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COLLEGE OF HUMANITIES

ASSESSING THE EFFECTS OF URBAN EXPANSION ON FLOOD SUSCEPTIBILITY

IN THE GA EAST MUNICIPALITY: A CASE OF DOME

BY

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DECLARATION

I, **Isaac Mbabil Kusohinam**, do hereby declare that the research work presented in this document is entirely my original and authentic work. I have not submitted this research to any university or institution for any academic degree or qualification. Any material or ideas that are not my own have been attributed to their respective authors through appropriate citations, whether they appear in the text or outside of it. Plagiarism and intellectual dishonesty have no place in my work, and I have strived to uphold the highest ethical standards in conducting and presenting this research.



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CERTIFICATION

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DEDICATION

I dedicate this research to Moses and Moses, to whom I owe eternal gratitude. Your support and encouragement have been invaluable to me through this journey.



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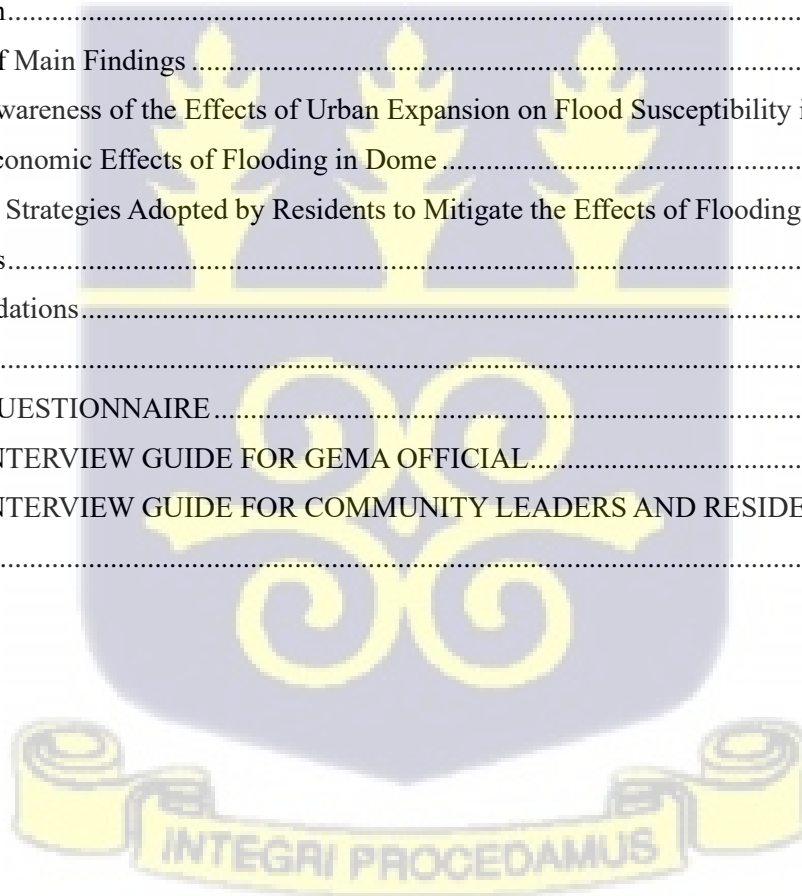


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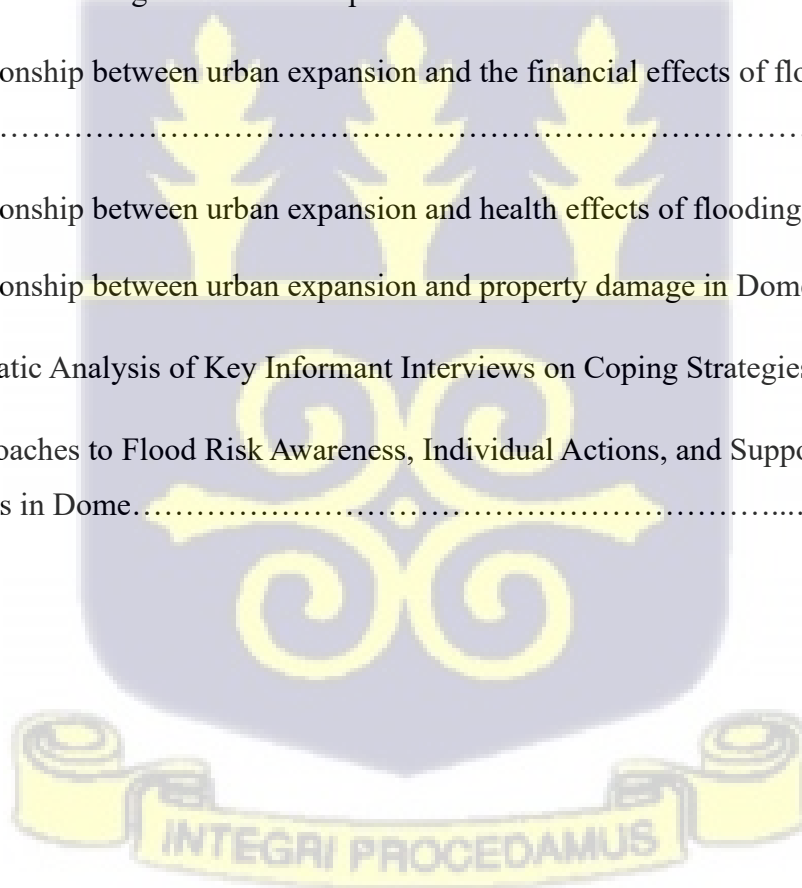
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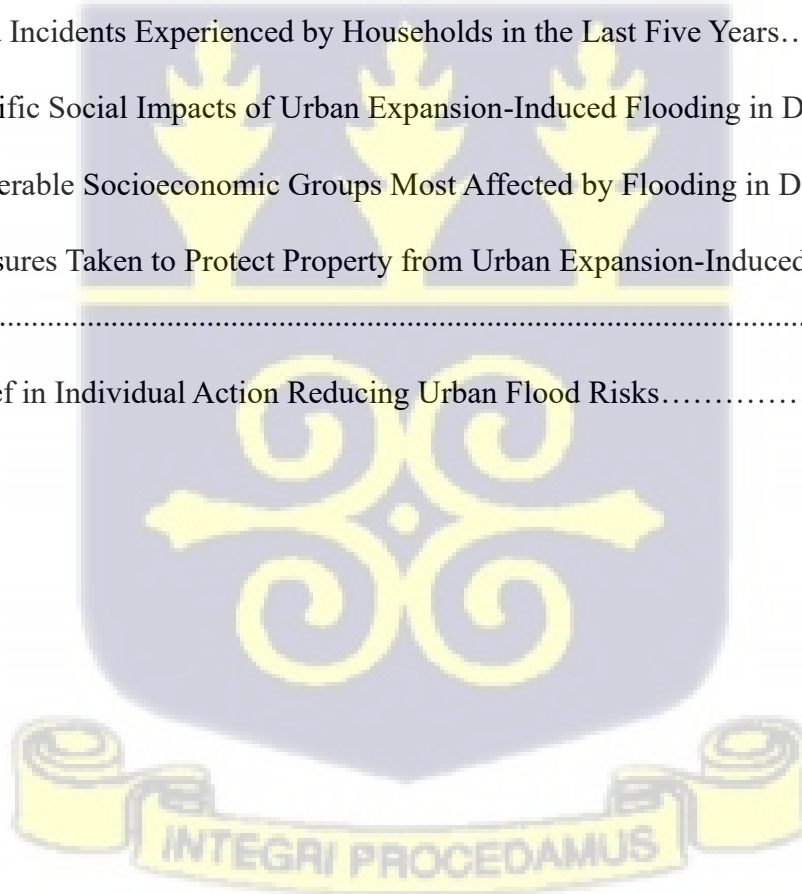
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ABSTRACT

Rapid urban expansion has heightened the vulnerability of urban communities to flooding. In view of this, the dissertation examined the effects of urban expansion on flood susceptibility in the Ga East Municipality, with a specific focus on Dome. The study explored the perceptions of residents on the influence of urban expansion on flood vulnerability, the socioeconomic effects of urban expansion-induced flooding, and the coping strategies adopted by residents to mitigate the effects of flooding. A simple random sampling technique was used to sample 215 respondents for the household questionnaire survey, whilst assembly officials, community leaders, and longstanding residents were purposively selected for the in-depth interviews. The findings revealed that residents were largely familiar with the impacts of urban expansion. Again, urban expansion-induced flooding was revealed to have severe consequences on residents. Comparatively, most residents faced severe financial and health challenges due to frequent floods in the area. The study further established that residents of Dome relied on structural coping mechanisms in the forms of sandbag usage and wall elevation to mitigate the impacts of flooding. These were, however, found to be insufficient due to the absence of flood insurance packages and the low adoption of evacuation strategies amidst the increasing and recurring nature of flooding as a result of urban expansion. In view of these, the study recommended the strict enforcement of urban planning regulations, improvement of the drainage infrastructure in the area, and community education on the dangers of uncontrolled urban expansion and flooding. The enhancement of early warning systems was also recommended to ensure timely actions and enable preventive response among affected residents.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Urban expansion, defined as the progressive geographical concentration of a nation's population in urban regions (Mahtta et al., 2022) has become widely recognized as a critical demographic characteristic influencing social, economic, environmental, and political connections on a worldwide scale (James, 2024). Urban centers have over the years become the place of power and process, attracting and inhabiting more than half of the world's population (Shaban et al., 2020). Global urbanization is expected to increase from 55% in 2018 to 68% in 2050 (Desa, 2019) as cited in (X. Li et al., 2022). Though Sub-Saharan Africa is currently the least urbanized in the world, it has been identified as the continent that is urbanizing the fastest (Güneralp et al., 2018). By 2030, projections suggest that approximately 5 billion individuals will reside in urban areas, with over 80% originating from developing nations (Shaban et al., 2020).

Factors including rural-urban migration, natural population increase, and the availability of economic opportunities have fueled substantial growth in urban population in recent decades (Tacoli et al., 2015). This influx of urban residents has increased the demand for housing, infrastructure, and commercial spaces in urban centers (Oluwatayo & Opoko, 2014). The World Bank (2023) reveals the annual urban population growth rate in 2022 is estimated at 3 percent (see Figure 1.1). This is similar to those of the previous years, perpetrating urban expansion. This overarching effect converts agricultural and conserved land spaces into commercial zones, perpetuating flood vulnerabilities (Mensah & Ahadzie, 2020).

Land use changes, often induced by unsustainable urban expansion have led to a reduction in green lands, exacerbating flood susceptibility (Manawi et al., 2020). This elucidates the existing synergy between urban expansion and the conversion of green lands into built-up areas, diminishing the natural ability of the land to absorb water, and leading to higher flood risks.

In the case of Ghana, the rapid urban expansion of the Greater Accra Metropolitan Assembly (GAMA) has contributed significantly to changes in land use/land cover (LULC) in the metropolis and its environs, resulting in a 152% increase in the urban area of the Awutu Senyo East Municipality (Doe et al., 2022). The ability of city authorities to effectively, equitably, and optimally manage demographic and landscape changes has been compromised by rapid population growth and urban expansion driven by rural-urban migration in Ghana (Cobbinah et al., 2022). According to (Toure et al., 2020), from 2000 to 2010, urban expansion in Accra and Kumasi mainly involved an increase in residential land use, although Accra experienced significantly more growth in non-residential built-up areas.

While urbanization brings benefits, such as increased economic opportunities and improved access to services (Turok & McGranahan, 2013), it also poses significant challenges, particularly regarding environmental sustainability and disaster risk management. Asomani-Boateng (2019) established that rapid urban expansion is a key contributor to flooding in Accra, Ghana. This phenomenon often involves altering natural drainage systems, paving over green spaces, and encroaching conserved land space, especially in low-lying and flood-prone areas. Such changes to the urban landscape often exacerbate flood risks by reducing natural flood protection mechanisms and increasing surface runoff during heavy rainfall events (Berndtsson et al., 2019)

The Ga East Municipality (GEM), located in the Greater Accra Region of Ghana, exemplifies the challenges faced by rapidly urbanizing areas in sub-Saharan Africa. Encroachment into floodplains

and waterbodies, driven by population growth and urban expansion, is exacerbating flood risks in GEM and undermining community resilience in the municipality (Andreasen, Agergaard, Kofie, et al., 2022). As urban expansion intensifies in GEM, there is a growing concern about the vulnerability of residents to flooding, particularly in informal settlements and low-lying areas (Moller-Jensen et al., 2023).

1.2 Statement of the Problem

Urban expansion is fundamentally transforming landscapes around the world, resulting in significant environmental challenges, particularly in rapidly growing municipalities. Urban expansion, in itself, does not necessarily lead to flooding; rather, it is the uncontrolled and unplanned nature of urban growth that exacerbates flood risks (Asibey et al., 2024). When expansion occurs without proper drainage infrastructure, land-use planning, and environmental considerations, it disrupts natural water flow, increases surface runoff, and reduces the capacity of land to absorb excess water (Oduro & Oduro, 2025). In Ghana, the Ga East Municipality (GEM) exemplifies the pressures that accompany such expansion. As rural areas are converted into built-up urban environments, the demand for infrastructure and land has intensified, leading to profound changes in land use that are causing serious environmental risks, particularly flooding (Mensah & Ahadzie, 2020).

Accra, the capital of Ghana, has long grappled with recurrent flooding due to a combination of geographic, hydrological, and urbanization factors (Asomani-Boateng, 2019). GEM, which forms part of the Greater Accra Metropolitan Area, experienced a population surge to 283,150 by 2020, with an annual intercensal growth rate of 0.0611% (GEMA, 2021). This rapid growth has led to the encroachment on floodplains and other natural landscapes, significantly altering the hydrology

of the municipality. As urban areas expand, there is an increase in surface runoff and a loss of natural floodplains, diminishing the municipality's capacity for flood attenuation (Boakye & Bawakyillenuo, 2018). Currently, the Ga East Municipal Assembly (GEMA) has identified thirty-one flood-prone hotspots, primarily in densely populated areas (GEMA, 2021).

The accelerating pace of urbanization and population growth in GEM has resulted in unplanned encroachment on conserved lands and floodplains, further aggravating flood risks and reducing environmental resilience (Asare, 2021). Over the years, the municipality has faced devastating flood events, leading to significant economic losses, damage to infrastructure, and displacement of residents. The conversion of natural landscapes into impermeable urban areas has altered local hydrological patterns, contributing to higher surface runoff and reduced infiltration, which have compounded flood susceptibility (Boakye & Bawakyillenuo, 2018).

Despite growing concerns, there remains limited research that comprehensively investigates the relationship between urban expansion and flood vulnerability in GEM. Key factors such as inadequate urban planning, poor drainage systems, and the proliferation of informal settlements, especially in low-lying areas (Okaka & Odhiambo, 2019), have further exacerbated the situation. The mechanisms through which urbanization increases flood susceptibility in GEM remain inadequately understood.

This study aims to address this research gap by examining the effects of urban expansion on flood susceptibility in GEM, focusing on Dome, the most populous and flood-prone community in the municipality, according to the Greater Accra Resilient and Integrated Development Project (GARID) 2023. Through a detailed analysis of land use changes, hydrological dynamics, and flood-prone hotspots, the research will provide critical insights into the socio-economic impacts of floods, local coping mechanisms, and potential policy interventions. The findings will inform

strategies to mitigate flood risks and promote sustainable urban development in the Dome and the municipality to a large extent.

1.3 Research Objectives

The overall aim of this thesis is to assess the effects of urban expansion on flood susceptibility in the Dome.

Specifically, the objectives of this study are to;

1. Explore the perceptions of residents regarding the effects of urban expansion on flood risks in Dome.
2. Investigate the socio-economic effects of urban expansion-induced flooding on residents in Dome.
3. Assess the coping strategies employed by residents in Dome to mitigate the effects of floods caused by urban expansion.

1.4 Research Questions

In line with the objectives stated above, this study seeks to answer the following questions:

1. What are the perceptions of residents in Dome regarding the effects of urban expansion on flood risks?
2. What are the socio-economic effects of urban expansion-induced flooding on residents in Dome?
3. How do residents in Dome cope to mitigate the impacts of floods induced by urban expansion?

1.5 Significance of Study

The study is significant for several reasons. Firstly, it will add to the existing discourse on climate resilience, disaster management, and community coping strategies in the face of urban expansion-driven environmental challenges in Ghana. Specifically, it aims to fill a critical gap in the literature by examining the effects of urban expansion on flood vulnerability in Dome.

Additionally, the findings from this study will provide a foundation for advocating proactive measures to address flood risks caused by urban expansion. These insights will be valuable in shaping policy directions and interventions that can mitigate flood risks, improve urban planning practices, and strengthen community resilience. Ultimately, the study aims to promote sustainable urban development by highlighting the importance of integrating flood risk management into the broader framework of urban expansion and planning.

1.6 Organization of Chapters

The study consists of five chapters, each addressing specific aspects of the research. Chapter One provides an introduction to the topic, including the background information, the research problem, objectives, research questions, justification, and the overall structure of the dissertation. Chapter Two thoroughly reviews relevant literature and presents the conceptual framework guiding the study. It also explores an existing theory relevant to the study. Chapter Three outlines the methodology used, including a study area description. Chapter Four focuses on presenting, analyzing, and discussing the research findings. Finally, Chapter Five summarizes the main findings, draws conclusions, and offers recommendations based on the study's outcomes.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviewed existing literature related to the study topic. It focused on various aspects, including how urban expansion affects flood risk perceptions, the socio-economic impacts of flooding, and the coping strategies people use to manage flood risks. It further explored urban planning as a way to reduce these risks. Additionally, this chapter discussed the urban ecology theory underpinning the study and outlined the key ideas that form the study's conceptual framework. The chapter concluded with a summary.

2.2 Urban Expansion and Flood Risk Perceptions

Flood susceptibility in urban communities is exacerbated by increases in rural-urban migration, rapid population growth and heightened business and residential construction (Bixler et al., 2021). The European Environment Agency (EEA) defined urban expansion as the rise in the percentage of individuals residing in urban areas, mostly seen in underdeveloped countries (EEA, 2017). Hussain & Imitiyaz (2018) also defined the term as the socioeconomic and cultural transformation of a given society, encompassing the migration of individuals and activities to urban settings. Urban expansion as a complex phenomenon is caused by varied elements ranging from social, economic, and environmental factors (Faseyi et al., 2023; Luan & Li, 2021). These among others include natural population growth, rural-urban migration, urban development sprawl, relatively better opportunities, industrialization, and commercialization in the urban centers (Bixler et al., 2021). The concept of urban expansion defined as the outward growth of urban areas into

surrounding lands, resulting in environmental and socioeconomic impacts (He et al., 2023; Inostroza & Taubenböck, 2024) is employed for the purposes of this study

Flooding, according to the Intergovernmental Panel on Climate Change (IPCC) is defined as the spillover of a stream or any water body beyond its usual boundaries or the gathering of water in regions not submerged (Field et al., 2012 as cited in Kundzewicz et al., 2014). Flood risk is the likelihood of this incident occurring and its accompanied consequences (Markanday et al., 2022). People's readiness for the incidence of flooding is considered the most efficient management mechanism for reducing the rate of its associated risks. However, their preparedness is largely affected by their perceptions (Yin et al., 2021). Factors such as residents' level of education, income, and gender influence their level of risk aversion to flooding (Yin et al., 2021). Similarly, a study by Shah et al., (2022) concluded that the perceptions of flood risks are influenced by several socioeconomic factors such number of household members, previous flood experiences, proximity to floodplains, education and income.

These studies therefore suggest that increases in urban population have invariably played a significant role in aggravating flood vulnerability. Urban expansion and its associated challenges compound the risks of urban flooding and undermine community resilience (Maheu, 2012).

2.3 Socioeconomic Impacts of Flooding Within Various Urban Contexts

Flooding, as a recurrent phenomenon, is often characterized by several forms of challenges in urban areas across the world. This exerts diverse socioeconomic impacts at different magnitudes across different urban contexts. Annual floods in Ghana invariably have devastating impacts on human livelihoods, infrastructure, and several properties, leaving a large number of people homeless (Mensah & Ahadzie, 2020). The perennial occurrence of flooding goes to the extent of

impeding the achievement of some Sustainable Development Goals (SDGs), with a study by Echendu (2020) establishing its effects on education quality, hunger, clean water, and sanitation.

2.3.1 Economic Effects of Flooding

Flooding imposes significant economic burdens on individuals, businesses, and government, as documented by various studies. According to (Krongthaeo et al., 2021), economic effects have to do with the wide range of financial impacts ranging from immediate costs such as property damage and infrastructure repairs, as well as broader, long-term consequences like decreased productivity, increased public expenditure and slowed regional or national growth. Jongman, (2018) in 2017 qualifies the global financial toll, noting that flood-related disasters resulted in over \$300 billion in losses, a figure that underscores the growing economic impact of climate-induced. Nelson & Ahmadpoor, (2023) furthermore shows that England suffered a huge cost of £3.2 billion in 2007 due to the detrimental impact flooding had on public and private finances, with much of this cost associated with efforts to mitigate the impacts of flooding, as well as recovery processes. On a global scale, the annual costs of flooding in coastal areas could reach up to 4.7% of world GDP by the end of the 21st century, indicating the extensive economic burden of flooding worldwide (Sánchez-García et al., 2023).

However, Chang et al., (2022) observed that these impacts are not isolated events but contribute to broader economic setbacks that affect all societal levels. Ifiok Enobong Mfon et al., (2022) corroborate these findings in their review also identifying economic and property losses, death, and environmental challenges as primary outcomes of flood events. This literature suggests that these losses persistently affect individuals and institutions, underscoring the recurrent and compounded economic strain associated with frequent flood incidents.

