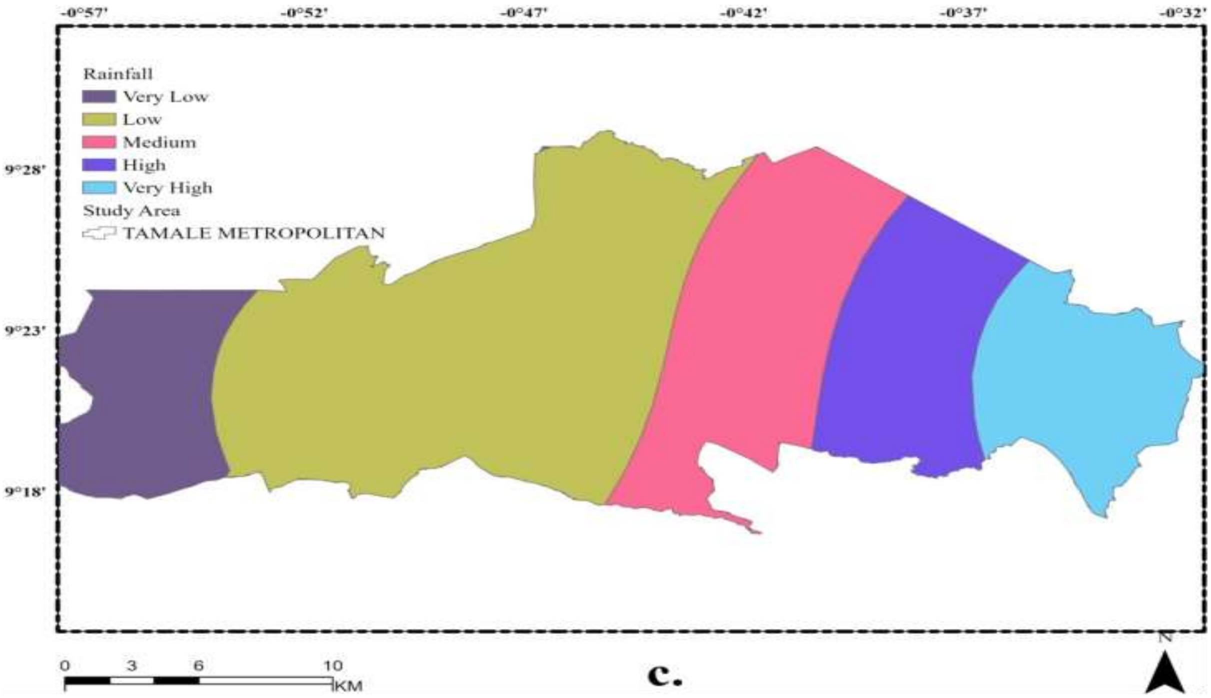

Figure 4.3: Mean annual rainfall

3.3 Soil type of Tamale Metropolis

The soil map of the Tamale Metropolis is presented in Figure 4.4 which indicates two main soil types in the metropolis. The Tamale Metropolis has two main soil types, Ferric Luvisols and Plinthic Luvisols, covering 162.65 km^2 and 406 km^2 of land area, respectively (see Figure 4.4 and Table 4.13). Ferric Luvisols has a high clay nature and low infiltration rate, making it prone to flooding (Ružičić et al., 2019). The main soil types in the Metropolis are sandstone, gravel, mudstone, and shale which have weathered into different soil grades. The presence of these soil types and their properties directly lead to flooding in the area. Ferric Luvisols is the main soil type responsible for flooding in the Tamale Metropolis. Its high clay content and low infiltration rate make it difficult for water to penetrate the soil, leading to surface runoff (Yang & Zhang, 2011). Whenever it rains in the area, rain water is not absorbed into the soil, and instead, it accumulates on the surface, causing the soil to become saturated. This excess water then flows downhill, leading to flooding in low-lying areas within the metropolis. The clay particles in Ferric Luvisols with a weight of 2.74, signifying a higher importance in influencing flooding, because it swell when wet, which further reduces the soil's permeability. This means that even after the rain has stopped, the soil remains saturated, and it takes longer for the water to drain away. Consequently, the risk of flooding remains high during and after rainfall.

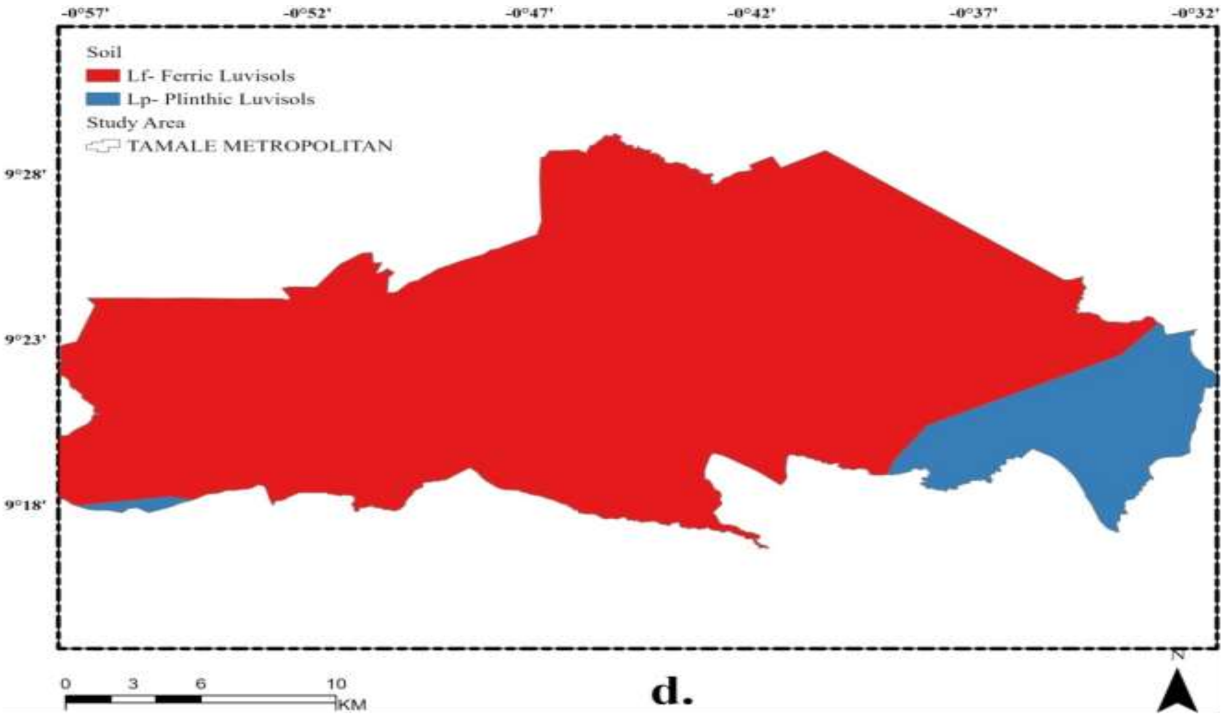

Figure 4.4: Soil types in the Tamale Metropolis

3.4 Elevation of Tamale Metropolis

The elevation of the area is one of the indicators leading to flooding in flood-prone areas (Zaharia et al., 2017). From Figure 4.7, the highest elevation in the area is 184.45 km^2 while the lowest elevation is 42.94 km^2 (see Table 4.13). The lowest elevation class was rated as a very high flood-prone area, whereas, the highest elevation class was rated as a low flood-prone area. From Figure 4.5, it is evident that lower elevation areas are dominant in the study area which makes it more prone to flooding. In the Tamale Metropolis, several areas are identified as prone to flooding due to their low elevation. These areas include Sakasaka, Taha, Kanvilla, Norrip village, Ghogu, Nyohni, Kunyilla, Zujung, Kaakpayili, Sishiagu, Jekeriyili, Lamashegu, and Kalpohim estate. This finding is consistent with the general understanding that lower elevations are more prone to flooding, as flood disasters often occur in areas with low topographic elevations or downstream areas (Mohanty et al., 2020; Klemas, 2015).