Other studies have examined how flooding affects economic productivity through indirect pathways, such as disruptions to transportation networks. Borowska-Stefańska et al., (2018), for example, examining flood effects on traffic density within the Mazovian Voivodeship's regional road network found that commuting times increased, nearly eightfold, which they attribute to altered traffic flows during floods. This disruption reduces productivity, emphasizing the far-reaching economic losses attributable to flooding beyond direct physical damage. Zheng et al., (2024) equally contributed to the discourse on the economic effects of flooding by asserting that, beyond the tangible destruction, flooding has an indirect implication on individuals and nations through mechanisms like decreases in productivity in areas affected which leads to supply shortages and price fluctuations.

Several other analyses further underscore the severe economic costs associated with extreme weather events. Marchiori et al., (2012) and Mensah & Ahadzie, (2020) also show that between 1960 and 2000, five million people were forced to flee their homes owing to extreme heat and heavy rains, with an additional 11.8 million individuals anticipated to be added to the population by the end of the twenty-first century. According to a study by Paprotny et al., (2018), over the past 150 years, the total amount of European urban areas susceptible to flooding has expanded by 1000%. This has led to tremendous effects on residents across the globe.

Gambo et al., (2024) also found a strong correlation between flood vulnerability and poverty in a study focusing on spatial distribution of flood risks and poverty determinants in Jigawa, Nigeria. The study highlighted that areas with higher poverty rates are more prone to flooding, largely due to inadequate infrastructure, limited access to flood-resilient housing, and restricted resources for flood preparedness and recovery. According to the authors, the economic impact of flooding extends beyond immediate losses. It can lead to long-term issues such as increased poverty,

reduced access to essential services like education and healthcare, and overall lower living standards.

2.3.2 Social Effects of Flooding

Flooding has a significant range of social impacts, including effects on social cohesion, access to resources, and community stability (Fan et al., 2020). Studies show that frequent floods disrupt social ties and displace residents, breaking down established community networks and support systems (Karunarathne & Gress, 2022). Adams & Nyantakyi-Frimpong, (2021) further emphasized that, aside from the strain on families and breaking of community ties, some communities are faced with issues of conflicts and reduced social cohesion due to floods. People affected by floods sometimes also get displaced, which affects already-established social networks (Al-Areeq et al., 2024). According to Pizzorni et al., (2024), displacement due to flooding often leads to temporary or permanent relocation, which fragments social bonds and hinders the collective recovery process within affected areas.

Furthermore, flooding restricts access to essential services such as education and transportation, as infrastructure damage limits the movement of goods and people, impacting residents' daily lives and impeding community resilience (Andreasen et al., 2022). A study by Lassa et al., (2022) revealed significant effects of flooding on education quality, school facilities, and educational recovery in Indonesia. Using both quantitative and qualitative methods and the Comprehensive School Safety (CSS) framework, the study assessed experiences from 100 schools to analyze the relationship between flooding and educational outcomes. Supporting this, Agyekum & Asibey (2024) established that the daily activities of people are often impeded in flood situations, posing a significant difficulty in accessing social services such as schools. The researchers also revealed that basic activities like sleeping schedules and patterns are also affected by floods.

In areas where agriculture is a primary livelihood, flooding has a devastating impact on the social fabric by destabilizing local economies and disrupting agricultural production cycles (Shrestha et al., 2024). Farmers lose crops and sometimes farmland due to soil erosion and damage to irrigation infrastructure, leading to reduced income and financial insecurity (Boateng et al., 2020). This instability affects entire households and communities that rely on agriculture, creating tension over resources and increasing dependence on aid.

2.3.3 Health Effects of Flooding

On the aspect of health, frequent flooding threatens the well-being of residents in urban settlements. According to Burton et al., (2016), the spectrum of health impacts is extensive, spanning from immediate dangers like fatalities, drowning, and injuries to secondary consequences such as hypothermia, psychological stress, and worsened conditions for vulnerable populations, including the elderly and those requiring medical care. Fanchiotti et al., (2020) further establish that water-borne diseases including cholera, diarrhea, typhoid fever, and leptospirosis become rampant during flooding, with the flood water sometimes carrying fecal matter and all forms of pollutants.

Flooding has a significant impact on mental health, with many survivors experiencing anxiety, depression, and post-traumatic stress disorder (PTSD) (Damte et al., 2023; Shah et al., 2020; Watts et al., 2018). This psychological toll is often compounded by concerns over lost property, disrupted livelihoods, and, in some cases, the loss of loved ones (Damte et al., 2023). Childbirth complications and outcomes during the consumption of contaminated water, as well as malnutrition, are also key health issues imposed by flooding. According to Zhong et al., (2018), in more severe cases, flood exposure has been linked to higher disability rates and an increased risk of cardiovascular events, such as myocardial infarction.

Additionally, inadequate post-flood waste management can result in the re-suspension of pollutants, further endangering public health and environmental stability, as observed by (Crawford et al., 2022). This cumulative impact of flooding on health underscores the complex array of risks, highlighting the need for comprehensive response measures to mitigate both immediate and long-term consequences.

2.4 Environmental Factors and Flood Susceptibility

Several environmental and anthropogenic factors contribute to flood susceptibility, influencing the likelihood and impact of flood events. Changes in land use, such as urbanization and deforestation, increase flood susceptibility by reducing natural water absorption and increasing surface runoff (Moharir et al., 2024 & Yang et al., 2024).

Flood susceptibility in Ghana is influenced by various environmental factors, including topography, land use/land cover changes (LULC), rainfall patterns, and climate change. According to Danso et al., (2020), the topography of Ghana plays a significant role in determining flood susceptibility. The country's low-lying coastal areas are particularly vulnerable to flooding, exacerbated by poor drainage systems and urban development in flood-prone zones. The study highlights the importance of considering topographical features when assessing flood risk in Ghana.

Larbi, (2023) emphasize the impact of land use/land cover changes on flood susceptibility in Ghana. According to him, rapid urbanization and deforestation have altered natural drainage patterns, leading to increased surface runoff and flooding events. The conversion of vegetated areas into impervious surfaces further exacerbates the problem by reducing infiltration capacity.

This research underscores the need for sustainable land management practices to mitigate flood risks associated with land use changes.

In recent years, changing rainfall patterns and climate variability have also contributed to increased flood susceptibility in Ghana. Owusu et al., (2024) discusses how climate change-induced shifts in precipitation intensity and frequency have led to more frequent and severe flooding across the country. This study indicates that extreme weather events, such as prolonged heavy rainfall and unpredictable storm surges, pose a significant threat to communities living in flood-prone areas. They call for adaptive measures to address the evolving climate-related challenges facing Ghana.

Additional, Ampadu, (2020) highlight the role of human activities in exacerbating flood susceptibility in Ghana. Poor waste management practices, improper urban planning, and inadequate infrastructure maintenance contribute to blockages in drainage systems and increase the likelihood of flooding during heavy rainfalls. The study emphasizes the importance of community engagement and government intervention in promoting sustainable development practices that reduce vulnerability to floods.

2.5 Coping Strategies for Flood Mitigation

Flooding is associated with various vulnerabilities, including loss of human lives and property, leading to significant socio-economic and environmental consequences (Ertan & Çelik, 2021). In response to these challenges, a range of coping mechanisms is often adopted at different levels, from individual households to national governments. These strategies can be broadly categorized into structural and non-structural measures, each addressing flooding in distinct but complementary ways.

2.5.1 Structural Measures

Several structural measures are employed to mitigate the impact of flooding including flood defenses, such as levees, floodwalls, and retention basins, which physically prevent water from inundating certain areas (Huang et al., 2022). Nature-Based Solutions (NBS) have also emerged as effective strategies that harness natural processes to manage flood risks. NBS includes the construction of rain gardens, permeable pavements, and the creation of ditches and channels to redirect excess water away from dwellings (Shrestha et al., 2024).

Studies by Ringo et al., 2024) and Zhang et al., (2018) asserted that institutions and national governments lead the construction of large-scale barriers with the aim to manage the flow of water and to prevent flooding in low-lying areas. These structures serve as barriers to prevent floodwaters from reaching urban towns Zhang. Ekoh et al., (2023) also postulated that aside from flood barriers, the focus on effective drainage systems is key to managing water flows and risks of flooding in urban areas.

Individuals affected by flooding also raise the foundation of their buildings above the suspected flood levels. This structural coping mechanism is prominent among modern urban settlements as it is seen as an effective flood coping strategy (FathiAzar et al., 2024). Diversion channels are further utilized to redirect the flow and direction of excess water away from vulnerable and floodable areas (Pérez-Morales et al., 2022). These approaches not only help reduce flood risk but also provide additional benefits, such as enhancing biodiversity, improving air quality, and increasing urban green space (Hobbie & Grimm, 2020).

2.5.2 Non-Structural Measures

Non-structural approaches play a critical role in flood mitigation and include early warning systems, community-based adaptation initiatives, and policy interventions. Tabe-Ojong et al.,

(2020) emphasized the importance of the Livelihood Empowerment Against Poverty (LEAP) program, which was introduced by the Government of Ghana in 2008 to support households affected by natural disasters such as floods and droughts. The study found that emergency social safety net programs like LEAP positively impact building resilience among households in Ghana. However, to maximize the program's benefits, the authors advocate for integrating Community-Driven Development (CDD) programs and promoting behavioral change through education and access to information.

According to Langkulsen et al. (2022), effective flood mitigation strategies encompass the establishment of surveillance systems to monitor environmental changes, rigorous disaster preparedness plans, and risk mapping exercises to identify vulnerable areas. Early warning systems and reliable databases are essential for alerting residents and informing decision-making during emergencies. These systems provide timely and effective information about impending floods, enabling various stakeholders to take preventive action (Ringo et al., 2024). The use of public awareness creation in vulnerable areas is also a non-structural measure to cope with the situation. Raising awareness about flood risks and educating the public on how to respond during flood events is crucial (Moradzadeh & Ahmadi, 2024). This includes awareness campaigns and training programs aimed the vulnerable population.

Furthermore, communities often employ both natural and artificial mechanisms alongside modern technologies to mitigate flooding impacts. The adoption of green infrastructure, a term that refers to strategically using vegetation, soils, and natural processes to manage water and improve environmental quality, is one of the most recommended flood mitigation strategies in Africa (Douglas, 2018). Land-use planning is also identified by Pérez-Morales et al., (2022) as key to

alleviating the vulnerability of floodable areas by ensuring minimal residential and industrial development of the areas.

Studies have further shown that people affected by floods sometimes resort to evacuation plans. Ringo et al., (2024) emphasized this by opining that the development and practice of evacuation plans ensures the quick and safe relocation of affected communities. Flood insurance policies which are intended to cater for the cost of damage caused by floods serve as an effective financial protection and encouragement of better risk management practices (Moradzadeh & Ahmadi, 2024)

2.5.3 Indigenous Coping Mechanisms

Scholarly investigations have highlighted that locally derived initiatives implemented by communities vulnerable to flooding represent an effective approach to mitigating flood impacts. Owusu et al., (2024) conducted a quantitative study to evaluate coping strategies for flood risks among residents of the Ga East Municipality (GEM). The study revealed indigenous coping mechanisms, such as excavating trenches around homes to channel floodwaters and erecting makeshift barriers with materials like rocks, sandbags, and concrete to redirect water away from residences. Some residents also seek refuge in elevated sections of their homes or temporarily relocate to the homes of relatives or friends during flood events. These locally adapted strategies reflect the resilience and ingenuity of communities facing recurrent flooding and underscore the importance of integrating traditional knowledge into broader flood management frameworks.

2.6 Theoretical Underpinning of the Study

This study employed Urban Ecology Theory, drawing on its core concepts and assumptions to shape the conceptual framework guiding this research.

2.6.1 The Urban Ecology Theory

Urban Ecology Theory emerged as an interdisciplinary framework that seeks to explain the complex interactions between urban environments and ecological systems. It originated in the mid-20th century as scholars began to recognize the need to study cities as dynamic ecosystems shaped by both human activities and natural processes (Sitas et al., 2021). Over time, Urban Ecology Theory has evolved and expanded, drawing insights from ecology, geography, sociology, and urban planning to address the challenges of urbanization and environmental sustainability (Lobo et al., 2020).

Urban Ecology Theory offers a valuable theoretical underpinning for understanding the intricate interactions between human activities and natural ecosystems within urban environments. It emphasizes the transformation of natural landscapes and ecosystems resulting from urban expansion processes (Y. Li et al., 2021).

Urban expansion is driven by various socioeconomic and environmental factors, which have significant impacts on flood susceptibility in urban contexts (Bixler et al., 2021). The theory provides a comprehensive framework for understanding the dynamics and interactions that exist between human activities and their natural environment within urban ecosystems. In this theoretical framework, the theory is applied to the assessment of the effects of urban expansion on flood susceptibility in Dome.

Urban Ecology Theory posits that urban expansion alters natural landscapes, leading to changes in ecological processes and patterns (Alberti et al., 2020). In the case of GEM, rapid urban expansion has transformed once-natural areas into built environments, resulting in alterations to land cover, hydrology, and drainage patterns (Asare, 2021). As impervious surfaces increase due to urban

expansion, the capacity of the land to absorb and retain rainfall diminishes, exacerbating flood susceptibility (Ertan & Çelik, 2021)..

The theory also recognizes the socio-economic drivers behind urban expansion, including population growth, economic development, and infrastructure expansion (Des Roches et al., 2021). In GEM, population growth and rural-to-urban migration fuel the demand for housing and infrastructure, leading to the conversion of agricultural land and green spaces into residential and commercial areas (Asomani-Boateng, 2019). This conversion further amplifies flood susceptibility by reducing natural flood buffers and increasing runoff.

Again, the theory emphasizes the importance of ecological resilience and adaptive capacity in urban ecosystems facing environmental challenges. In the context of GEM, preserving and enhancing natural ecosystems such as wetlands, riparian zones, and green corridors can bolster resilience to flooding by providing natural flood protection and regulating water flow (Asomani-Boateng, 2019). Additionally, incorporating green infrastructure and sustainable drainage systems into urban planning can enhance adaptive capacity and reduce flood vulnerability (Reu Junqueira et al., 2021).

Effective flood risk management requires active community engagement and robust governance mechanisms (Bark & Acreman, 2020; Matczak & Hegger, 2020). Urban Ecology Theory highlights the role of community participation, citizen science, and collaborative governance in fostering resilience to environmental hazards. In GEM, engaging local communities in flood risk assessment, early warning systems, and disaster preparedness initiatives can empower residents to mitigate flood impacts and build resilience collectively (Asare, 2021). The theory also advocates for an integrated approach to urban planning that considers the interconnectedness of social, economic, and environmental factors. In Dome, adopting a holistic planning framework that

integrates flood risk assessment, land use planning, and infrastructure development can help mitigate the adverse effects of urban expansion on flood susceptibility. Such an approach requires interdisciplinary collaboration among planners, policymakers, researchers, and local communities.

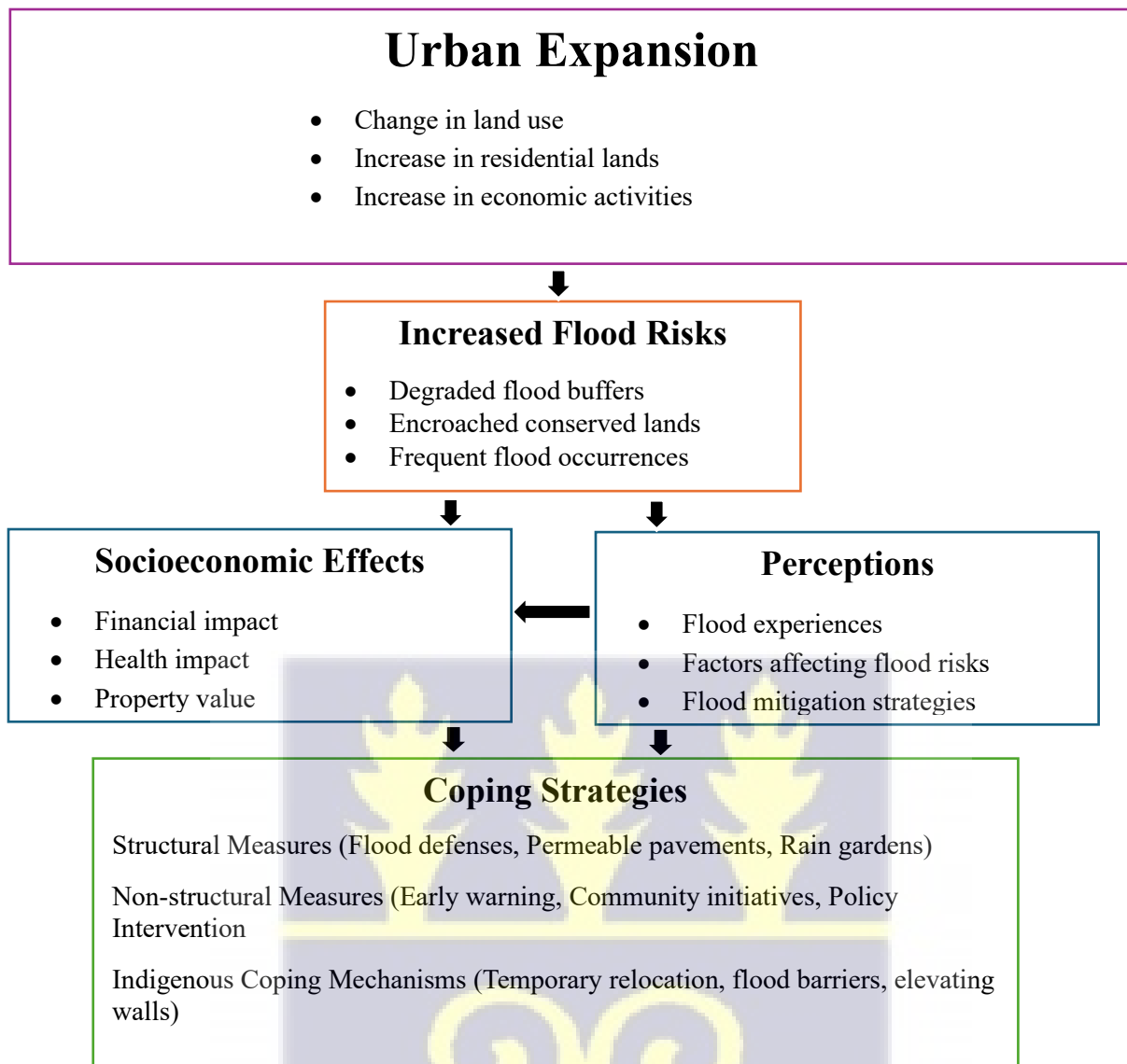
Urban Ecology Theory, therefore, offers valuable insights into the complex interactions between urban expansion and flood susceptibility in Dome. By applying this theoretical framework, researchers and practitioners can better understand the underlying dynamics driving flood risk in urban environments and develop context-specific strategies for resilience-building and sustainable urban development. Through interdisciplinary collaboration and community engagement, it is possible to navigate the challenges posed by urban expansion and mitigate the adverse effects of flooding in vulnerable urban areas like Dome and the Ga East Municipality as a whole.

2.7 Conceptual Framework of the Study

This study formulated a conceptual framework to explore how urban expansion triggers a surge of effects, resulting in increased flood vulnerabilities, socioeconomic effects, residents' perceptions, and the adoption of various coping mechanisms, as shown in Figure 2.1. Each variable of the framework is intrinsically linked, creating a continuous chain where urban expansion not only reshapes the physical environment but also influences individual resilience and response.

Figure 2.1: Conceptual Framework





Source: Owner's Construct, 2024

2.7.1 Urban Expansion

The key phenomenon of urban expansion serves as the initial driver in this framework, fundamentally altering land use and accelerating the transformation of natural landscapes into developed, often impermeable, surfaces. As cities grow, residential, commercial, and industrial development encroaches upon conserved lands and natural flood buffers, such as wetlands and vegetation-rich areas (Amoateng et al., 2018). This transformation disrupts hydrological cycles, reducing water infiltration and increasing surface runoff, which heightens flood susceptibility

(Dharmarathne et al., 2024a). Thus, urban expansion directly increases the frequency and intensity of flood events, a shift that profoundly impacts both physical and social environments.

2.7.2 Increased Flood Risks

The increased flood risks resulting from urban expansion are not merely a consequence of altered land use but also a crucial connection on the impacts of both socioeconomic factors and community perceptions. The degradation of natural flood buffers, combined with the encroachment into ecologically sensitive areas, leads to higher water volumes during rainfall, increasing the frequency and severity of flooding (Gupta et al., 2024). As flood risks intensify, they create a persistent threat to communities, influencing not only immediate responses but also longer-term perceptions and strategies for coping with the impacts (Dhar et al., 2023). This intensified flood susceptibility affects the day-to-day experiences and economic stability of residents who are affected by the increased likelihood of flooding and its associated costs.

2.7.3 Socioeconomic Effects

As urban areas face worsened flood risks, the socioeconomic effects become increasingly pronounced. Frequent and severe floods lead to significant financial burdens, including the costs of infrastructure repair, income loss, and disruptions in local economic activity, particularly affecting lower-income households with limited resources (Chettri et al., 2024). The impact on health is equally severe, with flooding contributing to the spread of waterborne diseases, heightened physical injury risks, and psychological stress. Moreover, recurrent flooding drives down property values in high-risk areas, affecting wealth accumulation and investment opportunities for residents (Sharma, 2023). These socioeconomic consequences are interconnected with the increased flood risks caused by urban expansion, creating a cycle where the financial, health, and property-related impacts of flooding further exacerbate community vulnerability.

2.7.4 Perceptions

The socioeconomic effects of flooding shape residents' perceptions, establishing a pivotal link between increased flood risks and coping strategies. Residents' experiences with flooding and the economic and health consequences they face influence their understanding of flood risks and potential mitigation measures. These perceptions are, therefore, both a response to the tangible impacts of flooding and a driver of community action (Sawaneh et al., 2024). When individuals and communities recognize the persistent threat posed by floods and the associated socioeconomic consequences, their attitudes toward risk reduction, preparedness, and adaptation change (Sawaneh et al., 2024). Perceptions become a medium through which communities and residents interpret the risks posed by urban expansion, shaping how they view their vulnerability and resilience to flooding (Coletta et al., 2024). Therefore, these shifts in perception directly inform the types of coping strategies to adopt.