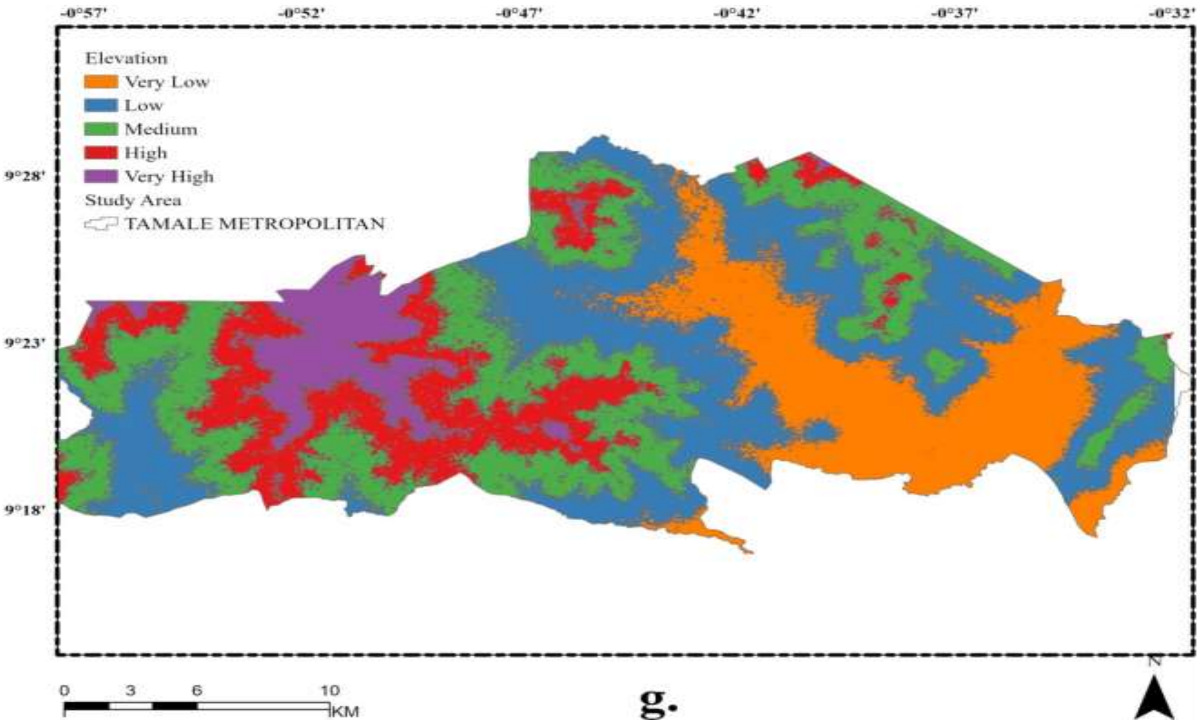

Figure 4.5: Elevation in the Tamale Metropolis

3.5 Slope of Tamale Metropolis

The inundation of an area depends on the length and steepness of its slope. Areas with low slope length and angle will experience inundation compared to areas with high slope length and angle. Areas with low slopes generally have a lower risk of rapid surface runoff, allowing for better water absorption and reducing the likelihood of flash floods. However, these areas may still be susceptible to flooding if there is prolonged rainfall or if the soil has limited drainage capacity. As the slope increases, there is a higher potential for surface runoff, resulting in faster movement of water over the land surface and contributing to increased flood risk (Wenger, 2015). Steeper slopes can enhance the speed of runoff, potentially leading to higher flood risk. Areas with slopes greater than 5% are generally more prone to rapid runoff and increased flood risk, making them susceptible to flash floods, especially during heavy rainfall (Abdelkareem, 2017). Figure 4.6 shows the slope map of the entire Tamale Metropolis which is classified into five classes 0-2, 2-3, 3-4, 4-5 to >5 (see Figure 4.6). It is worth noting that the part of the study area with the highest (5.97) and least (0-1.51) (see Table 4.13). This area is prone to flooding as compared to other areas within the study area. Despite the geographical advantage of Tamale Metropolis being fairly plain and low-lying, the metropolis has experienced consistent severe flooding over the past years, resulting in loss of lives and properties (Kasei, Kalanda-Joshua & Benefor, 2019).

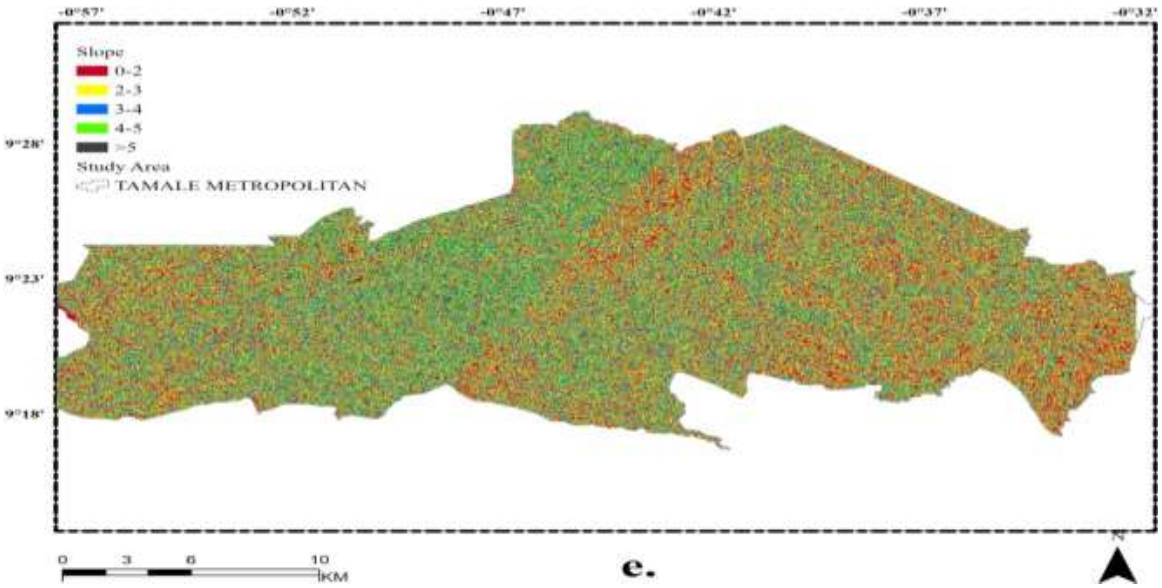

Figure 4.6: Slope in the Tamale Metropolis

3.6 Drainage Density of Tamale Metropolis

A high drainage density indicates a significant generation of surface runoff, consequently increasing the likelihood of flooding, and vice versa (Prokešová, Horáčková & Snopková, 2022). Urban areas with road networks and agricultural lands commonly exhibit high drainage densities. This is primarily due to the prevalence of impervious surfaces such as roads, buildings, and paved surfaces, which impede water infiltration into the soil. As a result, water flow is accelerated, leading to higher drainage densities. Conversely, areas devoid of vegetation, such as barren lands, typically exhibit very low drainage densities (Radwan, Alazba & Mossad, 2019). The absence of plant roots, which aid in soil particle cohesion and increased infiltration, contributes to the low water flow rates in such regions. Furthermore, the lack of vegetation promotes a higher proportion of surface runoff, thereby contributing to the reduced drainage density. Figure 4.7 shows the drainage density map of the Tamale Metropolis. The drainage density map is grouped into five density classes' namely very high, high, medium, low and very low (see Figure 4.7). Also, the very high drainage density class is (125.398 km^2), high (126.544 km^2), medium (92.300 km^2), low (204.92 km^2) and very low (227.36 km^2) drainage densities (see Table 4.13).

Areas classified as having very high drainage density (125.398 km²) are likely to have a dense network of streams and channels, indicating a high potential for rapid runoff and increased susceptibility to flash flooding during heavy rainfall events. High drainage density values reflect a high runoff volume and a greater potential for flash flooding (Karmokar & De, 2020). This is because a high drainage density is associated with a dense network of streams and channels, which can lead to rapid runoff and an increased risk of flash flooding, especially during heavy rainfall events. Similar to very high-density areas, those with high drainage density (126.544 km²) also exhibit significant stream channel networks. These areas may experience heightened flood risk due to the efficient conveyance of water through the drainage system. In addition, the moderate drainage density (92.300 km²) suggests a less extensive network of streams compared to high or very high-density areas. While these areas may still be prone to localized flooding, the overall flood risk may be lower compared to higher-density areas. Furthermore, areas with low drainage density (204.92 km²) have fewer natural channels, resulting in slower runoff and reduced flood risk under normal conditions. Low drainage density is associated with less efficient water conveyance through the landscape, as water moves more slowly over hillslopes. Finally, the lowest drainage density class (227.36 km²), indicates areas with minimal natural stream networks. Here, these areas with very low drainage density have minimal stream channels, ultimately resulting in slower runoff and reduced flood risk under normal conditions.