2.7.5.1 Coping Strategies

Coping strategies represent the conclusion of the framework, as they represent the response to the compounded effects of urban expansion, flood risks, socioeconomic impacts, and perceptions. Influenced by the experiences and attitudes of residents toward flood risks, coping strategies are implemented through structural, non-structural, and indigenous measures.

2.7.5.2 Structural Measures

According to Pérez-Morales et al., (2022), structural measures of coping with flooding are the physical or engineered interventions designed to manage water flow, reduce flood impact, and protect communities and infrastructure. These measures come in the forms of constructing flood defenses, permeable pavements, and rain gardens, aiming to manage water flow and reduce the

immediate impact of flooding (Ringo et al., 2024). The framework, therefore, allowed for the examination of these measures as residents of Dome attempt to cope with the situation of flooding.

2.7.5.3 Non-Structural Measures

Non-structural strategies for coping with flooding have to do with those strategies aimed at coping with flooding without relying on physical infrastructure. They include early warning systems, community-based initiatives, and policy interventions, emphasizing preparedness and community resilience (FathiAzar et al., 2024). These approaches help residents anticipate and respond to floods, creating a more adaptive and informed community.

2.7.5.4 Indigenous Coping Mechanisms

Indicating traditional knowledge and practices, indigenous measures such as temporary relocation, building flood barriers, and elevating walls are accessible, low-cost strategies that enhance resilience without relying heavily on external resources. These methods leverage local understanding of flood patterns and community-driven solutions to adapt to flood risks. These coping strategies illustrate the adaptive capacity of communities, shaped by the combined influence of socioeconomic impacts, perceptions, and flood risk severity due to urban expansion. As communities tackle the ongoing pressures of urban expansion and flood vulnerability, their responses reflect both immediate needs and long-term resilience goals.

2.7.6 Conclusion

The conceptual framework presented a sequential yet interconnected relationship between urban expansion, increased flood risks, socioeconomic impacts, perceptions, and coping strategies. Each component is closely interconnected, where urban expansion increases flood risks, which in turn impact socioeconomic conditions and shape residents' perceptions of flood hazards. These perceptions influence the coping strategies that are adopted, highlighting a feedback loop that

reinforces both vulnerability and resilience within urban settings. By examining these links, the framework underscores the importance of integrated flood management strategies that consider not only the environmental but also the social dimensions of flood risk, ultimately guiding sustainable urban planning that prioritizes community well-being and resilience.



CHAPTER THREE

METHODOLOGY AND STUDY AREA

3.1 Introduction

The methodology employed in the study is explained in this chapter. It covers a comprehensive outline of the primary approaches, including the specified data requirements, data collection methods, and data analysis and presentation. It also delves into the broader geographical characteristics of the study area. Predominantly, GEM's demographic characteristics, physical patterns, economic activities, settlement features, and household characteristics are highlighted in this chapter.

3.2 The Study Area

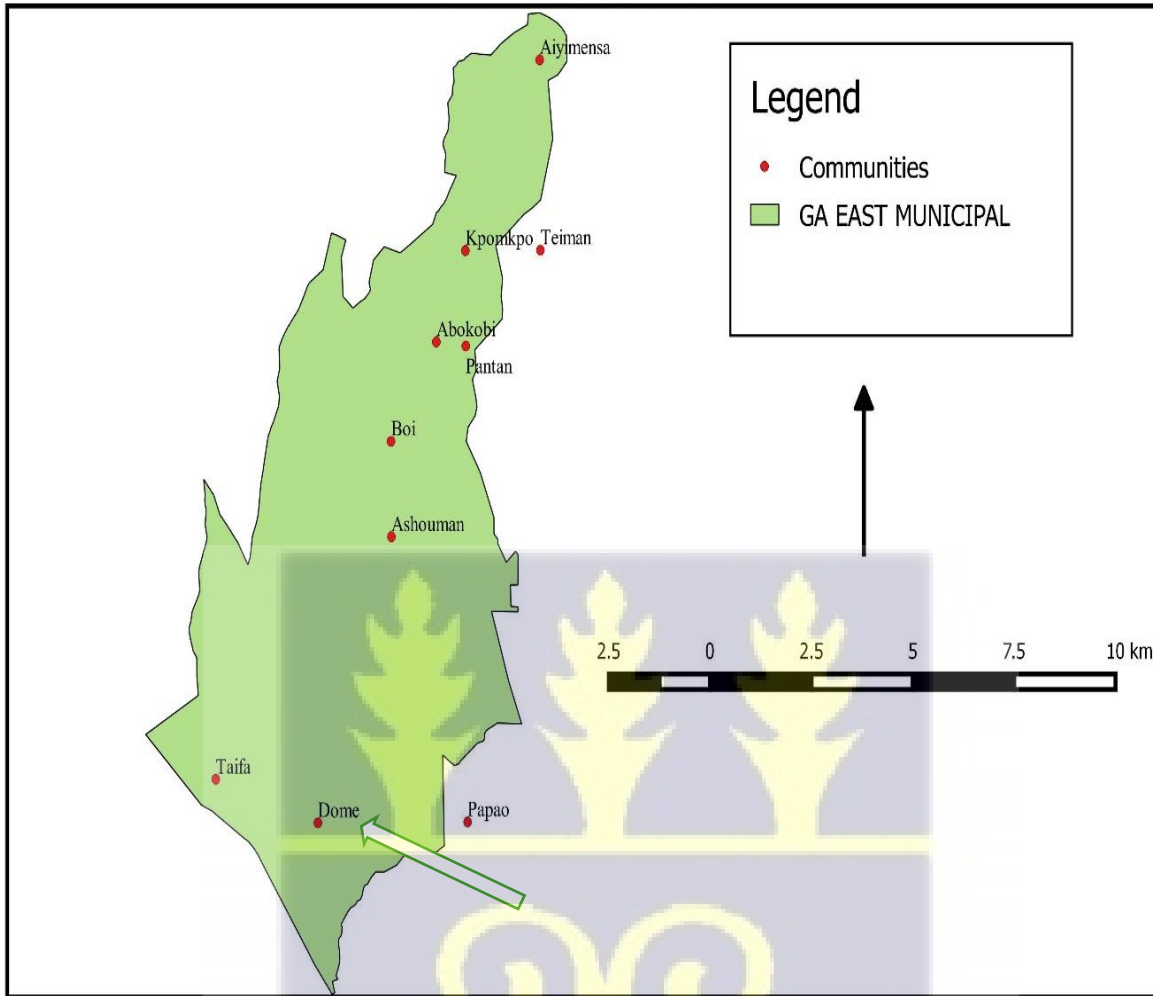
3.2.1 Background

The Ga East Municipality was originally part of the larger Ga District until 2004, when the eastern part was split off by an act of parliament to create the Ga East District. The remaining part was then elevated to municipal assembly status on February 29, 2008, and renamed Ga East Municipal Assembly (GSS, 2021). It has Abokobi, a suburb in the assembly, as the administrative capital (GEMA, 2021).

3.2.2 Location and Size

The municipality is located in the northern part of the Greater Accra Region and spans approximately 85.7 square kilometers. It shares borders with Ga West Municipal to the west, La-Nkwantanang-Madina Municipal to the east, Accra Metropolitan to the south, and Akwapim South District to the north. The municipality is divided into two administrative areas: the Abokobi Zonal Council and the Dome Zonal Council (GEMA, 2021).

Figure 3.1 Map of Ga East Municipality with a specific focus on Dome



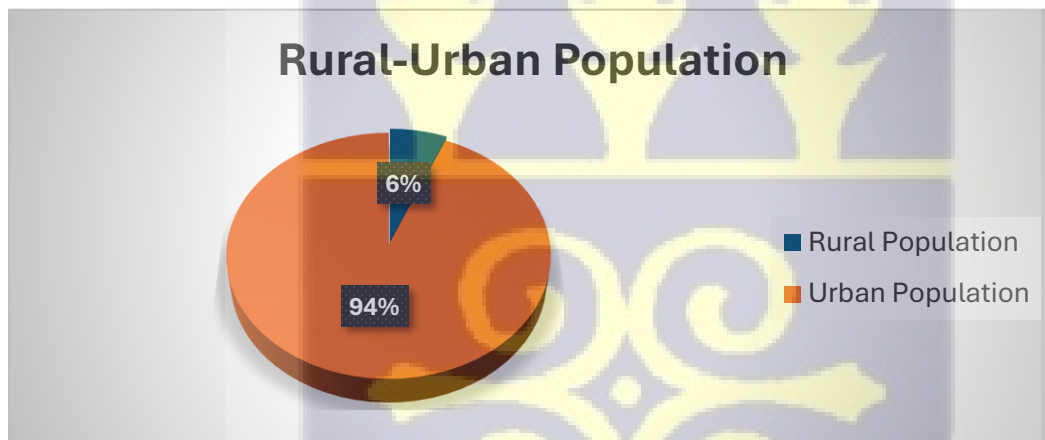
Source: GEMA, 2021

3.2.3 Population Size and Distribution

The Ga East Municipal has a population of 283,150 with females constituting about 50.6% and males 49.4%, with an intercensal growth rate of about 0.0611% per annum (GSS, 2021). This population figure yields a density of 4,223 per square kilometer, a growth of about three hundred per cent from the 2010 PHC figure of 1,214 (GSS, 2021). This is a succinct indication of a high increase in land occupancy.

The population is concentrated mainly along the urban and peri-urban areas of the Municipality thus Dome, Taifa, Kwabenya and Haatso among others. The Dome Zonal Council, the selected area for this study, is the most populous with 76,550 inhabitants (GEMA, 2021). With 94% of its total population residing in urban areas, GEMA is predominantly urban, with only a small 6% residing in rural areas toward the Akwapim Hills (GEMA, 2021). This demographic composition underscores the municipality's urban character and the associated challenges it faces. “The associated challenges of an urbanized municipality are the pressure on socio-economic infrastructure. These include housing, roads, water and sanitation, land etc that the Assembly has to manage” (GEMA, 2021).

Figure 3.2 Rural-Urban Population of Ga East Municipal



Source: GEMA, 2021

3.2.4 Land Tenure System

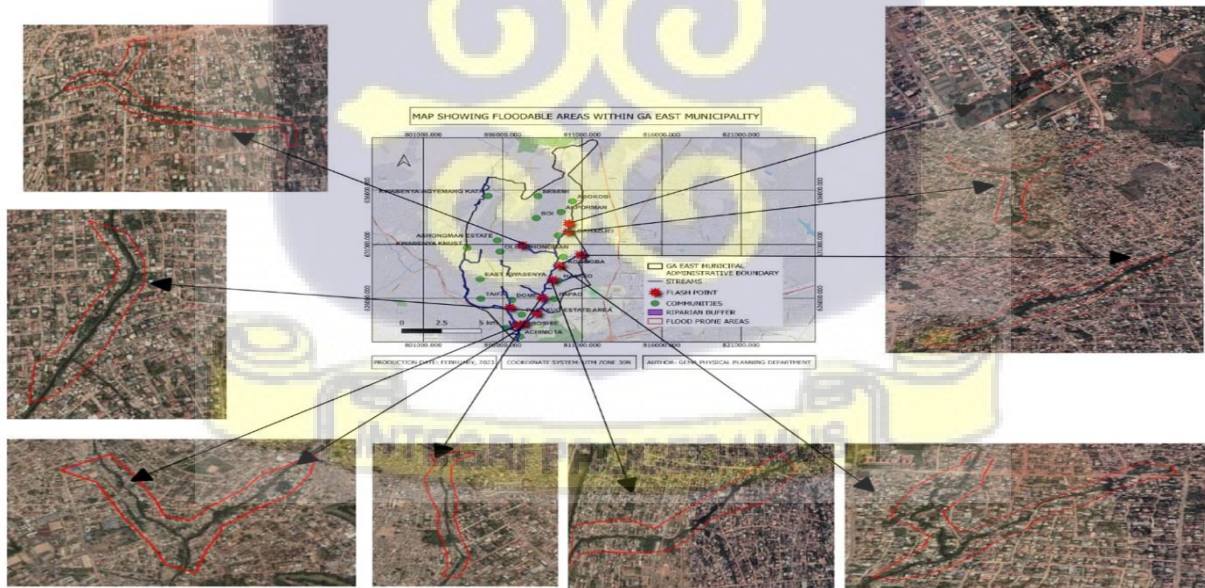
In the Municipality, land is typically owned by chiefs, clan or family heads who hold it in trust for their subjects. However, land can also be obtained through various means such as direct purchase, rental, leasehold, and sharecropping (GEMA, 2021). The ability to inherit land from parents or grandparents has led to frequent buying and selling of land, resulting in numerous land disputes

and conflicts over chieftaincy. This situation has also accelerated the loss of farmland, leading to increased unemployment. Additionally, GEMA is facing challenges with the conversion of agricultural lands into real estate developments as a result of the increased urban population (GEMA, 2021).

3.2.5 Climate Change Disaster Management

Over time, the Greater Accra Metropolitan Area (GAMA), including the Ga East Municipal Area (GEMA), has witnessed significant climate-related changes, with rising temperatures, erratic weather patterns, and escalating sea levels. These transformations have profoundly impacted the region's inhabitants and economies. In GEMA, the effects of climate change are evident in shifting rainfall patterns and temperatures, exacerbating the occurrence of recurrent flooding and other related disasters. Specifically, communities such as Pantang, Akporman, Dome, Abokobi, Ablorh Adjei, Taifa, and Boi face significant flooding challenges, often triggered by even minimal rainfall events (GEMA, 2021).

Figure 3.3 A map showing floodable areas within GEMA



Source: GARID, 2023

3.2.6 Employment Distribution

The informal private sector, which includes wholesale and retail as well as vehicle and motorcycle repair, employs the majority of the labor force at 60% according to the 2020 Census. This sector is highly unstable and often lacks protection from the government, leading to uncertain job security for its workers. On the other hand, the public sector offers limited job opportunities (GEMA, 2021).

3.2.7 Education

GEMA has a wide range of educational institutions, with a total of 405 schools spread across the area. These schools cater for students across various levels, including Kindergarten (KG), Primary, Junior High School (JHS), and Senior High School (SHS). The educational landscape in the municipality is diverse and extensive, providing a wide range of learning opportunities for the local population.

3.2.8 Health

In the Municipality, there are a total of 24 health institutions providing health services. These facilities are primarily located in the Dome, Taifa, Atomic, and Haatso areas, with fewer establishments in the Ashongman, Abokobi, and Boi Sesemi areas (GEMA, 2021). This concentration results in an uneven distribution of health services across the Municipality.

Out of the 24 health institutions, only 5 are publicly or state-owned, while the remaining 19 are privately owned. This indicates a significant dominance of private healthcare providers in the area (GEMA, 2021). The presence of a higher number of private health institutions compared to public ones can have various implications on accessibility, affordability, and quality of healthcare services for the residents.

3.3 Research Design

The primary approaches employed in social science research include the qualitative, quantitative, and mixed-method approaches (Taherdoost, 2022). The qualitative approach, rooted in the interpretivism and constructivism paradigms, advocates for subjective interpretation over objective data, offering insights into behaviours, perceptions, and experiences (Sale et al (2002) as cited in Holtz & Odağ, 2020). Nonetheless, it is criticized for its subjectivity and limited generalizability (Roald et al., 2021). Conversely, the quantitative approach aligns with the positivist paradigm, which views science as objective and aims to enlighten non-specific behavioural patterns (Topping, 2010) as cited by Quick & S Hall, 2015). It is key in analyzing quantifiable data as well as facilitating generalization and predictions. However, it may lack depth in capturing individuals' perceptions, emotions, beliefs, and experiences (O'Donovan et al., 2021). The mixed methods approach combines both quantitative and qualitative methods within a single study. This approach aims to offer a more thorough understanding of the research question (Dawadi et al., 2021).

The choice of a research approach depends on the specific characteristics of the research problem and the goals that the research aims to achieve (Taherdoost, 2022). By recognizing the complementary nature of quantitative and qualitative methodologies (UNDP, 2021), this study employed a mixed methodological approach to comprehensively examine the effects of urban expansion on flood susceptibility in GEM. According to Timans et al., 2019, mixed methods allow researchers to explore research questions from multiple perspectives, leading to a deeper understanding of the subject matter and potentially uncovering more comprehensive insights. The quantitative data was collected before the qualitative data collection to provide context and guide further exploration of issues and themes that require further probing at the institutional level.

3.4. Data Sources

The study employed both primary and secondary data to achieve its objectives. Primary data was obtained by conducting household surveys using questionnaires and conducting in-depth interviews with key institutional leaders in GEMA. Specifically, data was obtained within the Dome Zonal Area, particularly Dome. This was due to the large population, as well as the prevalence of flood situations in the area. Secondary data, on the other hand, was obtained from various sources such as the assembly inventory, books, journal articles, internet resources, and published reports.

3.4.1 Primary Data

Primary data refers to data gathered firsthand from its original source for a specific research or analysis purpose (Taherdoost, 2022). Primary data collection methods such as household questionnaire surveys and key informant interviews are utilized to gather data directly from the target population in this study. These methods involve interacting with individuals within their households to obtain responses to specific questions and conducting detailed interviews to delve deeper into their perspectives and experiences.

3.4.1.1 Household Survey

The research focused on examining the effects of urban expansion on flood vulnerability within the Ga East Municipal through a household survey. Roopa & Rani (2012) stated that surveys consist of a series of interrogative inquiries intentionally designed by a researcher to be answered by participants in a study. This approach was chosen as it allows for the gathering of data that reflects household demographics, the socioeconomic effects of urban expansion-induced flooding on residents and the coping strategies adopted to mitigate its effects. Quantitative data was, therefore, gathered using closed-ended questions designed specifically for this purpose. The survey

questionnaire (as shown in Appendix A) aimed to capture information regarding respondents' backgrounds, perceptions of residents on the effects of urban expansion on flood risks, the socio-economic effects of flooding on residents, as well as the coping strategies employed by residents to mitigate the effects of floods in GEM.

To ensure the effectiveness of the questionnaire, a pretest was conducted in Madina, the capital of La-Nkwantanang-Madina Municipal Assembly, due to its similarities with Dome, particularly regarding the occurrences of perennial floods. This pretest phase identified errors in the questionnaire and also aided in the refinement of language to facilitate translation into the local dialect. Data collection was therefore conducted by the researcher using Twi or English languages, based on the respondent's preference.

The data collection phase took about four weeks, during which an average of 30 questionnaires were administered each day on the weekend. This comprehensive approach enabled the researcher to make informed generalizations and draw meaningful inferences regarding the effects of urban expansion on flood susceptibility in Dome.

3.4.1.2 Key Informant Interviews

According to Lokot, (2021), a key informant interview is a qualitative research method involving in-depth interviews with individuals who have specialized knowledge or insights about the topic being studied. Employing this technique enables the researcher to gain detailed, expert perspectives that can provide a deeper understanding and context to the research findings. It captures the perspectives of research participants (Akhter Salma, 2022). Key informant interviews were therefore conducted with the heads of institutions involved in addressing urban development and flood susceptibility issues within the Dome Zonal area, as shown in Appendix B and C. These included the planning officer of the assembly, two officers of the National Disaster Management

Organization (NADMO) unit, a youth leader, a traditional leader, a Non-Governmental Organization (NGO) representative, an assembly member and two longstanding residents of GEMA. These institutions and individuals, whether partially or wholly, contribute to efforts aimed at mitigating flood risks and managing urban expansion. Through these interviews, valued insights were gathered regarding the municipality's capacity to manage flood susceptibility and urban expansion, as well as the diverse strategies implemented.

This methodology is considered instrumental in extracting pertinent information essential to the study's objectives, particularly in understanding the scope of flood vulnerability and urban development within the study area. By engaging with key informants, the research will gain wide-ranging insights into the various approaches and resources available for addressing flood risks and managing urban growth, thus enriching the study's analysis and findings.

3.4.2 Secondary Data

Secondary data refers to data that has already been collected, processed, and published by others for purposes other than the current research project (Johnston, 2017). This type of data allows researchers to leverage existing data to analyze trends, compare historical information, and validate findings with a broader context (Johnson et al., 2019). The study employed secondary data from different sources encompassing reports and development plans from the municipal assembly. Additionally, a wide range of supplementary sources such as books, journal articles, publications, internet websites, and working papers were consulted to gather information on the link between urban expansion and flood risks in GEM, particularly, Dome. These diverse resources were leveraged to enhance the depth and breadth of understanding regarding the subject of study.

3.5 Sample Size and Sampling Technique

3.5.1 Sample Size Determination

Sample size determination involves selecting an appropriate number of observations or individuals from a larger population to include in a sample (Singh & Masuku, 2014). This process is crucial for ensuring that the sample accurately represents the population and provides reliable results for statistical analysis (Bujang & Baharum, 2017). The Ga East Municipality recorded a total of 90,835 households in the 2021 Population and Housing Census (GSS, 2021). The sample frame for the study was therefore 90,835.

Using Yamane (1967) formula:

$$n = \frac{N}{1+N(e^2)}$$

Where:

n = Sample size

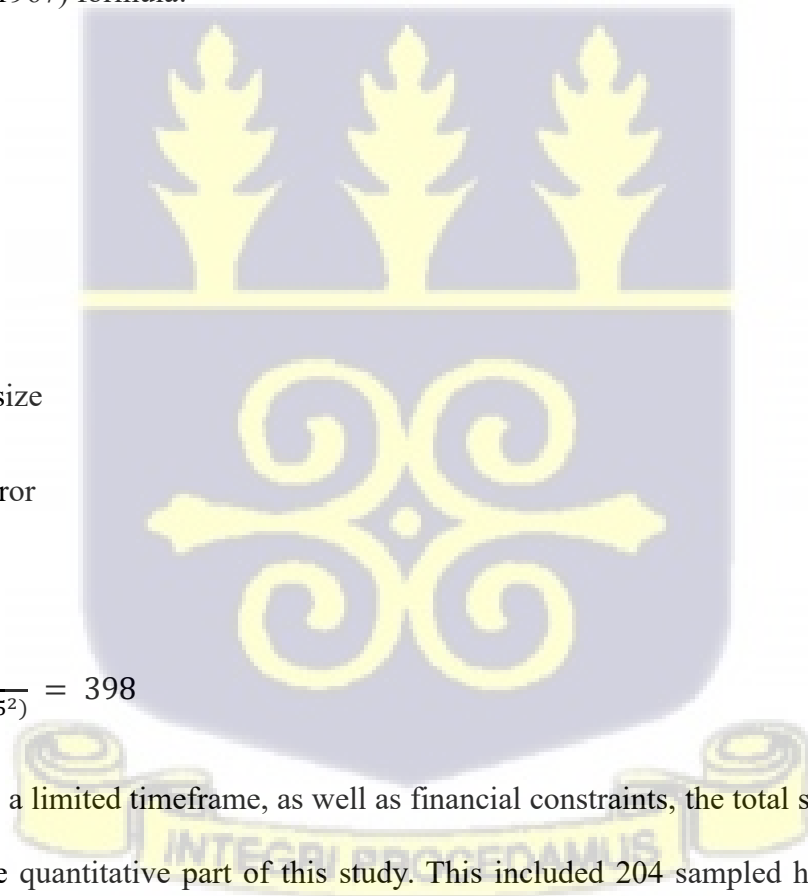
N = Population size

e = Margin of error

Therefore,

$$n = \frac{90835}{1 + 90835(0.05^2)} = 398$$

However, due to a limited timeframe, as well as financial constraints, the total sample size of 215 was used for the quantitative part of this study. This included 204 sampled households and an additional 5% to capture the possibility of non-responses.



3.5.2 Sample Selection Procedure

A simple random sampling was adopted to select a total of 215 households in Dome for this study. Simple random sampling is a fundamental sampling technique where each member of a population has an equal chance of being selected (Acharya et al., 2013). This method is often used to ensure that the sample is representative of the population, thereby minimizing bias and allowing for the generalization of results. This type of probability sampling technique is considered efficient as it avoids biases (Boakye, 2015). The primary unit of data collection for this study was the household head, selected to provide insights into the context of the study. This approach aligns with previous research conducted by Dinar et al. (2008), which observed that household heads are more inclined to implement adaptive measures due to their authority over household resources and decision-making processes.

The qualitative component, on the other hand included heads of various institutions pertaining to urban development. These included a respondent from the development planning office of GEMA due to their pivotal role in formulating the development plan for the municipality, the Dome Council of Elders was also involved as they serve as a body of traditional and local leadership, offering insights into local governance structures and decision-making processes related to flood management and urban development. Additionally, the Municipal National Disaster Management Organization (NADMO) was included as they are responsible for disaster management, including climate-related events, providing clear perspectives on the effects and coping strategies. Community leaders, including an Assembly Member and a Political Leader in the Dome Zonal Council, were also included to offer diverse viewpoints on the subject of the study. Finally, a representative from the Assembly's Community Development Office was also included, as well as a long-standing resident of Dome. This amounted to a total of eight (8) in-depth interviews,

enhancing the comprehensiveness of the study's findings regarding urban expansion and flood susceptibility in the Ga East Municipal.

3.6 Data Analysis

3.6.1 Quantitative Data Analysis

The quantitative data in the study was analyzed using STATA version 17. This software is commonly used for statistical analysis in various fields, including social sciences, health sciences, and business (Pant et al., 2023). It allows researchers to perform a wide range of statistical analyses, from simple descriptive statistics to complex multivariate analysis (Xue et al., 2022).

3.6.1.1 Frequency Tables and Cross Tabulation

Healey (2014) elaborates that frequency tables are essential tools in descriptive statistics, summarizing raw data into a more understandable form by counting the number of observations that fall into each of several categories. Frequency tables were therefore used to summarize the distribution of values for each variable in the dataset. This also involved calculating measures such as means, standard deviations, and percentages to describe the characteristics of the data

Cross tabulation, also known as contingency table analysis, was also employed to examine the relationship between two or more categorical variables. This technique helps researchers understand how the variables are related and whether there is a significant association between them (Dhir & Shukla, 2018).

3.6.1.2 Chi-Square Test

The chi-square test was employed to test relationships between variables in the dataset. It is a statistical test that evaluates whether there is a significant association between two categorical

variables (Turhan, 2020). The test compares the observed frequencies in the data with the frequencies that would be expected if there was no relationship between the variables.

3.6.2 Qualitative Data Analysis

Recorded interviews were transcribed and categorized into various themes. These themes were then subjected to thematic analysis, a method used to identify patterns and trends within qualitative data. Thematic analysis helps researchers interpret the meaning of textual data by systematically analyzing it for recurring themes or ideas (Castleberry & Nolen, 2018).

In summary, the research methodology involved both quantitative analyses using STATA for statistical tests like chi-square tests and qualitative analysis through thematic analysis of transcribed data as shown in Table 3.1 below.

Table 3.1: Research Objectives, Data Collection Methods, and Analysis Techniques

Objective	Data Type	Approach	Data Collection Method	Data Collection Unit	Analytical Technique
1	Primary Data	Qualitative And Quantitative	Semi-structured questionnaire and in-depth interview	Household heads and GEMA officials and Community leaders	Descriptive and Thematic analyses
2	Primary Data Secondary Data	Quantitative Qualitative and Quantitative	Semi-structured questionnaire and in-depth interview	Household heads and GEMA officials and Community leaders	Descriptive and Inferential and Thematic analyses
3	Primary Data		Semi-structured questionnaire and in-depth interview	Household heads and GEMA officials and Community leaders	Descriptive and Thematic analyses

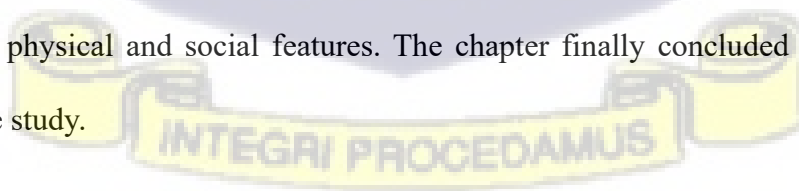
Source: Author's construct

3.7 Limitations of the Study

This study faced a number of limitations. First, while a sample of 215 participants for the quantitative survey and 8 for the qualitative interviews provided valuable insight, it may not fully capture the diversity of experiences and experiences across all residents within GEM. This small sample size may affect the generalizability of the findings, potentially limiting the statistical power and robustness of the findings. In addition, data on the socioeconomic effects and coping mechanisms largely relied on self-reported information, which could potentially produce bias, given its subjective nature. Finally, time and logistical constraints posed a challenge, limiting the ability of the researcher to conduct follow-up surveys and interviews during different stages of the flood season. This could potentially overlook seasonal variations in socioeconomic impacts and coping strategies. Future studies could, therefore consider a relatively larger and more diverse sample and longitudinal data to heighten the understanding of these interactions.

3.8 Conclusion

The chapter discussed above highlighted the research methodology adopted for this study. It explored the research design and where and how the data was collected and analyzed. It also highlighted the overview of the study area under several themes, including its demographic information, the physical and social features. The chapter finally concluded by discussing the limitations of the study.



CHAPTER FOUR

ANALYSIS AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the results of field data in relation to residents' perceptions of the effects of urban expansion on flood risks, the socio-economic impacts of urban expansion-induced flooding, and the coping strategies employed by residents in Dome. The first section provides an overview of respondents' background characteristics, including factors such as sex, age, level of education, occupation, and income. This is followed by a presentation of respondents' perceptions of how urban expansion influences flood susceptibility, examining how these views differ by demographic factors such as age and education. The chapter also explores the socio-economic effects of urban expansion-induced flooding on residents, delving into the immediate and long-term effects on their livelihoods and well-being. Residents' coping strategies to mitigate the effects of floods are also discussed, along with an assessment of the determinants that influence their adaptive capacities in the face of recurring flood risks in Dome. Further discussions are presented based on the themes generated from the qualitative analysis to provide a comprehensive understanding of the quantitative outcomes.

4.2 Demographic Information of Respondents in the Study Area

Out of the total sample of 215, Table 4.1 shows that 110 respondents (51.2%) were female, while 105 respondents (48.8%) were male. This near-equal distribution between males and females ensures a balanced gender representation, which is crucial for capturing the perspectives of both sexes in the study. It also minimizes gender bias in the findings (Kärkkäinen & Joo, 2021). The age distribution of respondents varied across six major categories. Respondents aged between 15

and 25 years accounted for 20.47% (44 respondents) of the total, while those in the 26 to 35 years age group constituted the largest proportion, at 32.09% (69 respondents). Respondents aged 36 to 45 years made up 25.58% (55 respondents), followed by those aged 46 to 55 years at 14.88% (32 respondents). The age groups 56 to 65 years and above 65 years represented 4.65% (10 respondents) and 2.33% (5 respondents), respectively (See Table 4.1). The relatively higher frequency of respondents in the 26 to 35 years and 36 to 45 years categories suggests that the study sample is predominantly made up of economically active individuals. These age groups have a direct stake in the socio-economic development of an area (Fakih et al., 2020) and may be more sensitive to the impacts of urban expansion on flood susceptibility.

Table 4.1 Summary Statistics of the Demographic Characteristics of Survey Respondents

Demographic Variable	Frequency	Percentage (%)
<u>Gender</u>		
Male	105	48.8
Female	110	51.2
<u>Age Categories</u>		
15 - 25	44	20.47
26 - 35	69	32.09
36 - 45	55	25.58
46 - 55	32	14.88
56 - 65	10	4.65
Above 65	5	2.33
<u>Level of Education</u>		
Elementary/Primary Education	53	24.7
No formal Education	42	19.5
SHS/SSS/O-Level/A-Level/Technical/Vocational	78	36.3
Tertiary Education	42	19.5
<u>Employment Status</u>		
Employed	175	81.4
Unemployed	40	18.6
<u>Type of employment</u>		
Sales and Trading (Retail and Informal Commerce)	80	45.8
Education and Training	16	9.1

Artisans and Skilled Labor	21	12
Services (Hospitality, Cleaning, and Security)	14	8
Business and Entrepreneurship	16	9.1
Technical and Engineering	12	6.9
Others (Agriculture, Laborers)	16	9.1
<u>Monthly Income Level (GHC)</u>		
1000 – 1499	40	18.6
1500 1999	22	10.2
2000 - 2499	7	3.3
2500 and above	20	9.3
500 - 999	62	28.8
Less than 500	58	27.0
None	6	2.8
<u>Residential Status</u>		
Tenant	126	57.8
Owner	81	37.16
Squatter	5	2.29
Caretaker	2	0.92
<u>Source of drinking water</u>		
Sachet/bottled water	140	65.12
Piped water (outside dwelling)	32	14.88
Piped water (inside dwelling)	26	12.09
Others (rainwater, water vendors)	13	6.05
Borehole/well	4	1.86
<u>Mode of transportation</u>		
Public transportation (taxi, “trotro”, uber, etc.)	190	87.16
Personal vehicle (car, motorcycle)	13	5.96
Walking	11	5.05
<u>Household durable assets</u>		
Smartphones	191	87.61
TV	190	87.16
Refrigerator	154	70.64
Bicycle	23	10.55
Motorbike	19	8.72
Car	17	7.8

Source: Field Data, 2024

Table 4.1 also shows the employment status of respondents, revealing that the majority, 81.4% (175 respondents), were employed, while 18.6% (40 respondents) were unemployed. The high

employment rate among respondents indicates that most individuals are engaged in economic activities, which could influence their perceptions of urban expansion and its effects on flood susceptibility. The relatively small proportion of unemployed respondents provides insight into the socio-economic challenges some individuals face in the community. This division in employment status, according to Oskorouchi & Sousa-Poza, (2021) affects how different groups experience the impacts of flooding, particularly in terms of socioeconomic losses and coping mechanisms. Respondents' levels of education varied significantly. The majority, 36.3% (78 respondents), had completed secondary or vocational education (SHS/SSS/O-Level/A-Level/Technical/Vocational). This was followed by 24.7% (53 respondents) who had elementary or primary education and 19.5% (42 respondents) who had attained tertiary education. Another 19.5% (42 respondents) had no formal education at all. The data suggests that the study included a diverse group in terms of educational attainment, which is critical for understanding how education influences perceptions of flood risks and urban expansion.

The occupational distribution of the respondents shows a high concentration in Sales and Trading (*Retail and Informal Commerce*) (80), accounting for 45.8% of the respondents. This aligns with the general trend in many urban and peri-urban areas, where informal trade dominates due to the ease of entry and the lower capital requirement for setting up such businesses (Tschirley et al., 2020). The high percentage also reflects the significant role of the informal sector in providing employment opportunities for the population. Artisans and Skilled Labor (21), representing 12% of the respondents, included professionals like mechanics, plumbers, and electricians. This category highlights the presence of technical skills within the population, though there is still a small percentage compared to the sales and trading sector. The Services sector (14), at 8%, includes hospitality, cleaning, and security, reflecting the importance of personal services and the demand

for security in urban environments. This sector could grow as urbanization and population densities increase, leading to more opportunities in the hospitality and security industries (Sukanya & Tantia, 2023).

Education and Training (16) accounts for 9.1% of respondents, which shows the moderate presence of teaching professionals in the area. As urbanization progresses, education services are crucial, and the need for more teachers is likely to increase, reflecting a potential growth area in the labor market. Business and Entrepreneurship (16), representing 9.1%, reflects a notable portion of the population engaged in self-employment or entrepreneurial activities. Technical and Engineering professions (12) represent 6.9% of the respondents. With urban expansion, the demand for these technical skills will likely increase as construction and infrastructure projects become more prevalent. Finally, the other occupation (16) category, covering 9.1%, includes a diverse range of jobs, including drivers, nurses, civil service workers, and students.

In terms of monthly income, the data reveals a broad spectrum of earnings. A significant portion of respondents, 28.8%, earn between GHC 500 and GHC 999, making it the largest income bracket. Following this, 27.0% of respondents earn less than GHC 500, indicating a substantial proportion of the population living with very low income. At the higher end of the spectrum, 18.6% earn between GHC 1000 and GHC 1499, and 10.2% between GHC 1500 and GHC 1999. These groups reflect a moderate-income class within the population. Only 9.3% earn above GHC 2500, representing a small, higher-income segment of the community. Interestingly, 2.8% of respondents reported having no income at all, which could indicate financial dependency.

The distribution of residential status of respondents shows that more than half of the households (57.8%) resided in rented dwelling units. This aligns with the trend of more individuals moving into cities and towns but may not have the financial capacity to own homes. Households residing

in their own dwelling units (37.16%) constituted the second-highest proportion of the distribution. Very few households (2.29%) and (0.92%) lived as squatters and caretakers respectively in the places they occupied. This diverse mix of housing arrangements may influence residents' capacity to adapt to or mitigate flood risks, particularly for those without ownership security.

Sources of drinking water highlight that 65.12% rely on sachet or bottled water, with fewer households accessing piped water, especially inside dwellings (12.09%). This could signify limited access to resilient infrastructure, potentially exacerbating the effects of floods.

The modes of transportation are dominated by public transport usage (87.16%), with personal vehicle ownership being minimal (5.96%). This aligns with the low percentages of car and motorbike ownership. This dependency on public transport may become problematic during floods, as access to roads and transport services can be severely disrupted. Additionally, 5.05% of respondents walk as their primary mode of transportation, possibly due to proximity to their workplace or the nature of their work.

In terms of household durable assets, most respondents possessed essential items like smartphones (87.61%), televisions (87.16%), and refrigerators (70.64%), while fewer households owned items like personal vehicles (7.8%), motorbikes (8.72%), and bicycles (10.55%). The low ownership rate of these items suggests a reliance on alternative transport modes during emergencies, which could affect mobility during floods.

4.3 Background Characteristics of Respondents of Key Informant Interviews

Out of the eight purposively selected key informants used in this study, as shown in Table 4.3 below, males and females constituted 62.5% and 37.5%, respectively. The age distribution was mainly an adult population, with the majority within 30 to 40 years. Only one individual (12.5%)

was above 60yrs. All respondents had at least secondary education, with the majority (62.5%) being tertiary graduates.

Table 4.2: Distribution of Key Informants by Sex, Age, and Level of Education

Demographic Variable	Frequency	Percentage (%)
<u>Gender</u>		
Male	5	62.5
Female	3	37.5
<u>Age categories</u>		
30-40	3	37.5
51-50	2	25
51-60	2	25
Above 60	1	12.5
<u>Level of Education</u>		
Secondary	3	37.5
Tertiary	5	62.5
TOTAL	8	100

Source: Field Data, 2024

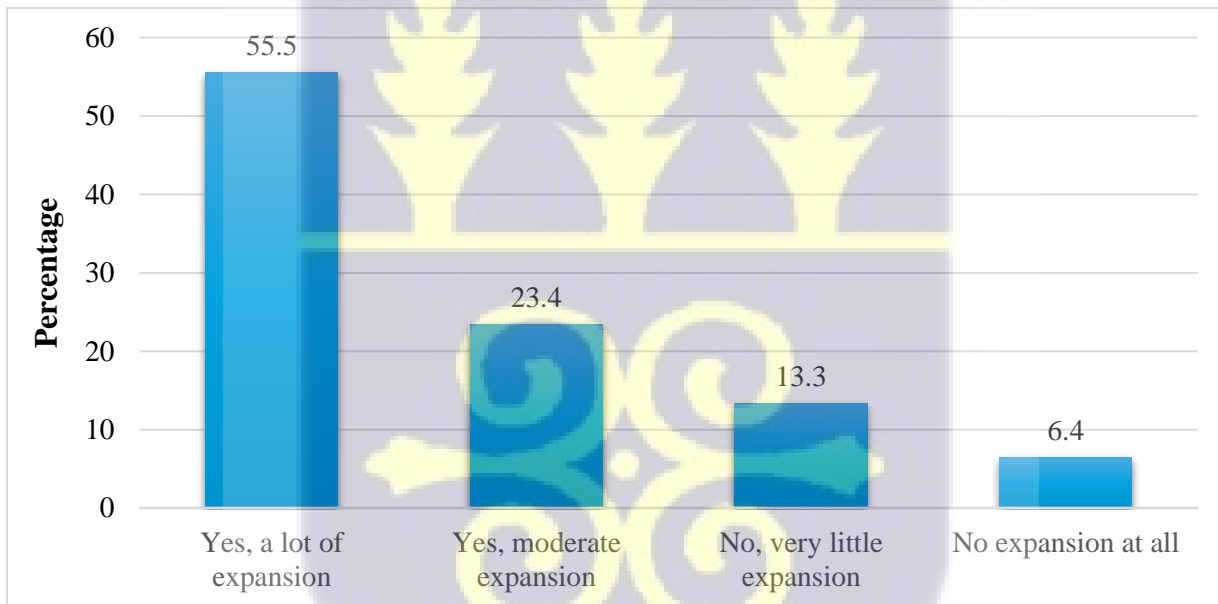
4.4 Perceptions of Urban Expansion and Flood Susceptibility

The perceptions of people on a given phenomenon provide a fundamental framework to mitigate its negative impacts effectively (Maddux et al., 2021). Grounded by this, one of the aims of this study was to examine the perceptions of residents regarding the effects of urban expansion on flood susceptibility.

A question on residents' perceptions of urban expansion over the past decade, expressed on a scale from "no expansion" to "significant expansion" (see Figure 4.1), showed that a larger proportion of respondents (55.5%) have noticed a significant urban expansion in Dome. About 23 % noticed a relatively moderate urban expansion over the last decade. A smaller percentage (13.3%) of respondents reported very little expansion, while an even smaller group (6.4%) indicated they had

seen no expansion at all. This high observation of urban expansion over the past years aligns with existing literature on the subject. Major metropolitan areas like Accra and Kumasi have experienced uncontrolled rapid urban expansion. For instance, Asare et al. (2023) indicate that the Greater Accra Metropolitan Area saw a 35% increase in physical expansion between 1985 and 2015. Similarly, findings from Zhong et al., (2024) discovered that significant increases in urban expansion patterns were observed between 1990 to 2018 in the Yanhe urban setting in China. Yu et al., (2019) also indicated that a given city in 2017 was thirty-five times larger than it was in 1979, indicating massive urban expansion.

Figure 4.1: Perceptions of Urban Expansion in Dome Over the Past Decade



Source: Field Data, 2024

The qualitative interviews further backed the findings of significant urban expansion in Dome. An assembly official who had served for over 10 years explained.

“Everyone wants a place to live. They want to come here because of work or employment, Urban expansion has brought so many challenges in the urban area because, as we all know, each and every person wants to come to the urban area to experience life and all good things. This is exactly the situation we face in our municipality” (Community development official, GEMA, 2024).

This also aligns with a study by Akubia & Bruns, (2019) who described urban expansion to be exceptionally high and intense in Accra Metropolitan Assembly, which has similar features to GEM.

4.4.1 Types of Urban Expansion Observed in Dome

Residential development was identified as the most prevalent form of urban expansion in Dome, as shown in Figure 4.2, with 75.7 % of respondents highlighting its occurrence. This substantial growth in housing reflects the increasing demand for living spaces as urban populations rise. According to Ibrahim et al., (2023), the proliferation of residential areas often leads to the conversion of natural land surfaces into impervious materials, such as concrete, which can hinder water absorption and contribute to heightened flood risks. This expansion is, therefore a key factor in the area’s susceptibility to flooding, as increased housing developments place additional pressure on land use and existing drainage systems.

This was further explained by an old resident of GEM.

“People are building everywhere without considering what will happen in the future when it rains. They are just building, and the town planners are not helping us at all. They see that the place is not suitable for building, but they still give permits to build. This is not helping us” (Longstanding resident, GEMA, 2024).