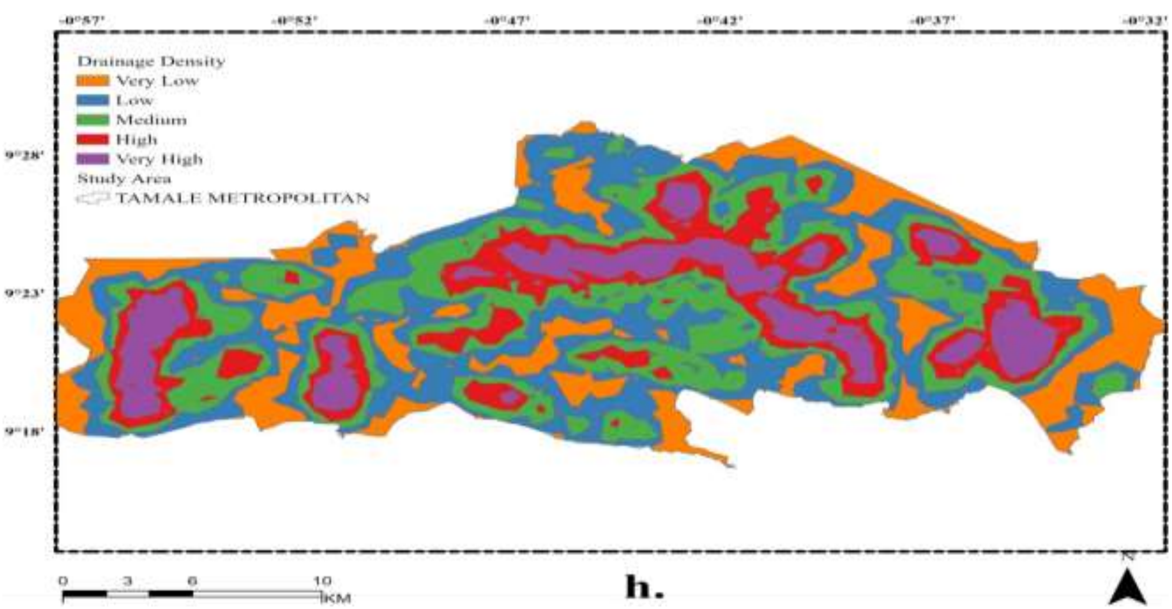

Figure 4.7: Drainage Density in the Tamale Metropolis

3.7 Flow Accumulation of Tamale Metropolis

The flow accumulation is considered a significant factor in assessing flood risk within the Tamale Metropolis. A high flow accumulation level indicates a higher likelihood of flooding. This is supported by research conducted by Bannari et al. (2016), which demonstrates that areas with high flow accumulation tend to have larger runoff volumes and a greater potential for flash floods. Figure 4.8 visually represents this relationship, with red and pink pixels indicating areas of high flow accumulation, while green, light yellow, and light blue pixels represent low, very low, and moderate flow accumulation levels, respectively. The findings of the study further highlight that the study area is predominantly characterized by high-flow accumulation areas, making them more susceptible to flood inundation. High flow accumulation values are associated with a dense network of streams and land area, which lead to rapid runoff and increased susceptibility to flash flooding during heavy rainfall events. As shown in Table 4.13, the flow accumulation value of 611.73 indicates the flow accumulation over a particular land area, representing the sum of water runoff from upstream contributing areas. Flow accumulation in land areas suggests significant water flow convergence, potentially due to the presence of low slopes in the study area that facilitate runoff. On the other hand, the flow accumulation in the stream category (10.228) represents the accumulated water discharge within the stream network.