Similarly, the respondent from the planning office also expressed concerns on how the increased residential development has affected the area.

“People are building very close, we have streams flowing, people are building very close. We engage in demolition, send notices, and all that, but some people do not actually bother. They continue to engage in whatever they are doing” (Planning office respondent, GEMA, 2024).

The second most significant form of urban expansion was commercial development, identified by 58.7 % of the respondents. This depicts the rise in commercial activities, including shops, markets, and office spaces, which contributes to the effects of urban expansion in Dome. According to Son et al., (2023), while commercial development enhances local economies, it also poses environmental challenges. Like residential growth, commercial spaces often require extensive land alteration, which can disrupt natural water flow patterns and increase surface runoff, further amplifying the risk of floods in urbanized areas (Ibrahim et al., 2023).

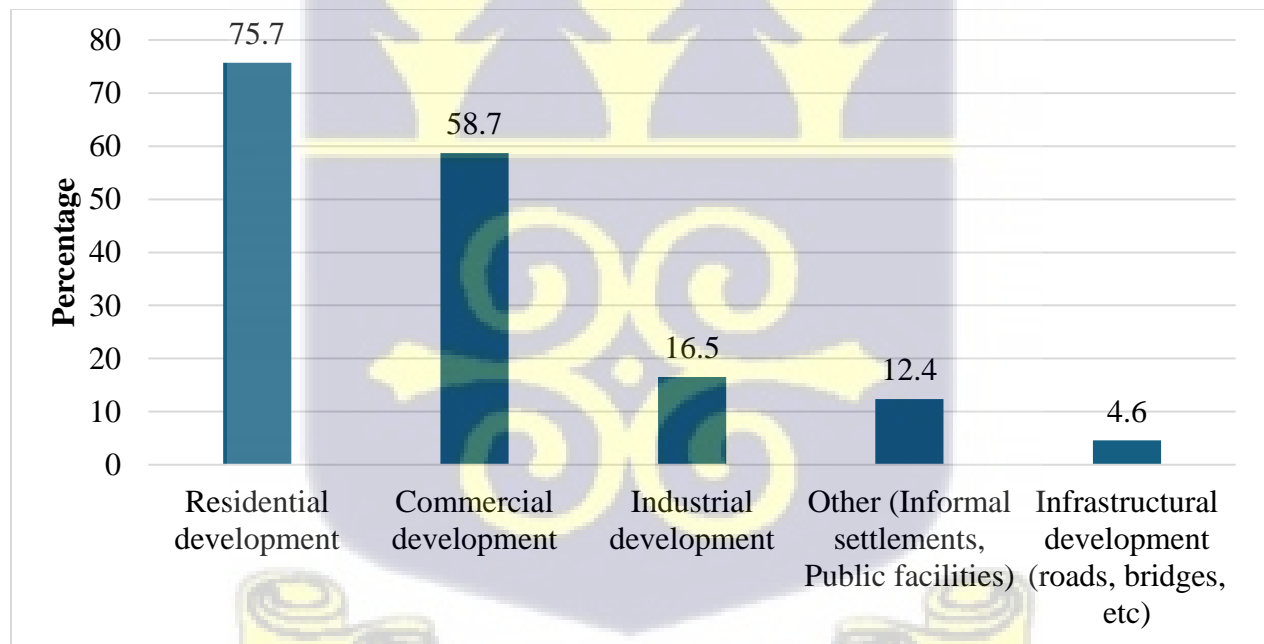
Industrial development in Dome was less common, with only 16.5% of respondents noting its presence. Although the contribution of industrial activities to urban expansion is modest compared to residential and commercial sectors, its impact can still be significant. Industrial sites often involve large-scale land use changes and may contribute to environmental degradation. These areas, if not properly managed, can contribute to increased water runoff and pollution, compounding flood-related issues in nearby residential and commercial zones.

Infrastructural development, including roads, bridges, and other public works, was the least frequent type of expansion, cited by just 4.6 % of respondents. While infrastructural projects are crucial for improving mobility and connectivity in urban areas, the low percentage suggests that Dome may be lagging in the development of essential flood mitigation structures, such as drainage

systems. This lack of critical infrastructure could exacerbate the effects of flooding, as existing roads and bridges may not be equipped to handle the increased water flow resulting from other forms of urban expansion.

Approximately 12% of respondents indicated other forms of urban expansion, including informal settlements, public facilities, or other infrastructure that contribute to land use changes. Though not as prevalent, these developments can still have localized impacts on flood risks, particularly in areas with inadequate planning or drainage systems. Nkonu & Antwi, (2024) stated that urban expansion often leads to the development of settlements which can have an immediate and long-term environmental impact, as revealed in this study.

Figure 4.2: Types of Urban Expansion Observed in Dome



Source: Field Data, 2024

4.4.2 Perceptions of the Effects of Urban Expansion on Flood Risks in Dome

The analysis of the respondents' perceptions of the effects of urban expansion on flood risks was scaled from no influence at all to significant influence (see Figure 4.4). Out of the 215 sample respondents, 88 % indicated that urban expansion had increased the vulnerability of Dome to flooding. This aligns with a study by Agyekum & Asibey, (2024) which emphasizes the conversion of conversed and agricultural land spaces to meet the demands of urban expansion, exacerbating flood risks. A respondent from the assembly's NADMO office emphasized this.

“My perception is that as the community is developing, areas earmarked for gutters, and such have been encroached upon. People have bought those lands and built on them. So, when it rains, the rainwater doesn't pass through the places it needs to pass. This has resulted in many flooding situations within this municipality” (NADMO official, GEMA, 2024).

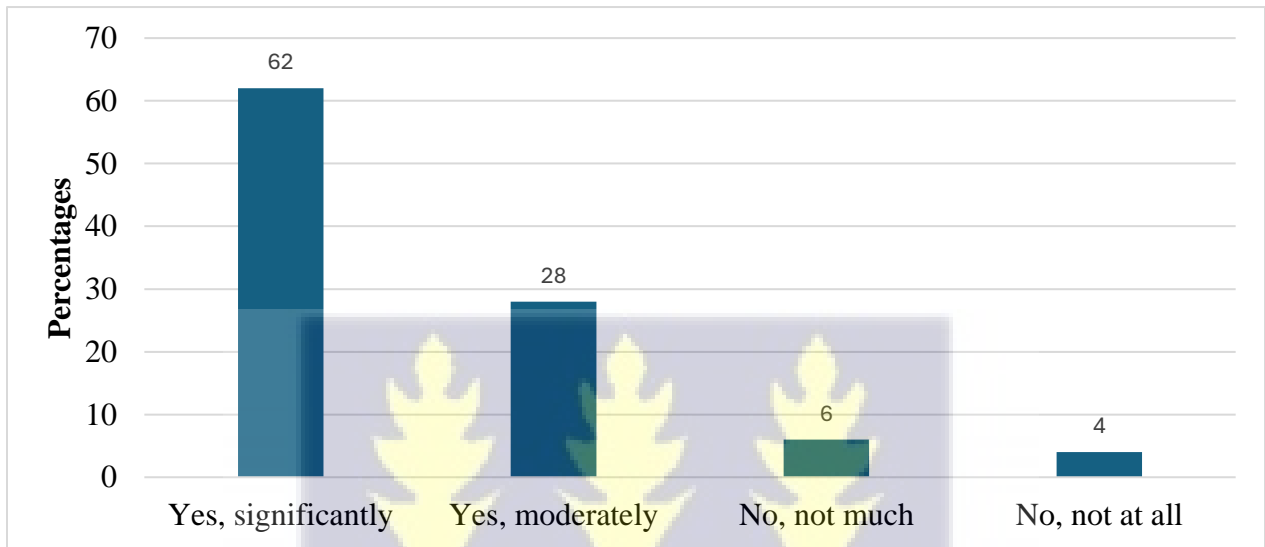
The disaggregation of this shows that 62 % of the respondents indicated a significant impact of urban expansion on flood susceptibility. The second largest proportion (28%) indicated a moderate increase. The planning office respondent stated that.

“We are aware that once the population is growing, issues of flooding will become a major concern because in our municipality specifically, people are actually building and encroaching on wetlands. In fact, these are not just wetlands; these are areas we have marked and indicated as restricted areas, wetlands, stay away. Yet, you see people encroaching on it. And that's as a result of urban expansion. Once they do, the water will still have to find its way, so it will overflow and affect other residents around” (Planning office respondent, GEMA, 2024).

A smaller portion of the respondents (6%) observed a minimal effect of urban expansion on flooding, while only 4% stated that urban expansion does not affect flood susceptibility in the area.

These findings suggest that the majority of residents are experiencing the effects of urban expansion, while a small fraction perceive little or no impact on flood vulnerability. This data underscores the significant effects of urban expansion on flood risks in Dome.

Figure 4.3: Perceptions of the Effects of Urban Expansion on Flood Risks in Dome



Source: Field Data, 2024

From the key informant interviews, broad themes, including urban expansion, flood risks, and community awareness, were identified, which were further broken down into more specific sub-themes. As shown in Table 4.3, under urban expansion, all respondents (100%, n=8) identified rapid development as a critical concern, while 87.5% (n=7) specifically noted encroachment on waterways as problematic. In terms of flood risks, there was unanimous agreement (100%, n=8) about increased flood incidence, and 75% (n=6) of respondents highlighted drainage problems as a significant issue. These findings align with Abebe et al., (2019), who emphasized that the growth of urban communities alters green spaces, which in turn increases the frequency and severity of flooding. Additionally, Idowu & Zhou, (2023) also note that edge expansion and leapfrogging

patterns which are different urban expansion patterns have a strong correlation with increased flood hazards.

Community awareness emerged as the third major theme, with 62.5% (n=5) of respondents indicating a lack of information as a key concern, demonstrating the need for more comprehensive approaches to both urban planning and community education regarding flood.

Table 4.3: Results of Thematic Analysis on Perceptions of Urban Expansion and Flood Risks

THEMATIC AREA	SUB-THEME	FREQUENCY	PERCENTAGES (%)
Urban Expansion	Rapid Development	8	100
	Encroachment on waterways	7	87.5
Flood Risks	Increased Flood Incidence	8	100
	Drainage Problems	6	75
Community Awareness	Lack of information	5	62.5

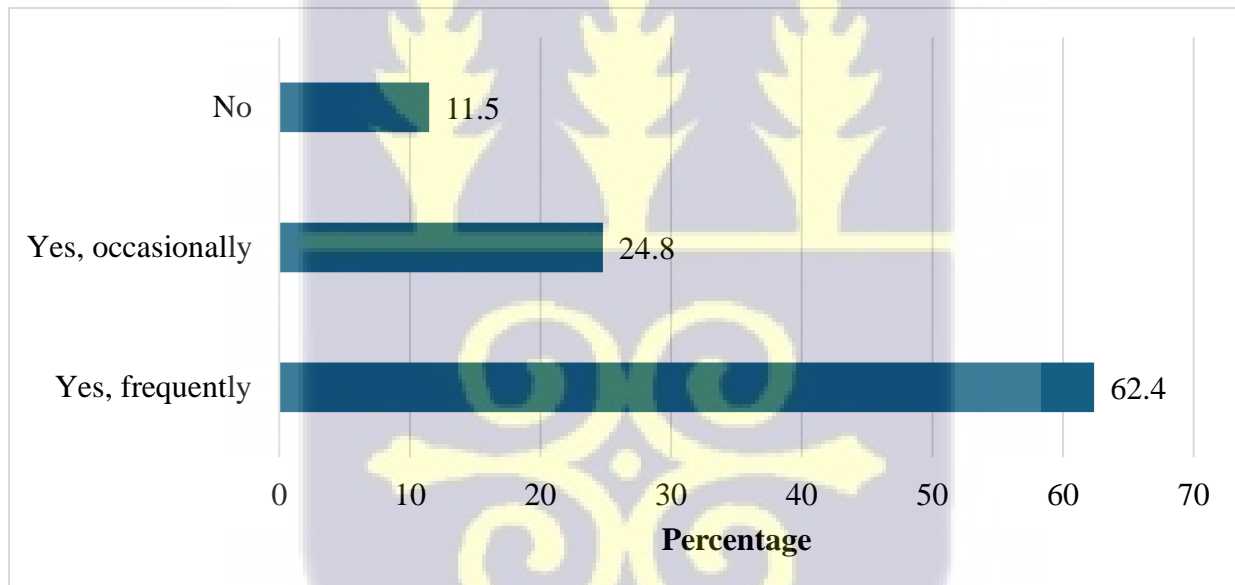
Source: Field Data, 2024

4.4.3 Flood Experiences by Residents of Dome

The situation of rapid urban expansion poses a significant challenge in urban communities, particularly in terms of flood risks (Maheu, 2012). To assess the frequency of flood experiences over the past five years, residents were asked about their flood experiences over the past five years, using a three-point Likert scale with options ranging from "Yes, frequently" to "No". Out of the 215 respondents, the results showed (see figure 4.4) that 62.4 % of the sample respondents stated that they experienced floods frequently over the period, while 24.8 % reported experiencing floods occasionally, representing a combined 87.2 % of residents who experienced flooding during this

timeframe. This high percentage shows how the phenomenon has persisted in recent years and that the area is highly susceptible to floods. The fact that nearly a quarter of the population faces occasional flooding emphasizes that the issue is widespread, affecting a broad cross-section of the community. These outcomes also align with the views of the key informants (see Table 4.3), with all of them (100%) expressing the persistence of flooding in Dome. This is also in line with a study by Nkonu & Antwi, (2024), which suggested that rapid urban growth has contributed significantly to the city of Accra’s flooding problems. Only 11.5 % of the respondents said they had not experienced flood incidents over the period.

Figure 4.4 Flood Incidents Experienced by Households in the Last Five Years



Source: Field Data, GEM 2024

4.4.4 Factors Affecting Flood Susceptibility in Dome

The results provided insight into the factors associated with urban expansion that have exacerbated flood risks in Dome, as shown in Table 4.4. The most frequently mentioned factor was sanitation issues, with 72.48% of respondents identifying this as a key contributor to increased flood risk. A

study by Duku et al., (2020) supported this finding by revealing that accessibility to sanitation facilities among a large portion of the Ghanaian population is a key issue that contributes to heightened flood risks in the urban communities. In addition, from the qualitative study, an assembly official emphasized that poor sanitation practices, such as improper waste disposal, often led to blocked drainage systems and waterways, exacerbating flooding during heavy rains.

“A major reason for our flood is the dumping of rubbish anyway and everywhere. We’ve been educating them on hygiene, that when you eat or do something, don’t throw the rubbish around so that the place will be decent, but we still have many of our gutters choked” (Assembly official, GEMA, 2024)

Following closely on factors leading to flood susceptibility in Dome was encroachment on natural waterways and drainage systems, which was noted by 61.47% of respondents. Urban expansion often involves the construction of buildings and infrastructure on or near natural water channels, obstructing water flow and increasing the likelihood of floods (Agyekum & Asibey, 2024). This highlights the negative impact of haphazard construction in flood-prone areas. This was emphasized in the interview with the representative of the traditional council of Dome.

“My perception is that as the community is developing, areas earmarked for gutters, and such have been encroached upon. People have bought those lands and built on them. So, when it rains, the rainwater doesn’t pass through the places it needs to pass. This has resulted in many flooding situations within this municipality” (Traditional leader, GEMA 2024)

Inadequate urban planning and zoning regulations were also identified by 29.82% of respondents as factors leading to flood susceptibility in Dome. The lack of proper regulation and enforcement of building codes has allowed urban development in areas that are vulnerable to flooding (Ibrahim

et al., 2023). This issue is compounded by weak infrastructure maintenance, with 27.98% of respondents citing poor infrastructure maintenance, such as blocked drains and culverts, as another critical factor.

A smaller proportion of respondents (8.72%) pointed to the reduction of green spaces and natural vegetation as a factor contributing to flood risks. The loss of natural areas that can absorb rainfall increases surface runoff, which overwhelms drainage systems (Duah et al., 2021). Similarly, climate change and extreme weather events were noted by 8.26% of respondents, reflecting the growing awareness of how global environmental changes are influencing local flood patterns.

Finally, increased impermeable surfaces (7.34%) and other factors, such as illegal sand mining and weak enforcement of building regulations (2.75%) were also mentioned as contributing to the heightened flood risk in Dome. A political leader emphasized that the rise of impermeable surfaces, such as concrete and asphalt, prevents water from infiltrating the ground, leading to more surface runoff and flooding.

“The tiles they are using in their houses are also causing problems because they prevent water from sinking into the ground” (Political leader, GEMA, 2024)

Table 4.4: Factors of Urban Expansion and Flood Risks in Dome

THEMATIC AREA	FREQUENCY	PERCENTAGES (%)
Sanitation issues	158	72.48
Encroachment on natural waterways and drainage systems	134	61.47
Inadequate urban planning and zoning regulations	65	29.82
Poor infrastructure maintenance (e.g., blocked drains, culverts)	61	27.98
Reduction of green spaces and natural vegetation	19	8.72

Climate change and extreme weather events	18	8.26
Increased impermeable surfaces (e.g., concrete, asphalt)	16	7.34
Other (illegal sand mining, weak enforcement)	6	2.75

Source: Field Data, GEM 2024

4.4.5 Mitigation Strategies of Urban Expansion and Flood Risks in Dome

The results also provided insights into the perceived strategies that residents of Dome believe would effectively mitigate the increasing flood risks associated with urban expansion (see Table 4.5). The most widely supported strategy (84.86%) was the need for improved drainage infrastructure. This overwhelming consensus reflects the belief that the existing drainage systems are inadequate to cope with the heightened water flow and surface runoff caused by urban expansion. Given that much of Dome's urban expansion involves the construction of impervious surfaces such as roads and buildings as purported by Agyekum & Asibey (2024), effective drainage is seen as essential to divert excess water and prevent flooding. Following this, better urban planning and land use regulations were mentioned by 107 respondents. This significant proportion reflects widespread concern about the unchecked growth of the municipality, particularly in terms of land use mismanagement and the encroachment of buildings on flood-prone areas. Thus, residents are evidently aware of the role that poor planning plays in exacerbating flood risks, particularly when new developments do not consider the natural flow of water or when floodplains are converted into residential or commercial areas.

Public awareness and education campaigns accounted for 36.24% of the total responses of mitigation strategies. This suggests that a significant portion of the population believes in the power of education as a preventative measure. Building codes and regulations were also seen as a significant mitigation strategy to curb increased flood rates in Dome. 22.48% reflected a need for

the stringent enforcement of existing codes and regulations, aimed at controlling the high incidence of building in unauthorized areas. A smaller, yet notable proportion of respondents (10.55%) stressed the importance of the preservation of green spaces and natural waterways. Green spaces and vegetated areas can absorb water, reduce surface runoff, and help manage flood risks (Abass et al., 2020). Finally, other measures including the installation of flood barriers and rainwater harvesting systems were mentioned by 3.67 percent of the total. Though fewer respondents identified these alternative strategies, they nonetheless suggest a recognition that a variety of innovative solutions may be necessary to address the complex issue of flooding in Dome.

To test the robustness of the awareness of available mitigation strategies for flooding in Dome, a Chi-square test was carried out in this section. This was to test the independence of the knowledge of flood mitigation strategies from the educational level of household heads. It was established that the knowledge of flood mitigation strategies depended on the respondent’s level of education ($\chi^2 = 24.0255$, $p < 0.004$).

Table 4.5 Mitigation Strategies of Urban Expansion and Flood Risks in Dome

THEMATIC AREA	FREQUENCY	PERCENTAGES (%)
Improved drainage infrastructure	185	84.86
Better urban planning and land use regulations	107	49.08
Public awareness and education campaigns	79	36.24
Enforcement of building codes and regulations	49	22.48
Preservation of green spaces and natural waterways	23	10.55
Other (flood barriers, rainwater harvesting)	8	3.67

Source: Field Data, GEM 2024

4.5 Socioeconomic Effects of Flooding on Residents of Dome

The general socioeconomic effects of flooding across various urban domains cannot be overemphasized. These effects range from human livelihoods, infrastructure, health, and financial losses (Gambo et al., 2024). This section, therefore, assesses the effects of urban expansion-induced flooding in Dome. The quantitative analysis categorized the responses from residents based on the degree of urban expansion in the area and the corresponding socioeconomic impacts experienced into financial and health impacts, as well as damage to properties.

4.5.1 Financial Effects of Flooding in Dome

Table 4.6 presents the relationship between urban expansion and the financial impact of flooding among residents in Dome. The data shows the frequency distribution of respondents who reported experiencing financial impacts from flooding under different levels of urban expansion in their areas. The relationship was tested using the Chi-square test, yielding a Chi-square value (χ^2) of 41.1373 with a p-value of 0.000, indicating a statistically significant association between urban expansion and the financial impact of flooding. Among areas with no urban expansion, only 7 respondents experienced financial impacts from flooding, while 7 reported no financial impacts, giving a total of 14 respondents in this category. In areas with very little urban expansion, 14 respondents reported financial impacts, while 15 did not, totaling 29 respondents. This is consistent to Fox et al., (2024) who revealed that minimal or no urban expansion can lower development, significantly decreasing the financial losses associated with urban flooding. This also aligns with studies by Dharmarathne et al., (2024) and La Loggia et al., (2020), who suggested that urban centers with minimal or no expansion retain a significant level of livability and minimal financial effects.

Areas with moderate urban expansion had the highest frequency of financial impacts from flooding, with 112 respondents affected financially compared to only 9 who reported no financial impact. This group has a total of 121 respondents, suggesting that moderate expansion areas are particularly vulnerable to the financial consequences of flooding. The financial impact of flooding was also very substantial in areas with high levels of urban expansion. Out of 51 respondents, only 8 reported no financial impact, while 43 experienced considerable financial losses.

Overall, out of the 215 respondents, 176 (81.86%) reported experiencing financial impacts from flooding, indicating the widespread economic burden of flooding in Dome, especially in areas with moderate to high levels of urban expansion. This significant association underscores the financial vulnerability that accompanies urban expansion in flood-prone areas, suggesting a need for strategic planning and flood mitigation measures to minimize the financial impacts on residents as urbanization continues in Dome. The significant financial strains among residents in parts of the study area with significant urban expansion align with Jongman, (2018) findings, which reported that weather-related disasters, including flooding, resulted in losses surpassing \$300 billion in 2017 alone, with a continuing consistent pattern of increasing costs over time.

Findings from the interviews align with the results as a key informant from the Community Development office of GEMA further emphasized the financial effects of flooding induced by urban expansion.

“Flooding, in fact, flooding has caused more harm than good in our municipality. When it rains, you can't go anywhere. Our markets, like the big one – Dome, you can't even cross with your car. And so those who go to bring goods to come and sell get highly affected. And those who are government workers. We can't come to work. Traders, everybody. So, in fact, economic-wise, flooding affects us a lot” (Community development respondent, GEMA 2024).

Table 4.6: Relationship between urban expansion and the financial effects of flooding in Dome

Urban Expansion	Financial Effect of Flooding		
	No	Yes	Total
No expansion at all	7	7	14
No, very little expansion	15	14	29
Yes, moderate expansion	9	112	121
Yes, a lot of expansion	8	43	51
Total	39	176	215

Chi-square value (χ^2) = 41.1373, P value = 0.000

Source: Field Data, GEM 2024

4.5.2 Health Effects of Flooding in Dome

The analysis also explored the relationship between urban expansion and health issues reported by residents following flooding events. The chi-square test as shown in Table 4.7 revealed a statistically significant relationship between urban expansion and the health consequences of flooding ($\chi^2 = 17.444$, P value = 0.001). Similar to the relationship between urban expansion and the financial impact of flooding, 7 of a total of 14 respondents in areas with no expansion reported experiencing health impacts while the other 7 did not. In areas with very little urban expansion, 11 of the 29 respondents experienced health impacts. Ndiaye et al., (2024) asserts that in areas where urban expansion has not occurred, the natural environment provides better protection from flood-related health hazards, such as the spread of waterborne diseases, contamination of water sources, and other health risks associated with poor drainage and stagnant water.

Health impacts become significantly prevalent in areas with moderate and high levels of urban expansion. 89% out of the 121 respondents who indicated witnessing moderate urban expansion reported experiencing health effects as a result of flooding. Similarly, in regions with significant expansion, over half (26 out of 51 respondents) reported health impacts. Overall, 133 out of the 215 respondents (61.86%) faced health challenges linked to flooding, underscoring the increased public health vulnerability associated with urban expansion in flood-prone areas. This pattern highlights the urgent need for health-focused interventions and infrastructure to mitigate the health risks of flooding as urbanization continues in Dome.

According to Crawford et al., (2022), among communities with high expansion, the disruption of natural water flow, poor waste management, and overburdened drainage systems lead to the accumulation of contaminated water, exacerbating health risks for residents. The finding is also consistent with Rahaman et al., (2023), who asserted that rapid urban expansion often outpaces the development of public health infrastructure, leaving residents more vulnerable to the health impacts of flooding.

The most prevalent health conditions highlighted by respondents were malaria, cholera, typhoid, and diarrhea. This is in line with Ndiaye et al., (2024) who stated that rapid urban expansion coupled with recurrent flooding has led to increased malaria transmission. The respondents from the Council of Elders further emphasized these effects.

“When there is flooding and people get affected, it can lead to the spread of diseases as well. Cholera becomes very viral during the rainy seasons because flooding carries vectors that contain diarrhea and can contaminate food and water supplies. (Traditional leader, GEMA 2024).

Table 4.7: Relationship between urban expansion and health effects of flooding

Urban Expansion	Health Impact of Flooding		Total
	No	Yes	
No expansion at all	7	7	14
No, very little expansion	18	11	29
Yes, moderate expansion	32	89	121
Yes, a lot of expansion	25	26	51
Total	82	133	215

Chi-square value (χ^2) = 17.444, P value = 0.001

Source: Field Data, GEM 2024

4.5.3 Relationship between Urban Expansion and Damage to Properties in Dome

The analysis of flood impact on properties in Table 4.8 across the 215 respondents reveals a significant relationship between urban expansion and property damage due to flooding ($\chi^2 = 41.1373$, $p = 0.000$). Among the surveyed residents, the majority (56.3%, $n=121$) were located in areas with moderate urban expansion, while only 6.5% ($n=14$) were in areas with no expansion. Overall, 81.4% ($n=175$) of respondents experienced some level of property damage due to flooding, with 18.6% ($n=40$) reporting no impact. Properties in areas with moderate urban expansion showed markedly higher vulnerability, with 92% ($n=111$) experiencing flood damage. In contrast, properties in areas with no expansion displayed greater resilience, with 57.1% ($n=8$) reporting no damage and only 42.9% ($n=6$) experiencing any flood impact. These findings strongly suggest that increased urban expansion is associated with greater susceptibility to flood damage,

with properties in high-expansion areas being substantially more likely to experience severe flooding impacts compared to those in areas with minimal development.

According to Abass et al., (2020), the extensive use of impervious surfaces, combined with unplanned or rapid urban growth, exacerbates the flood impacts on properties, leading to widespread damages. A study by (Abdrabo et al., 2022) also supported this finding by revealing that urban expansion can induce flooding, leading to significant economic damage, including losses in infrastructure, residential properties, and agricultural land. This is also similar to the findings that unplanned urbanization and population growth in flood zones have led to increased flood losses and damage (Tiepolo & Galligari, 2021)

A respondent from the office of NADMO in GEMA emphasized that

“When it floods, it can destroy small gardens, poultry, and other sources of income. When these are destroyed, people lose their means of making money. When it floods, maybe you have a garden, small garden around your house. The flood will destroy all those things over there. Maybe you have a pottery farm, imagine what will happen. A man close to me lost all his birds. A tent that gives you small money will be washed away when it floods. Where are you going to get the money to continue your business?” (NADMO official, GEMA, 2024).

Table 4.8: Relationship between urban expansion and property damage in Dome

Impact of Flooding on Properties			
Urban Expansion	No	Yes	Total

No expansion at all	6	8	14
No, very little expansion	15	14	29
Yes, moderate expansion	10	111	121
Yes, a lot of expansion	9	42	51
Total	40	175	215
Chi-square value (χ^2) = 41.1373, P value = 0.000			

Source: Field Data, 2024

4.5.4 Specific Social Impacts of Urban Expansion-Induced Flooding in Dome

The social impacts of flooding in the Ga East Municipality, particularly, Dome, are multifaceted, as evidenced by the data collected. A significant 67% of respondents reported experiencing disruption to transportation and daily routines as a result of frequent flooding, thus highlighting the community's pervasive nature of flood-related inconveniences. This disruption not only affects individuals but also contributes to broader societal challenges, such as reduced productivity and increased stress (Mishra et al., 2022; Perera et al., 2020). To buttress the result, a political leader in GEM indicated.

“Flooding can disrupt daily life. People cannot go to work if the roads are flooded. Government vehicles, as well as private vehicles, can also be swept away by the water” (Political leader, GEMA, 2024).

Furthermore, 42.2% of respondents indicated being displaced from their homes or neighborhoods due to flooding, underscoring the profound personal and social upheaval caused by flooding. This displacement can lead to temporary or even long-term instability for affected households,

exacerbating various socioeconomic vulnerabilities. The survey also revealed that 18.4 % of respondents reported experiencing mental health or emotional distress as a result of flooding. This finding underscores the psychological burden and effects that flooding, compounded by urban expansion, has on the residents of Dome. A NADMO officer indicated

“Flooding leads to displacement and mental health issues due to the stress and discomfort it causes. Economically, it destroys businesses and properties, forcing people to find resources to rebuild. The consequences are significant in terms of both economic loss and mental health” (NADMO official, GEMA 2024).

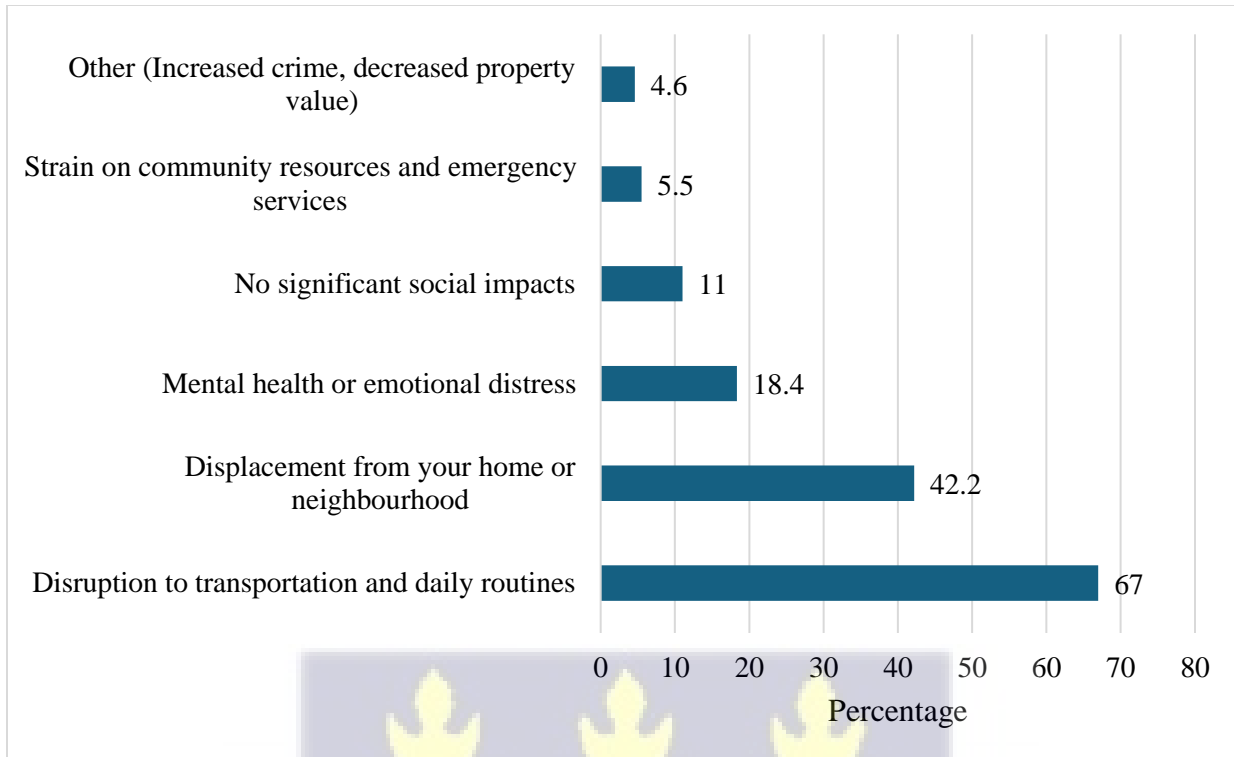
An assembly leader further explained that.

“My home sometimes accommodates displaced people, and I help put up temporary structures for them. I do this on humanitarian grounds to support my people” (Assembly official, GEMA 2024).

Despite these challenges, 11 % of respondents reported no significant social impacts from flooding, suggesting variability in how different households and neighborhoods perceive and experience the effects of urban expansion-induced floods. Nonetheless, 5.5% acknowledged strain on community resources and emergency services, indicating additional pressures on local infrastructure and support systems during flood events.

Moreover, 4.6 % of respondents highlighted other impacts, such as increased crime and decreased property values linked to flooding. These factors further underscore the interconnectedness of social dynamics and environmental hazards in urban settings like GEM, where effective mitigation strategies and community resilience efforts are essential for sustainable development and improved quality of life.

Figure 4.5: Specific Social Impacts of Urban Expansion-Induced Flooding in Dome



Source: Field Data, GEM 2024

4.5.5 Vulnerable Socioeconomic Groups Most Affected by Flooding in Dome

The study further explored which socioeconomic groups were most vulnerable to flooding in Dome, with the options including low-income households, informal settlers, people living with disabilities, and the elderly population. The results highlighted significant disparities in the vulnerability of demographic groups to the impacts of flooding caused by urban expansion. Among these groups, low-income households were noted as the most affected, comprising over half of the surveyed population at 54.6%. These demographic faces substantial challenges in dealing with flood-related damages and disruptions due to limited financial resources and often residing in areas more prone to flooding.

Informal settlement residents constituted 25.7%, underscoring their precarious living conditions in densely populated and poorly serviced areas. These parts of Dome typically lack adequate

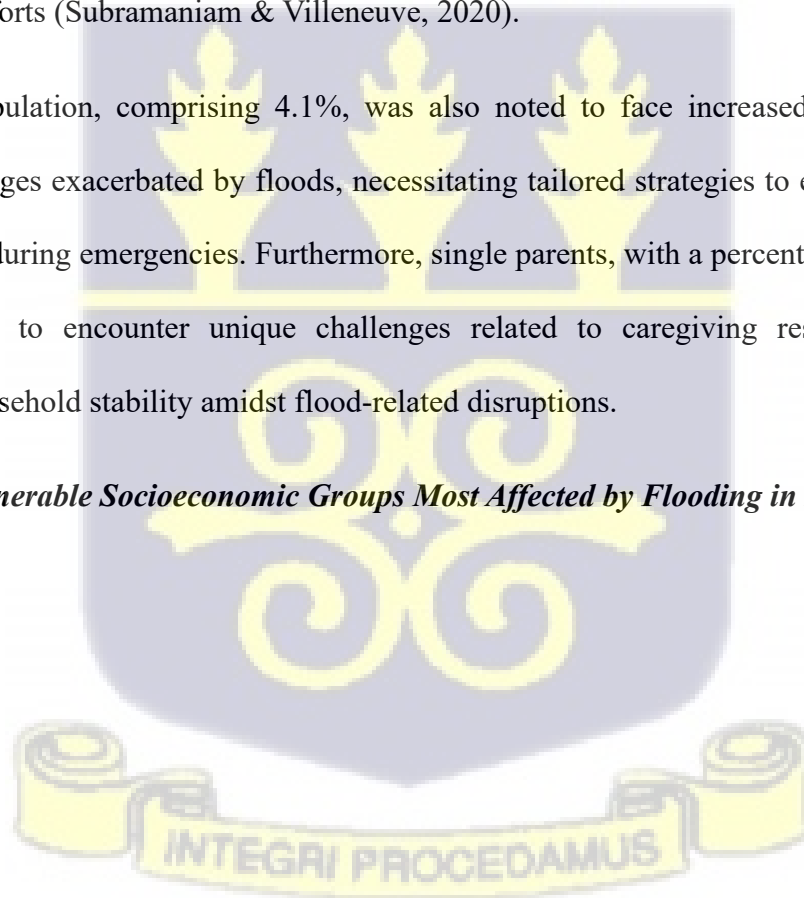
drainage systems and infrastructure, making them more susceptible to flood risks and the resulting socioeconomic impacts. The respondent from the planning unit in GEMA indicated

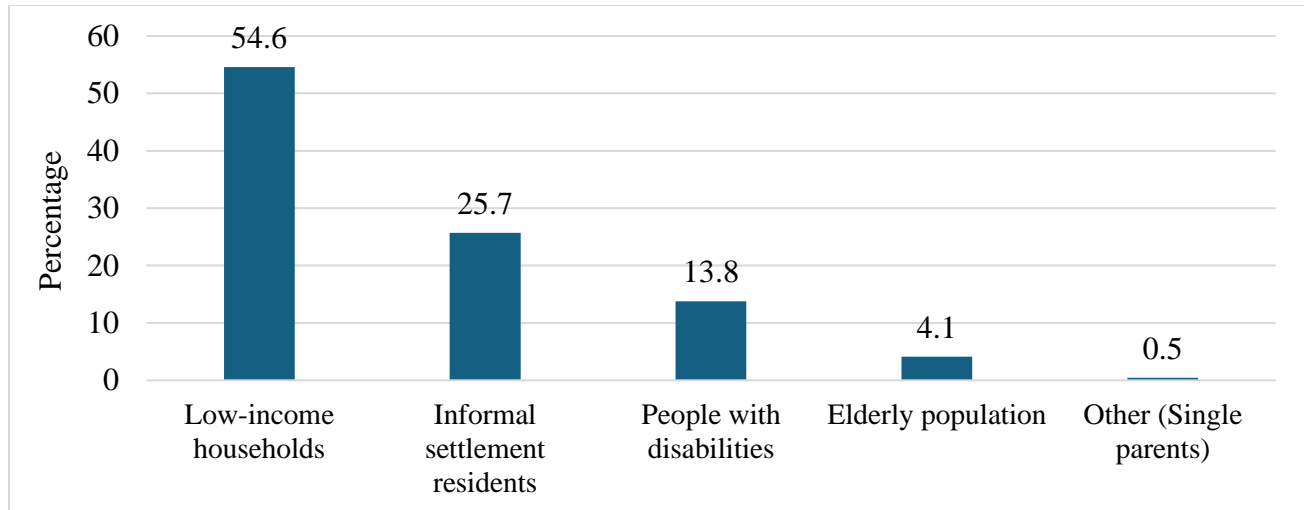
“In the informal sector, a lot of the people come from slums and are squatters around, which makes them vulnerable to flooding. When they are affected, it means their services are truncated for that short period of time, so it greatly affects productivity”. (Planning office respondent, GEMA 2024).

People with disabilities, accounting for 13.8%, were said to experience heightened vulnerabilities during flooding events, including barriers to evacuation and accessing essential services. Their specific needs for accessible facilities and support are often overlooked in disaster preparedness and response efforts (Subramaniam & Villeneuve, 2020).

The elderly population, comprising 4.1%, was also noted to face increased health risks and mobility challenges exacerbated by floods, necessitating tailored strategies to ensure their safety and well-being during emergencies. Furthermore, single parents, with a percentage of 0.5%, were also considered to encounter unique challenges related to caregiving responsibilities and maintaining household stability amidst flood-related disruptions.

Figure 4.6: Vulnerable Socioeconomic Groups Most Affected by Flooding in Dome





Source: Field Data, GEM 2024

4.6 Coping Strategies Employed by Residents to Mitigate the Effects of Flooding in Dome

In response to the underlying socioeconomic and environmental consequences of flooding, individuals adopt various coping mechanisms to moderate its impacts. This section highlights measures undertaken by households to cope with flooding.

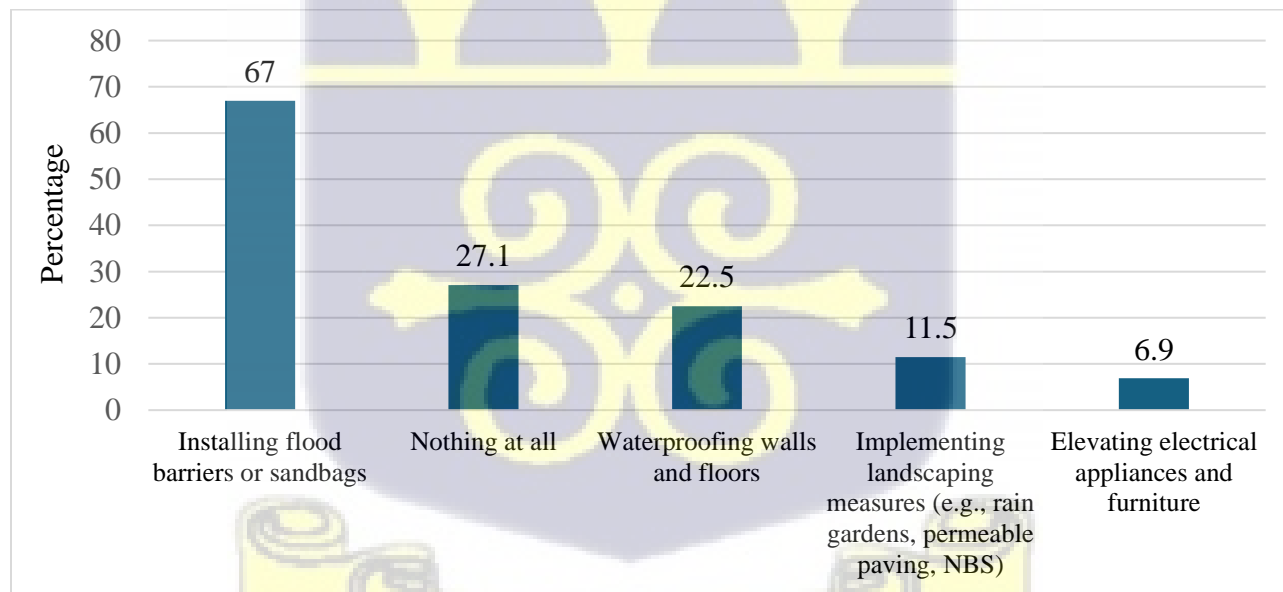
4.6.1 Measures Taken to Protect Property from Urban Expansion-Induced Flooding

Mensah & Ahadzie, (2020) emphasize that annual floods in Ghana invariably exert devastating impacts on infrastructure and several properties. In view of this, respondents expressed their views on the indigenous structural measures they adopted to protect their properties during floods (See Figure 4.7). Among the 215 respondents from the survey, installing flood barriers or sandbags was the most common measure, chosen by 146 individuals, representing 67% of the total. This method was regarded by residents as effective in temporarily holding back floodwater and protecting entry points into buildings. A study by Burnett & Edgeley, (2023) supported this finding by revealing that sandbags are frequently used as a temporary measure to protect properties from flooding, with 47.6% of the study's respondents placing sandbags around their property. Waterproofing walls and

floors was another prevalent strategy highlighted by 22.5% of the respondents in Dome. Khartode et al., (2024) are of the view that waterproofing helps prevent water from seeping into structures and causing damage.

Implementing landscaping measures, such as rain gardens, permeable paving, and Nature-Based Solutions (NBS), were chosen by 25 individuals, constituting 11.5% of the responses. These techniques are adopted to absorb and redirect rainwater away from buildings, reducing the overall flood risk in the surrounding area (FathiAzar et al., 2024). Elevating electrical appliances and furniture was less frequently reported, with 15 respondents (6.9%) opting for this precautionary measure to mitigate potential damage to valuable items during flooding events. Conversely, 27.1% of respondents indicated that they had not implemented any flood protection measures at all.