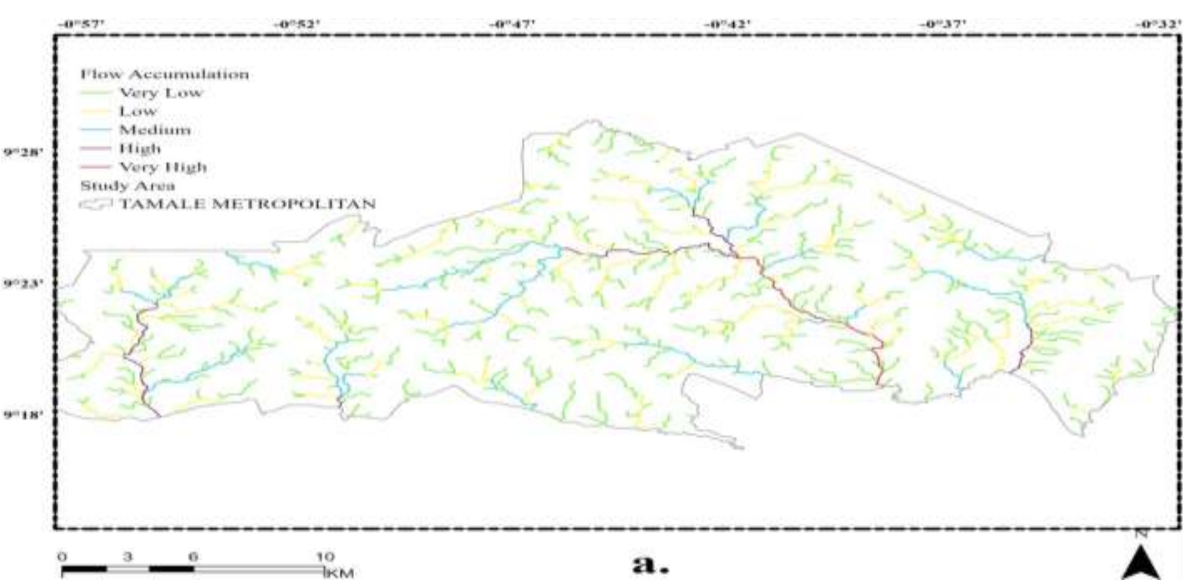

Figure 4.8: Flow Accumulation in the Tamale Metropolis

3.8 Land use dynamics of the Tamale Metropolis

The land use in the Tamale Metropolis shows the distribution of various land cover types and their dynamics. The characteristics of different land types in the Tamale Metropolis are water bodies, developed/urban areas, bare land, vegetation, and agricultural/cultivated land, which all significantly influence flood risk and inundation. In the study area, water bodies cover 29.98 km², this water includes rivers and ponds which act as natural drainage channels, aiding in the absorption and conveyance of excess water during rainfall events (see Figure 4.9). However, extensive water bodies also pose a risk of overflow, potentially leading to localized flooding. Therefore, while water bodies help manage water flow, their extensive presence also contributes to flood risk, especially during heavy rainfall or storm events (Ward et al., 2020). In addition, the developed/urban areas in the study area cover 136.45 km². As a result of development, impervious surfaces like roads and buildings, reduce natural infiltration and increase surface runoff during heavy rainfall, potentially causing urban flooding. In the Tamale metropolis, the built-up area has increased from 12% to 24% from 2009 to 2020, due to considerable urban expansion (Abubakari, Anaman & Ahene-Codjoe, 2022). Additionally, the increased impermeable surfaces in urban areas lead to a higher risk of flooding, as there is less space for water to absorb into the ground (Amoateng et al., 2018).

Furthermore, bare land in the study area covers 251.07 km², which can potentially reduce surface runoff during rainfall. However, the area for bare land is not much. Also, vegetation covers 135.88 km², which plays a major role in mitigating flooding by promoting infiltration, reducing surface runoff, and stabilizing soil. However, changes in land use that reduce vegetation cover, such as deforestation or urban expansion, may increase the risk of flooding. Finally, agricultural/cultivated land covered only 52.89 km², of the study area. However, the impact of agricultural areas on flooding does vary based on cultivation practices. Well-managed agricultural lands with effective drainage systems help reduce flood risk. However, improper land management, such as inadequate soil conservation practices, leads to soil erosion and increased runoff, potentially contributing to flooding. Generally, the transformation from vegetation-covered land to urban structures has led to increased surface temperature and the potential for higher levels of runoff and flooding (Dibaba, 2023). Furthermore, the change in land use has also affected the natural water cycle in the area. The vegetation in the area helps to regulate the water cycle by absorbing and storing water, and urbanization has reduced the amount of vegetation, leading to an imbalance in the water cycle.

This imbalance causes flooding, as there is more water than the area can absorb, leading to a higher risk of flooding during rainfall.