Figure 4.7: Measures Taken to Protect Property from Urban Expansion-Induced Flooding



Source: Field Data, 2024

The key informants presented similar results with 75% (6) of them (as shown in Table 4.8) indicating that residents often rely on structural coping mechanisms including dredging of water

channels, sandbags, and flood barriers. A longstanding resident emphasized that they sometimes seek technical assistance from the assembly in the form of equipment to aid their efforts to cope with flood situations.

“Sometimes communities also rent excavators and seek the assembly's assistance for supervision. This intervention by the assembly has significantly helped improve the situation.” (Longstanding resident, GEMA 2024).

50% of the key informants also indicated residents participate in community activities aimed at cleaning choked gutters around their residences. An assembly executive explained further.

“We do community labor, like dredging gutters, especially where I stay. There’s a big gutter that we clean together” (Assembly official, GEMA 2024).

All the respondents (100%) also indicated that resident raise their building above flood levels to reduce its impact. This is consistent with findings by Nofal & van de Lindt, (2021) who emphasized that households often elevate their first-floor buildings in an attempt to reduce the vulnerabilities to flooding.

Table 4.9: Thematic Analysis of Key Informant Interviews on Coping Strategies

THEMES	SUB-THEMES	FREQUENCY	PERCENTAGES (%)
Community-Led Initiatives	Community labor for gutter cleaning	4	50%
	Self-developed drainage systems	6	75%
Assembly and Government Support	Dredging of water channels	7	87.5%

	Technical assistance from the assembly	3	37.50%
Infrastructure Modifications	Elevated building structures	8	100%
	Creating retention ponds	2	25%

Source: Field Data, GEM 2024

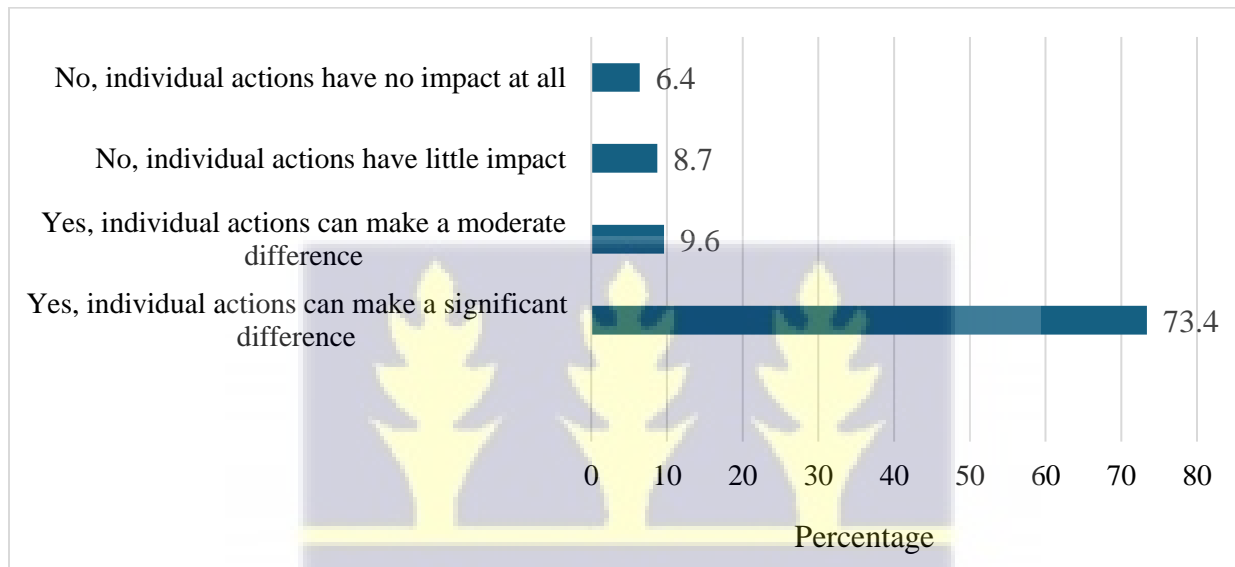
4.6.2 Residents beliefs in their actions as a measure to reduce flood risks in Dome

Responding to the question on residents' beliefs in their actions as a measure to reduce urban expansion-induced flood risks, the data in Table 4.10 shows a strong inclination towards the effectiveness of personal responsibility. A substantial 73.4 % of respondents believe that individual actions can make a significant difference in mitigating flood risks in Dome. This aligns with the studies of Rufat et al., (2020) which stated that individual actions can positively affect the efforts to mitigate floods. Also, the adaptive capacity framework (IPCC, 2001) suggests that communities' ability to respond to climate-induced hazards is directly related to their understanding of environmental risks, hence their ability to adopt coping mechanism (Yaro et al., 2015). This belief suggests a high level of awareness of individual action and personal accountability within the community. Additionally, 9.6 % of respondents believe that individual actions can make a moderate difference.

Conversely, 8.7 % of respondents believe that individual actions have little impact, while 6.4 % see no impact at all from individual efforts. These groups feel disempowered or believe that large-scale issues, such as climate change and urban development require governmental or institutional solutions rather than personal efforts. The respondent from the council of elders emphasized this assertion.

“Let me be frank with you, we cannot control this flooding problem. The government who should be doing its work does not show concern. Do you think the people you see living here can afford to expand our gutters? The Member of Parliament and Assemblyman do not help us at all. These politicians will only come for their votes and go” (Traditional leader, GEMA 2024).

Figure 4.8: Belief in Individual Actions Reducing Urban Flood Risks



4.6.2 Flood Insurance and Evacuation Plans among Residents of Dome

Based on the data on the coping strategies employed to mitigate urban expansion-induced flooding in Dome, it was evident that there is an absolute absence of flood insurance among residents. None of the respondents reported having flood insurance, demonstrating a significant gap in financial readiness for flood-related damage. This finding also underlines a significant vulnerability in the community's resilience against flooding. Without flood insurance, residents are exposed to potentially devastating financial losses in the event of flood damage to their properties Kousky et al., (2020). This absence was attributed to factors including no or limited availability of flood insurance, low awareness about the importance of flood insurance, and socioeconomic constraints

that hinder the interests of such financial protections. To buttress this point, the respondent from the council of elders of GEM stated.

“Flood insurance? Are they even there? I have never heard about it. But look at us, even if we have insurance, we cannot pay. Insurance is for rich people” (Traditional leader, GEM 2024).

Equally, regarding evacuation plans, Figure 4.8 revealed that only a small proportion (6.5%) of respondents reported having emergency evacuation plans such as safe shelters and evacuation kits in place in instances of flooding. This suggests a prevalent lack of preparedness and structured response mechanisms for dealing with flood emergencies within the community. An overwhelming majority (93.5%) indicated a lack of formal evacuation plans. Effective evacuation plans are, however, crucial for ensuring the safety and well-being of residents during flood events, according to Kako et al., (2020), and ensuring timely and organized relocation to safer areas. Twerefou et al., (2023) also added that households without an evacuation plan are significantly less prepared for floods. The low adoption rate of evacuation plans, according to the assembly officials, was attributed to various factors, including insufficient infrastructure to support evacuation efforts. A respondent from the planning office further emphasized.

“Look, the reality is that we cannot be talking about evacuation facilities when the people on normal days don't even have good places to sleep. Go to areas in Dome or even Abokobi here, you will be amazed by where some people sleep. So where to sleep first is a problem, not to talk of places to evacuate them too. The assembly cannot do all these all together you know” (Planning office respondent, GEMA 2024)

Therefore, while residents of Dome demonstrated resilience through physical flood mitigation measures, such as barriers and waterproofing, the absence of flood insurance and formal

evacuation plans poses significant challenges to their overall preparedness and ability to cope with urban expansion-induced flooding. This aligns with the study by Chan et al., (2021), which suggests the lack of contingent plans, support initiatives, and flood insurance among vulnerable and urban populations against urban expansion-induced floods. Zulfa et al., (2024), however, stated that many residents lack knowledge about local evacuation shelters and accessible routes. Ringo et al., (2024) also revealed the issue of late warnings to flood incidences as a big threat to vulnerable populations, making it difficult to organize timely evacuations.

4.6.3 Approaches to Flood Risk Awareness, Individual Actions, and Support Measures for Managing Floods in Dome

Gaisie & Cobbinah, (2023) suggested that increased preparedness and insights about the changing scope of flood-related events are key to enhancing the effectiveness of coping among communities. This study, therefore, looked at the various methods residents adopt to stay informed about the potential of floods in Dome, as shown in Table 4.10. The majority of respondents (52.09%) stated that they relied on following local news updates through televised and broadcasted sources such as De Youngi FM, Valley View Radio, Kessben FM, TV3, among others. This is consistent with Ryan, (2018) who found local television to be the most important source for weather information during floods, with radio also being significant. This suggests that news outlets play a vital role in disseminating timely information about flood risks, as this method was widely used due to its accessibility and trust among residents, making it a primary source of flood-related information. A further 23.72% of the respondents indicated a reliance on weather forecasts and warnings, mainly through the Ghana Metrological Services. According to Bakhtiari et al., (2024), Meteorological organizations play an impressive role in flood preparation by providing early warnings and flood alerts.

Contrary to a study by Ahadzie et al., (2020) which revealed that community preparedness programs are essential for long-term resilience, as they provide practical knowledge and community-based solutions to mitigate flood risks, only 11.16% of the respondents saw participation in community flood preparedness programs as a key medium to stay informed about the potential of flooding in Dome. 27.91% of respondents reported having no method of being informed about potential floods. This large proportion represents a significant gap in awareness and preparedness. A final 2.33% rely on other methods, such as self-prediction or subscribing to emergency alert systems, representing innovative or personal approaches to flood risk management and awareness creation.

Responding to the question on the preferences for support measures, an overwhelming majority (80.28%) mentioned improved drainage infrastructure as the most vital measure. This strong preference for a structural coping mechanism indicates a widespread understanding that infrastructural problems in the form of weak buildings and impervious surfaces are key causes of urban expansion-induced flooding. Poor drainage systems can exacerbate the severity of floods, especially in heavily urbanized areas where natural water absorption is limited (Qi et al., 2021). This was emphasized by an assembly official of GEM.

“Good drainage systems are very important. Look at this, we don’t have proper drainage systems. We often blame those who pour water and waste into the gutters. The critical thing is, there is nothing most of them can do” (Respondent 5, GEMA 2024).

An official from the NADMO office added that

“Without adequate drainage systems, roads become very bad, and it becomes difficult to commute from one end to another. I will say this is the key thing the people need” (Assembly official, GEMA 2024).

In addition, 36.7% of respondents advocated financial assistance for flood-resistant home improvements. This showed that residents recognized the need to individually prepare for potential flood events but lacked the financial capacity to do so. Flood-resistant home improvements, such as raising building foundations, waterproofing walls and reinforcing windows and doors, can significantly reduce flood damage (Dharmarathne et al., 2024b). Financial assistance could come in the form of government grants, subsidies, or loans, which would empower homeowners to implement these flood mitigation measures. Community-based flood preparedness training was highlighted by 34.4% of respondents, reflecting a demand for knowledge and skills that could help individuals and communities better manage flood risks.

Interestingly, 23.39% of respondents indicated a preference for enhanced early warning systems. While early warning systems are critical in providing timely alerts about potential floods according to Perera et al., (2020), the lower preference for this measure suggests that some residents see existing systems as sufficient or less important than physical infrastructure and financial support. A small portion (4.13%) suggested other forms of support, such as Non-Governmental Organizations (NGO) aid and improved waste management. This also highlights the vital role that NGOs play in flood mitigation efforts, particularly in delivering emergency relief and implementing community-based solutions. The planning office respondent indicated that.

“Government organizations like NADMO provide mattresses and other items to affected people. NGOs and other private institutions and individuals also donate food, money, and other items to the community.” (Planning office respondent, GEMA 2024).

Table 4.10 Approaches to Flood Risk Awareness, Individual Actions, and Support Measures for Managing Floods in Dome

THEMATIC AREA	FREQUENCY	PERCENTAGES (%)
<u>Methods of Staying Informed About Potential Flood Risks</u>		
Following local news updates	112	52.09
Monitoring weather forecasts and warnings	51	23.72
Participating in community flood preparedness programs	24	11.16
None at all	60	27.91
Other (self-prediction, subscribing to emergency alert systems)	5	2.33
<u>Support Measures to Enhance Residents' Flood Coping Ability</u>		
Improved drainage infrastructure	175	80.28
Financial assistance for flood-resistant home improvements	80	36.7
Community-based flood preparedness training	75	34.4
Enhanced early warning systems	51	23.39
Other (NGO aid, improved waste management)	9	4.13

Source: Field Data, 2024

4.7 Conclusion

This chapter examined the perceptions of residents on the effects of urban expansion on flood susceptibility in Dome. It again looked at the socioeconomic effects of urban expansion-induced flooding on residents of the study area. Finally, the chapter analyzed the measures adopted by residents to cope with the growing concern of urban flooding in Dome. The outcome showed that residents of Dome fully acknowledged that urban expansion in the area has exacerbated their vulnerability to flooding over the years. Activities such as the increase in the demand for residential and commercial spaces were highlighted as the main causes of urban expansion in Dome. Financial burden, health impacts, and loss of properties were the key socioeconomic effects of urban

expansion-induced flooding identified by residents. An interesting finding, however, was that residents have absolutely no flood insurance, despite the persistence of flooding.



CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings of the study, based on its objectives. Overall conclusions are further drawn, and deductions are made based, employing concepts of the Urban Ecology Theory and the framework underpinning the study. The chapter also makes recommendations to inform policy direction and further research.

5.2 Summary of Main Findings

The study sought to examine the effects of Urban Expansion on Flood Sustainability in Dome, in the Ga East Municipality (GEM). It specifically focused on the perceptions of residents on the effects of urban expansion on flood risks; the socioeconomic effects of urban expansion-induced flooding on residents, and the coping strategies employed by residents to mitigate the effects of floods in Dome. 215 respondents were sampled through the simple random sampling technique for the quantitative aspect of the study. 8 key informants were further interviewed through the purposive sampling technique, and their responses were transcribed and analyzed thematically to provide a qualitative understanding of the study. The key findings are discussed below.

5.2.1 High Awareness of the Effects of Urban Expansion on Flood Susceptibility in Dome

The study revealed that residents are largely aware of the implications of urban expansion on flood susceptibility in Dome. Relatively, a high proportion of the respondents attributed the increased flood vulnerability of Dome to urban expansion. Prominent components of the phenomenon of

urban expansion were highlighted as rapid urban development in the form of residential and commercial developments and the encroachment on water and converted natural landscapes.

Residents also expressed concern about the likelihood of experiencing floods over the past five years, indicating that flooding has become a persistent issue in the area. This widespread concern was emphasized by key informants, who unanimously recognized the perennial threat of flooding in Dome. Although a small fraction of respondents indicated they had not experienced flooding during this period, they acknowledged that flooding is prevalent in the majority of the study area and has become a perennial phenomenon.

The study observed that while most residents were aware of the increasing flood risks, there was a disconnect between this awareness and effective preventive action. Despite recognizing the risks associated with urban expansion, many residents continue to build in vulnerable areas due to a lack of affordable housing alternatives and inadequate policy enforcement.

5.2.2 Socioeconomic Effects of Flooding in Dome

The study highlighted the profound socioeconomic impacts of flooding on the residents of Dome, with both short and long-term consequences for livelihoods, health, and infrastructure. Financial losses were reported as one of the most significant effects, with many households losing valuable assets such as furniture, electronics, and agricultural produce during flood events.

The study also revealed that marginalized groups, including low-income households and residents of informal settlements, disproportionately bear the impact of flooding. These groups were revealed to be facing various constraints, including financial resources to implement effective flood mitigation strategies, and are often forced to rely on temporary, reactive measures such as the use of sandbags or the elevation of furniture.

Health implications were another critical aspect of the socioeconomic impacts observed in the study. Floods in Dome often led to the spread of waterborne diseases such as cholera, malaria, and typhoid fever, exacerbating public health issues in the area. Key informants from the Council of Elders and NADMO emphasized that the accumulation of stagnant water during flood events creates grounds for disease vectors, further endangering the community's well-being.

The Urban Ecology Theory further contextualizes these findings by highlighting the interactions between the urban socioeconomic structure and its natural environment. As urban expansion progresses without sufficient planning, the natural landscape comprising vegetation and water bodies becomes increasingly stressed. This transformation affects vulnerable socio-economic groups the most as they often reside in areas where natural ecosystems have been compromised, as found in the study.

Aside from the abovementioned impacts, the psychological toll of flooding was evident, with respondents reporting high levels of stress, anxiety, and displacement. A significant number of households indicated that they are often displaced by flooding, leading to disruptions in their daily routines and economic activities. The displacement of residents also increases their vulnerability to poverty and food insecurity, as livelihoods are interrupted, and productive assets are destroyed.

5.2.3 Coping Strategies Adopted by Residents to Mitigate the Effects of Flooding in Dome

The study identified various coping strategies employed by residents of Dome to mitigate the impacts of flooding. These strategies ranged from individual household-level interventions to community-driven efforts aimed at addressing collective flood risks. At the household level, the use of flood barriers such as sandbags was one of the most common methods of protecting homes

from floodwaters. Other strategies included the elevation of buildings and the waterproofing of walls and floors.

Despite these efforts, the study found that many coping strategies were reactive rather than anticipatory and lacked sustainability. While some households engaged in community labor to clean drainage systems, these efforts were often irregular and poorly coordinated. Moreover, the insufficiency of evacuation plans and alternative housing during flood events highlighted the inadequacy of coping mechanisms.

At the community level, residents often relied on communal efforts to dredge choked drains or build temporary waterways to manage floodwater. However, the study found that the effectiveness of these strategies was constrained by weak institutional support and insufficient resources. While NADMO occasionally provided relief items and technical assistance, the organization's capacity to respond to flood emergencies was limited by funding and logistical challenges. This highlights the importance of strengthening institutional frameworks to enhance community resilience to climate change.

5.3 Conclusions

The study concluded that the perceptions of residents in Dome regarding flood risks were shaped by a strong awareness of the impacts of urban expansion. The majority recognized that the rapid development, encroachment on wetlands, and poor urban planning had contributed significantly to their vulnerability to floods. This high level of awareness indicated that residents understand the environmental challenges but lack a deep engagement with the fundamental causes of these risks, particularly in terms of urban governance and planning failures.

In terms of the socioeconomic effects, the study found that urban expansion-induced flooding had severe consequences for residents. Financial losses were widespread, with households losing assets, homes, and income sources. The health impacts, including the spread of diseases such as cholera and malaria, further compounded the socio-economic strain, particularly for low-income households and residents of informal settlements. These effects led to displacement, disruption of livelihoods, and long-term economic difficulties, deepening existing inequalities within the community.

Coping strategies employed by residents were primarily reactive and short-term, reflecting both individual and community-level efforts to mitigate flood damage. These included measures such as using sandbags, raising furniture, and clearing drains. However, the study revealed that these strategies were largely insufficient in the face of recurrent and increasingly severe floods. The lack of comprehensive institutional support, such as flood insurance and early warning systems, left residents vulnerable, emphasizing the need for more sustainable and coordinated approaches to flood adaptation in Dome.

5.4 Recommendations

Based on the findings, the following recommendations are proposed:

1. Strengthening early warning systems is crucial to ensure residents can take timely and appropriate actions before floods occur. Early warning systems should be improved, with information disseminated through trusted local channels, such as television and radio stations. By utilizing these platforms, residents will receive accurate and reliable alerts that allow them to prepare adequately for flood events. This enhanced communication strategy would minimize the impacts of flooding by enabling preventive responses.

2. Community education on climate adaptation is another key recommendation. GEM, in collaboration with the National Disaster Management Organization (NADMO) and Civil Society Organizations (CSOs), should intensify public education campaigns to raise awareness about the dangers of urban expansion and flooding. These campaigns should focus on promoting environmentally sustainable practices, such as tree planting, proper waste disposal, and flood-resilient building techniques. By fostering a deeper understanding of these issues, Dome will be better equipped to adopt long-term strategies that mitigate flood risks.
3. The study also highlights the urgent need to improve drainage infrastructure in Dome. Existing drainage systems should be expanded and regularly dredged to prevent water stagnation and reduce the likelihood of flooding. Proper supervision and monitoring of drainage projects are essential to ensure that they are executed effectively and sustainably. Adequate drainage infrastructure is critical to managing water flow during heavy rains and minimizing the damage caused by flooding.
4. Additionally, enforcing urban planning regulations is vital in controlling the expansion of flood-prone areas. Existing laws and policies related to urban expansion and flood mitigation must be strictly enforced to prevent the construction of buildings in vulnerable areas, such as wetlands and waterways. Zoning regulations should prioritize the protection of these ecological zones to maintain their natural flood-mitigation functions. Establishing feedback channels to monitor the enforcement and effectiveness of these policies will allow for timely revisions and improvements where necessary.
5. Finally, the local government assembly should collaborate with various stakeholders, including insurance companies and Non-Governmental Organizations (NGOs), to develop

and promote affordable flood insurance schemes for residents in Dome. This would address the current gap in flood insurance and enhance the overall community preparedness against flooding.