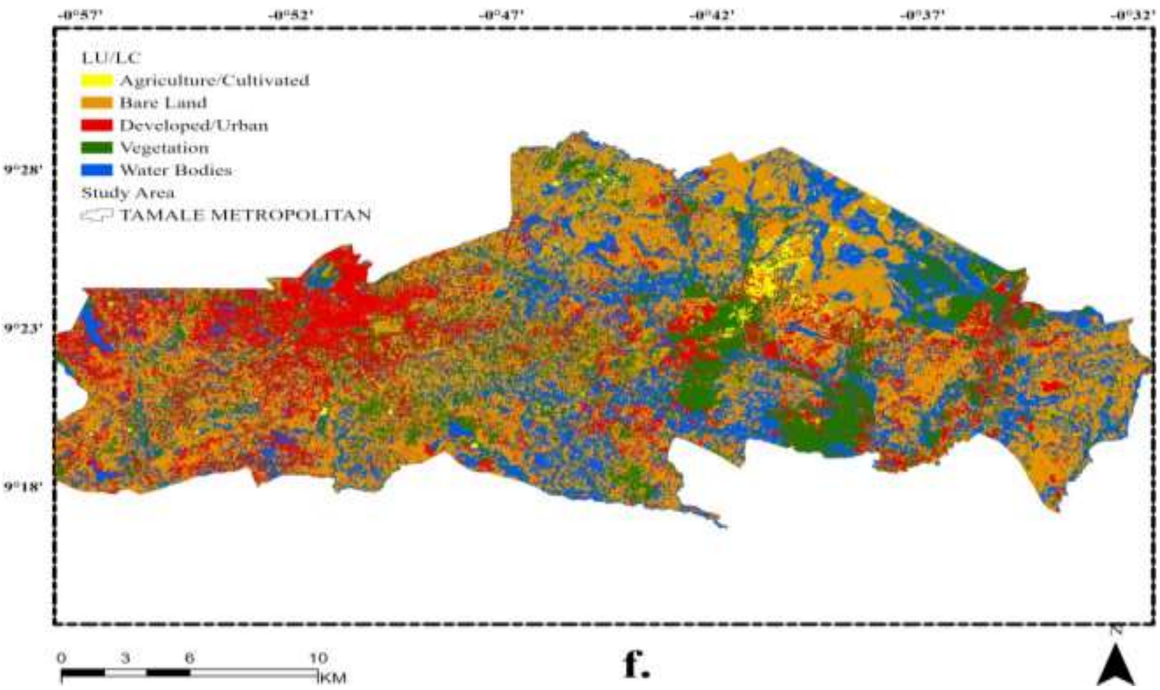

Figure 4.9: Land Use Land Cover for the Tamale Metropolis

3.10 Distance to Stream of the Tamale Metropolis

The distance to the stream is an essential measure of the separation between any location in the study area and an accessible stream. Figure 4.10 illustrates that regions shaded in red denote all locations within a 1 km radius of an accessible stream, while green indicates areas situated more than 5 km away from any accessible stream. The distance to the stream holds significant importance in the evaluation of flood risks, as it directly impacts the potential for flash floods and other water-related hazards. Streams and drainage systems are intricately connected, and each stream within a drainage system serves to drain a specific area known as a drainage basin or catchment (Leibowitz et al., 2018).

The distance to the stream plays a crucial role in the assessment of flood risks. Areas in close proximity to streams are particularly vulnerable to flooding due to the heightened probability of stream overflow during intense rainfall or other water-related occurrences (Korichi, Hazzab & Atallah, 2016). Moreover, the topography of the land and the presence of impermeable surfaces such as roads and buildings exacerbate flooding in areas adjacent to streams (Kaur et al., 2020).

Furthermore, the proximity to a stream can influence the capacity of the drainage system to manage substantial volumes of water, thereby increasing the risk of flooding in these areas.

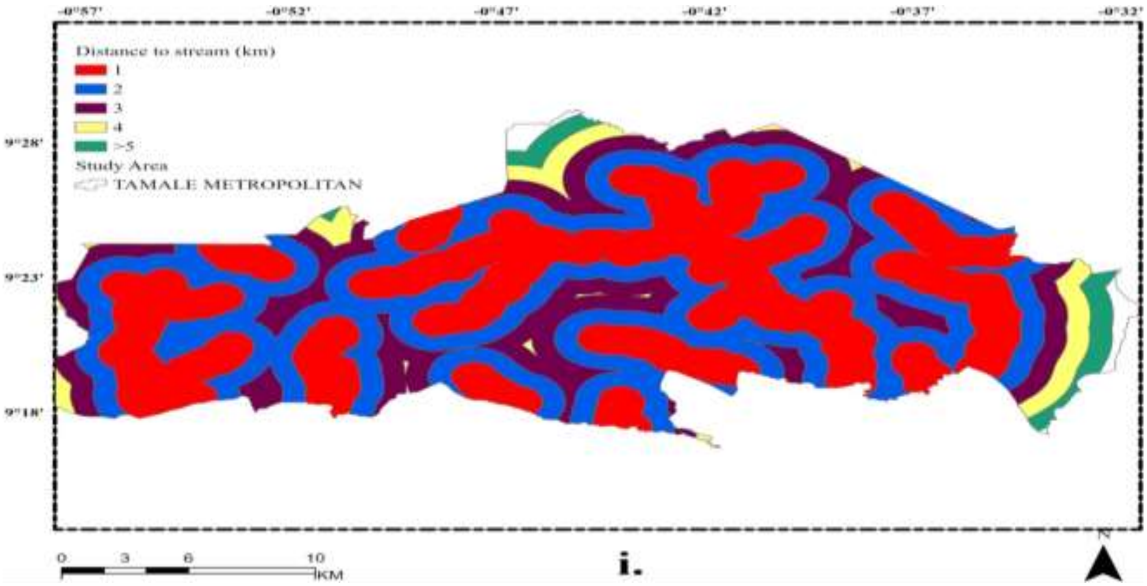

Figure 4.10: Distance to Stream for the Tamale Metropolis

3.11 Total Wetness Index (TWI) for the Tamale Metropolis

The Total Wetness Index (TWI) for the Tamale Metropolis is a metric that measures the overall moisture conditions of the atmosphere, which can affect precipitation and flood risk. In the given results, the TWI ranges from -2.0 to -7.7, with negative values indicating an excess of moisture in the atmosphere. The TWI is used to evaluate the potential for flash floods and other water-related hazards in the study area. According to Figure 4.11, the highest TWI range (-2.0 to -7.7) indicates a high level of moisture, leading to heavy rainfall and increased flood risk (see Table 4.13). This is consistent with the recurring floods in the city, as external factors like heavy rainfall have impacted the area, resulting in serious consequences for the food system and local population. Conversely, the lowest TWI range (-7.0 to -5.24) suggests a lower level of moisture in the atmosphere, leading to less intense rainfall and potentially reduced flood risk. This interpretation aligns with the existing literature, which highlights the influence of climatological factors on flood vulnerability and the necessity for proactive measures to prevent and mitigate the destructive effects of flooding, especially in rapidly urbanizing regions (Martinez, Bakheet & Akib, 2020; Idris & Dharmasiri, 2015) such as the Tamale Metropolis.

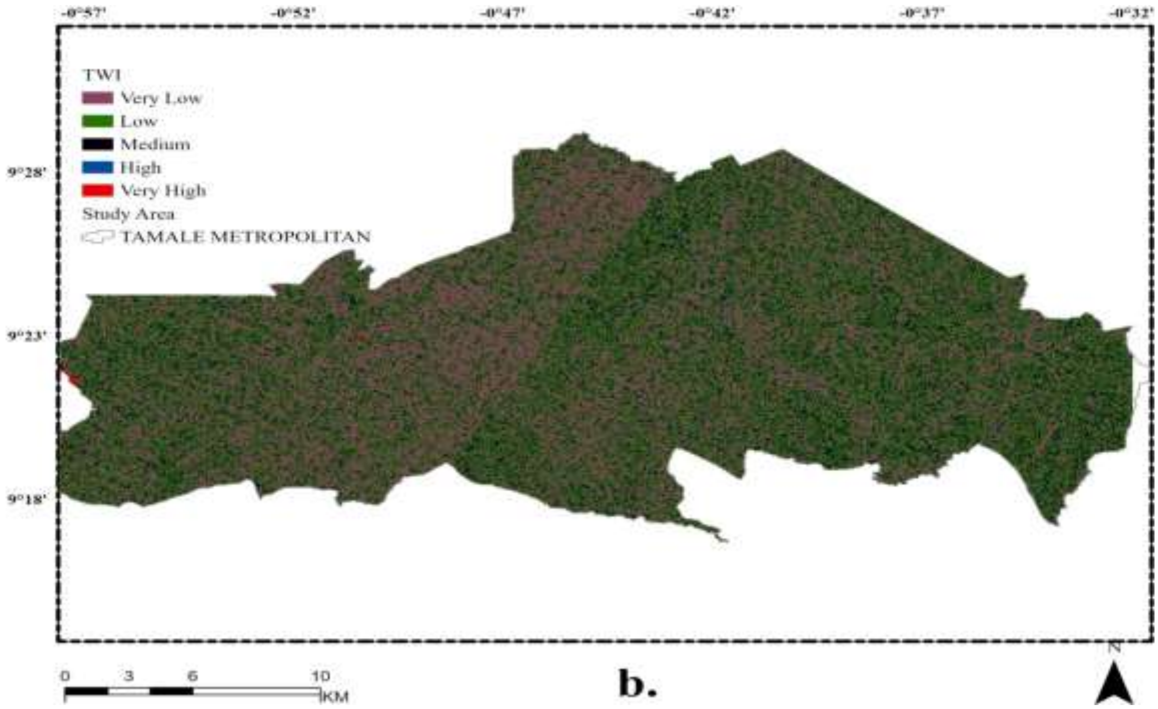

Figure 4.11: Total Wetness Index (TWI) for the Tamale Metropolis

4.0 Conclusion and Recommendation

In identifying and mapping flood prone areas in the Tamale Metropolis, the study concluded Sakasaka, Taha, Kanvilla, Norrip village, Ghogu, Nyohni, Kunyilla, Zujung, Kaakpayili, Sishiagu, Jekeriyili, Lamashegu, and Kalpohim estate were more prone to flooding due to their low elevation. The study recommends that the metropolitan assembly should invest in infrastructure projects that reduce flood vulnerability, such as the construction of bridges, roads, and other transportation networks that can withstand flooding during the raining season. Also, the assembly should implement socio-economic interventions to reduce the vulnerability of low-income communities to flooding. This may involve providing financial assistance to help residents rebuild after floods, offering training programs to help residents develop flood-resistant livelihoods, and promoting the use of flood-resistant building materials. Furthermore, the government through town and country planning should develop and implement land use and zoning regulations that take into account the identified hydrological and socio-economic factors to reduce the risk of flooding in the Tamale Metropolis. Also, the Tamale Metropolitan Assembly should include measures to control unplanned development, improve drainage systems, and preserve natural water bodies within the metropolis.

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Code availability: Not applicable

Declarations

Ethics approval and consent to participate
All human and/or animal subjects involved in this study were treated in strict adherence to ethical principles and regulations established by the University for Development Studies, Tamale, Ghana. Data collection from participants was carried out with their informed consent, and subsequent analysis adhered to standardized methodologies developed by the Graduate School of the University for Development Studies, Tamale, Ghana. Participants were thoroughly briefed on the purpose and usage of their data, providing explicit consent for its publication. Moreover, the data collection process received approval from the Department of Environment and Sustainability Sciences at the University for Development Studies, Tamale, Ghana.

Competing interest
The authors declared that they have no competing interests.

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