REFERENCES

- Abass, K., Buor, D., Afriyie, K., Dumedah, G., Segbefi, A. Y., Guodaar, L., Garsonu, E. K., Adu-Gyamfi, S., Forkuor, D., Ofosu, A., Mohammed, A., & Gyasi, R. M. (2020a). Urban sprawl and green space depletion: Implications for flood incidence in Kumasi, Ghana. *International Journal of Disaster Risk Reduction*, *51*, 101915. <https://doi.org/10.1016/J.IJDRR.2020.101915>
- Abass, K., Buor, D., Afriyie, K., Dumedah, G., Segbefi, A. Y., Guodaar, L., Garsonu, E. K., Adu-Gyamfi, S., Forkuor, D., Ofosu, A., Mohammed, A., & Gyasi, R. M. (2020b). Urban sprawl and green space depletion: Implications for flood incidence in Kumasi, Ghana. *International Journal of Disaster Risk Reduction*, *51*, 101915. <https://doi.org/10.1016/J.IJDRR.2020.101915>
- Abdrabo, M. A., Abdelwahab, R. G., & Hassaan, M. A. (2022). Urban dynamics and potential vulnerability of coastal urban areas to sea level rise in the southeastern Levantine Basin. *Urban Climate*, *44*, 101212. <https://doi.org/10.1016/J.UCLIM.2022.101212>
- Abebe, Y. A., Ghorbani, A., Nikolic, I., Vojinovic, Z., & Sanchez, A. (2019). A coupled flood-agent-institution modelling (CLAIM) framework for urban flood risk management. *Environmental Modelling & Software*, *111*, 483–492. <https://doi.org/10.1016/J.ENVSOFT.2018.10.015>
- Acharya, A. S., Prakash, A., Saxena, P., & Nigam, A. (2013). Sampling: why and how of it? *Indian Journal of Medical Specialities*, *4*(2). <https://doi.org/10.7713/ijms.2013.0032>
- Adams, E. A., & Nyantakyi-Frimpong, H. (2021). Stressed, anxious, and sick from the floods: A photovoice study of climate extremes, differentiated vulnerabilities, and health in Old Fadama, Accra, Ghana. *Health & Place*, *67*, 102500. <https://doi.org/10.1016/J.HEALTHPLACE.2020.102500>
- Agyekum, S., & Asibey, M. O. (2024). Co-producing disaster-resilient urban settlements in Ghana: Case of Ahensan, Kumasi. *International Journal of Disaster Risk Reduction*, *108*, 104498. <https://doi.org/10.1016/J.IJDRR.2024.104498>
- Ahadzie, D., Dinye, I.-N., & King, R. S. (2020). Weathering the storm. *Reframing the Urban Challenge in Africa*, 152–182. <https://doi.org/10.4324/9781003008385-6>
- Akhter Salma. (2022). *Principles of Social Research Methodology - Google Books*. Springer Nature Singapore. https://books.google.com.gh/books?hl=en&lr&id=KV2YEAQAQBAJ&oi=fnd&pg=PA389&ots=4xz2pS8l8-&sig=DBbfG_DeJmQPzK3_sTbcT0hL0&redir_esc=y#v=onepage&q&f=false
- Akubia, J. E. K., & Bruns, A. (2019). Unravelling the Frontiers of Urban Growth: Spatio-Temporal Dynamics of Land-Use Change and Urban Expansion in Greater Accra Metropolitan Area, Ghana. *Land* 2019, Vol. 8, Page 131, 8(9), 131. <https://doi.org/10.3390/LAND8090131>
- Al-Areeq, A. M., Saleh, R. A. A., Ghaleb, M., Abba, S. I., & Yaseen, Z. M. (2024). Implication of novel hybrid machine learning model for flood subsidence susceptibility mapping: A representative case study in Saudi Arabia. *Journal of Hydrology*, *630*, 130692. <https://doi.org/10.1016/J.JHYDROL.2024.130692>
- Alberti, M., Palkovacs, E. P., Roches, S. Des, De Meester, L., Brans, K. I., Govaert, L., Grimm, N. B., Harris, N. C., Hendry, A. P., Schell, C. J., Szulkin, M., Munshi-South, J., Urban, M. C., & Verrelli,

- B. C. (2020). The Complexity of Urban Eco-evolutionary Dynamics. In *BioScience* (Vol. 70, Issue 9, pp. 772–793). Oxford University Press. <https://doi.org/10.1093/biosci/biaa079>
- Amoateng, P., Finlayson, C. M., Howard, J., & Wilson, B. (2018). A multi-faceted analysis of annual flood incidences in Kumasi, Ghana. *International Journal of Disaster Risk Reduction*, 27, 105–117. <https://doi.org/10.1016/J.IJDRR.2017.09.044>
- Ampadu, I. (2020). *Risk Factors, Effects and Management of Flood in the Ashaimann Municipality of the Greater Accra Region*. <https://repository.ensign.edu.gh/xmlui/handle/123456789/114>
- Andreasen, M. H., Agergaard, J., Kofie, R. Y., Møller-Jensen, L., & Oteng-Ababio, M. (2022). Urban encroachment in ecologically sensitive areas: drivers, impediments and consequences. *Buildings and Cities*, 3(1), 920–938. <https://doi.org/10.5334/bc.210>
- Andreasen, M. H., Agergaard, J., Møller-Jensen, L., Oteng-Ababio, M., & Yiran, G. A. B. (2022). Mobility Disruptions in Accra: Recurrent Flooding, Fragile Infrastructure and Climate Change. *Sustainability 2022, Vol. 14, Page 13790, 14*(21), 13790. <https://doi.org/10.3390/SU142113790>
- Asare, P. (2021). *Nature-Based Solutions (Nbs) as an Urban Flood Mitigation Measure: The Case of Ga East Municipality, Accra, Ghana*.
- Asare, P., Atun, F., & Pfeffer, K. (2023). Nature-Based Solutions (NBS) in spatial planning for urban flood mitigation: The perspective of flood management experts in Accra. *Land Use Policy*, 133, 106865. <https://doi.org/10.1016/J.LANDUSEPOL.2023.106865>
- Asibey, M. O., Osei, D. A., Doe, B., & Agyei, F. (2024). Rethinking the implications of sprawl for sustainable urban development: Insights from the Ejisu Municipality of Ghana between 2003 and 2023. *Habitat International*, 152, 103161. <https://doi.org/10.1016/J.HABITATINT.2024.103161>
- Asomani-Boateng, R. (2019). Urban Wetland Planning and Management in Ghana: a Disappointing Implementation. *Wetlands*, 39(2), 251–261. <https://doi.org/10.1007/S13157-018-1105-7/METRICS>
- Bakhtiari, V., Piadeh, F., Chen, A. S., & Behzadian, K. (2024). Stakeholder analysis in the application of cutting-edge digital visualisation technologies for urban flood risk management: A critical review. *Expert Systems with Applications*, 236, 121426. <https://doi.org/10.1016/J.ESWA.2023.121426>
- Bark, R. H., & Acreman, M. C. (2020). Investigating social processes that underpin local flood risk management action. *Environmental Science and Policy*, 109, 95–102. <https://doi.org/10.1016/j.envsci.2020.04.009>
- Berndtsson, R., Becker, P., Persson, A., Aspegren, H., Haghghatafshar, S., Jönsson, K., Larsson, R., Mobini, S., Mottaghi, M., Nilsson, J., Nordström, J., Pilesjö, P., Scholz, M., Sternudd, C., Sörensen, J., & Tussupova, K. (2019). Drivers of changing urban flood risk: A framework for action. *Journal of Environmental Management*, 240, 47–56. <https://doi.org/10.1016/j.jenvman.2019.03.094>
- Bixler, R. P., Paul, S., Jones, J., Preisser, M., & Passalacqua, P. (2021). Unpacking Adaptive Capacity to Flooding in Urban Environments: Social Capital, Social Vulnerability, and Risk Perception. *Frontiers in Water*, 3. <https://doi.org/10.3389/frwa.2021.728730>
- Boakye, W. A. (2015). *University Of Ghana Examining the Adaptive Strategies of the People Of Dome in the Ga-East Municipality to the Effects of Climate Change and Variability Partial Fulfillment of The*

Requirements for the Award of Master Of Arts (Ma) in Development Studies.
<http://ugspace.ug.edu.gh>

- Borowska-Stefańska, M., Domagalski, A., & Wiśniewski, S. (2018). Changes concerning commute traffic distribution on a road network following the occurrence of a natural disaster – The example of a flood in the Mazovian Voivodeship (Eastern Poland). *Transportation Research Part D: Transport and Environment*, 65, 116–137. <https://doi.org/10.1016/j.trd.2018.08.008>
- Bujang, M. A., & Baharum, N. (2017). A simplified guide to determination of sample size requirements for estimating the value of intraclass correlation coefficient: a review. In *Archives of Orofacial Sciences The Journal of the School of Dental Sciences, USM Arch Orofac Sci* (Vol. 12, Issue 1).
- Burnett, J. T., & Edgeley, C. M. (2023). Factors influencing flood risk mitigation after wildfire: Insights for individual and collective action after the 2010 Schultz Fire. *International Journal of Disaster Risk Reduction*, 94, 103791. <https://doi.org/10.1016/J.IJDRR.2023.103791>
- Castleberry, A., & Nolen, A. (2018). Thematic analysis of qualitative research data: Is it as easy as it sounds? In *Currents in Pharmacy Teaching and Learning* (Vol. 10, Issue 6, pp. 807–815). Elsevier Inc. <https://doi.org/10.1016/j.cptl.2018.03.019>
- Chan, F. K. S., Yang, L. E., Scheffran, J., Mitchell, G., Adekola, O., Griffiths, J., Chen, Y., Li, G., Lu, X., Qi, Y., Li, L., Zheng, H., & McDonald, A. (2021). Urban flood risks and emerging challenges in a Chinese delta: The case of the Pearl River Delta. In *Environmental Science and Policy* (Vol. 122, pp. 101–115). Elsevier Ltd. <https://doi.org/10.1016/j.envsci.2021.04.009>
- Chang, S. E., Brown, C., Handmer, J., Helgeson, J., Kajitani, Y., Keating, A., Noy, I., Watson, M., Derakhshan, S., Kim, J., & Roa-Henriquez, A. (2022). Business recovery from disasters: Lessons from natural hazards and the COVID-19 pandemic. *International Journal of Disaster Risk Reduction*, 80, 103191. <https://doi.org/10.1016/J.IJDRR.2022.103191>
- Chettri, D., Datta, P., & Behera, B. (2024). Climate change and household food security in the Himalayas: A systematic review of the challenges and household adaptive measures. *Environmental Development*, 51, 101019. <https://doi.org/10.1016/J.ENVDEV.2024.101019>
- Cobbinah, P. B., Korah, P. I., Bardoe, J. B., Darkwah, R. M., & Nunbogu, A. M. (2022). Contested urban spaces in unplanned urbanization: Wetlands under siege. *Cities*, 121. <https://doi.org/10.1016/j.cities.2021.103489>
- Coletta, V. R., Pagano, A., Zimmermann, N., Davies, M., Butler, A., Fratino, U., Giordano, R., & Pluchinotta, I. (2024). Socio-hydrological modelling using participatory System Dynamics modelling for enhancing urban flood resilience through Blue-Green Infrastructure. *Journal of Hydrology*, 636, 131248. <https://doi.org/10.1016/J.JHYDROL.2024.131248>
- Crawford, S. E., Brinkmann, M., Ouellet, J. D., Lehmkuhl, F., Reicherter, K., Schwarzbauer, J., Bellanova, P., Letmathe, P., Blank, L. M., Weber, R., Brack, W., van Dongen, J. T., Menzel, L., Hecker, M., Schüttrumpf, H., & Hollert, H. (2022). Remobilization of pollutants during extreme flood events poses severe risks to human and environmental health. *Journal of Hazardous Materials*, 421. <https://doi.org/10.1016/j.jhazmat.2021.126691>
- Damte, E., Manteaw, B. O., & Wrigley-Asante, C. (2023). Urbanization, climate change and health vulnerabilities in slum communities in Ghana. *The Journal of Climate Change and Health*, 10, 100189. <https://doi.org/10.1016/J.JOCLIM.2022.100189>

- Danso, S. Y., Ma, Y., Adjakloe, Y. D. A., & Addo, I. Y. (2020). Application of an Index-Based Approach in Geospatial Techniques for the Mapping of Flood Hazard Areas: A Case of Cape Coast Metropolis in Ghana. *Water* 2020, Vol. 12, Page 3483, 12(12), 3483. <https://doi.org/10.3390/W12123483>
- Dawadi, S., Shrestha, S., & Giri, R. A. (2021). Mixed-Methods Research: A Discussion on its Types, Challenges, and Criticisms. *Journal of Practical Studies in Education*, 2(2), 25–36. <https://doi.org/10.46809/jpse.v2i2.20>
- Des Roches, S., Brans, K. I., Lambert, M. R., Rivkin, L. R., Savage, A. M., Schell, C. J., Correa, C., De Meester, L., Diamond, S. E., Grimm, N. B., Harris, N. C., Govaert, L., Hendry, A. P., Johnson, M. T. J., Munshi-South, J., Palkovacs, E. P., Szulkin, M., Urban, M. C., Verrelli, B. C., & Alberti, M. (2021). Socio-eco-evolutionary dynamics in cities. *Evolutionary Applications*, 14(1), 248–267. <https://doi.org/10.1111/eva.13065>
- Dhar, T., Bornstein, L., Lizarralde, G., & Nazimuddin, S. M. (2023). Risk perception—A lens for understanding adaptive behaviour in the age of climate change? Narratives from the Global South. *International Journal of Disaster Risk Reduction*, 95, 103886. <https://doi.org/10.1016/J.IJDRR.2023.103886>
- Dharmarathne, G., Waduge, A. O., Bogahawaththa, M., Rathnayake, U., & Meddage, D. P. P. (2024a). Adapting cities to the surge: A comprehensive review of climate-induced urban flooding. *Results in Engineering*, 22, 102123. <https://doi.org/10.1016/J.RINENG.2024.102123>
- Dharmarathne, G., Waduge, A. O., Bogahawaththa, M., Rathnayake, U., & Meddage, D. P. P. (2024b). Adapting cities to the surge: A comprehensive review of climate-induced urban flooding. *Results in Engineering*, 22, 102123. <https://doi.org/10.1016/J.RINENG.2024.102123>
- Dhir, S., & Shukla, A. (2018). The influence of personal and organisational characteristics on employee engagement and performance. *International Journal of Management Concepts and Philosophy*, 11(2), 117. <https://doi.org/10.1504/ijmcp.2018.092321>
- Doe, B., Amoako, C., & Adamtey, R. (2022). Spatial expansion and patterns of land use/land cover changes around Accra, Ghana – Emerging insights from Awutu Senya East Municipal Area. *Land Use Policy*, 112. <https://doi.org/10.1016/j.landusepol.2021.105796>
- Douglas, I. (2018). The challenge of urban poverty for the use of green infrastructure on floodplains and wetlands to reduce flood impacts in intertropical Africa. *Landscape and Urban Planning*, 180, 262–272. <https://doi.org/10.1016/j.landurbplan.2016.09.025>
- Duah, A. A., Akurugu, B. A., Darko, P. K., Manu, E., & Mainoo, P. A. (2021). Groundwater recharge and potential exploitation in the Densu basin, Southwestern Ghana. *Journal of African Earth Sciences*, 183, 104332. <https://doi.org/10.1016/J.JAFREARSCI.2021.104332>
- Duku, G. A., Appiah-Effah, E., Nyarko, K. B., & Dwumfour-Asare, B. (2020). Early live-prototype testing of a low-cost latrine technology for rural and peri-urban communities: The case of a modified pour-flush latrine. *Scientific African*, 8, e00338. <https://doi.org/10.1016/J.SCIAF.2020.E00338>
- Echendu, A. J. (2020). The impact of flooding on Nigeria’s sustainable development goals (SDGs). *Ecosystem Health and Sustainability*, 6(1). <https://doi.org/10.1080/20964129.2020.1791735>

- Ekoh, S. S., Teron, L., & Ajibade, I. (2023). Climate change and coastal megacities: Adapting through mobility. *Global Environmental Change*, *80*, 102666. <https://doi.org/10.1016/J.GLOENVCHA.2023.102666>
- Ertan, S., & Çelik, R. N. (2021). The assessment of urbanization effect and sustainable drainage solutions on flood hazard by gis. *Sustainability (Switzerland)*, *13*(4), 1–19. <https://doi.org/10.3390/su13042293>
- Fakih, A., Haimoun, N., & Kassem, M. (2020). Youth Unemployment, Gender and Institutions During Transition: Evidence from the Arab Spring. *Social Indicators Research*, *150*(1), 311–336. <https://doi.org/10.1007/S11205-020-02300-3/TABLES/7>
- Faseyi, C. A., Miyittah, M. K., & Yafetto, L. (2023). Assessment of environmental degradation in two coastal communities of Ghana using Driver Pressure State Impact Response (DPSIR) framework. *Journal of Environmental Management*, *342*. <https://doi.org/10.1016/j.jenvman.2023.118224>
- FathiAzar, A., De Angeli, S., & Cattari, S. (2024). Towards integrated multi-risk reduction strategies: A catalog of flood and earthquake risk mitigation measures at the building and neighborhood scales. *International Journal of Disaster Risk Reduction*, *113*, 104884. <https://doi.org/10.1016/J.IJDRR.2024.104884>
- Fox, D. M., Banitalebi, M., & Rainaud, A. (2024). Building footprint layers show that flooding risk increased more due to greater building exposure than to greater peak discharge with urbanisation in SE France. *Journal of Hydrology: Regional Studies*, *54*, 101882. <https://doi.org/10.1016/J.EJRH.2024.101882>
- Gaisie, E., & Cobbinah, P. B. (2023). Planning for context-based climate adaptation: Flood management inquiry in Accra. In *Environmental Science and Policy* (Vol. 141, pp. 97–108). Elsevier Ltd. <https://doi.org/10.1016/j.envsci.2023.01.002>
- Gambo, J., binti Roslan, S. N. A., Zulhaidi Mohd Shafri, H., Che Ya, N. N., Ahmed Yusuf, Y., & Ang, Y. (2024). Unveiling and modelling the flood risk and multidimensional poverty determinants using geospatial multi-criteria approach: Evidence from Jigawa, Nigeria. *International Journal of Disaster Risk Reduction*, *106*. <https://doi.org/10.1016/j.ijdr.2024.104400>
- Güneralp, B., Lwasa, S., Masundire, H., Parnell, S., & Seto, K. C. (2018). Urbanization in Africa: Challenges and opportunities for conservation. *Environmental Research Letters*, *13*(1). <https://doi.org/10.1088/1748-9326/aa94fe>
- Gupta, R., Chembolu, V., Marjoribanks, T. I., & Dutta, S. (2024). Assessing the efficacy of hydro-ecological based wetland management approach for flood resilience of a large river catchment. *Journal of Hydrology*, *641*, 131761. <https://doi.org/10.1016/J.JHYDROL.2024.131761>
- He, Q., Yan, M., Zheng, L., & Wang, B. (2023). Spatial stratified heterogeneity and driving mechanism of urban development level in China under different urban growth patterns with optimal parameter-based geographic detector model mining. *Computers, Environment and Urban Systems*, *105*, 102023. <https://doi.org/10.1016/J.COMPENVURBSYS.2023.102023>
- Hobbie, S. E., & Grimm, N. B. (2020). Nature-based approaches to managing climate change impacts in cities. *Philosophical Transactions of the Royal Society B*, *375*(1794). <https://doi.org/10.1098/RSTB.2019.0124>

- Holtz, P., & Odağ, Ö. (2020). Popper was not a Positivist: Why Critical Rationalism Could be an Epistemology for Qualitative as well as Quantitative Social Scientific Research. *Qualitative Research in Psychology*, 17(4), 541–564. <https://doi.org/10.1080/14780887.2018.1447622>
- Huang, Y., Lange, E., & Ma, Y. (2022). Living With Floods and Reconnecting to The Water – Landscape Planning And Design For Delta Plains. *Journal of Environmental Engineering and Landscape Management*, 30(1), 206–219. <https://doi.org/10.3846/jeelm.2022.16352>
- Hussain, M., & Imitiyaz, I. (2018). *Urbanization Concepts, Dimensions And Factors*. <https://doi.org/10.24327/ijrsr.2018.0901.1483>
- Ibrahim, A., Salifu, A. H., & Peprah, C. (2023). Does governance matter when disaster looms? Zooming into proactive institutional measures for flood risk management. *International Journal of Disaster Risk Reduction*, 97, 104021. <https://doi.org/10.1016/J.IJDRR.2023.104021>
- Idowu, D., & Zhou, W. (2023). Global Megacities and Frequent Floods: Correlation between Urban Expansion Patterns and Urban Flood Hazards. *Sustainability* 2023, Vol. 15, Page 2514, 15(3), 2514. <https://doi.org/10.3390/SU15032514>
- Ifiok Enobong Mfon, Michael Chukwuemeka Oguike, Salvation Ubi Eteng, & Ndifreke Moses Etim. (2022). Causes and Effects of Flooding in Nigeria: A Review. *East Asian Journal of Multidisciplinary Research*, 1(9), 1777–1792. <https://doi.org/10.55927/eajmr.v1i9.1261>
- Inostroza, L., & Taubenböck, H. (2024). Searching for the DNA of urbanisation. A material perspective. *Cities*, 151, 105079. <https://doi.org/10.1016/J.CITIES.2024.105079>
- J Quick, & S Hall. (2015). *Spotlight On Research*.
- James, N. (2024). Urbanization and Its Impact on Environmental Sustainability. *Journal of Applied Geographical Studies*, 3(1), 54–66. <https://doi.org/10.47941/JAGS.1624>
- Johnson, S. L., Gray, P., & Sarker, S. (2019). Revisiting IS research practice in the era of big data. *Information and Organization*, 29(1), 41–56. <https://doi.org/10.1016/J.INFOANDORG.2019.01.001>
- Jongman, B. (2018). Effective adaptation to rising flood risk. In *Nature Communications* (Vol. 9, Issue 1). Nature Publishing Group. <https://doi.org/10.1038/s41467-018-04396-1>
- Kako, M., Steenkamp, M., Ryan, B., Arbon, P., & Takada, Y. (2020). Best practice for evacuation centres accommodating vulnerable populations: A literature review. In *International Journal of Disaster Risk Reduction* (Vol. 46). Elsevier Ltd. <https://doi.org/10.1016/j.ijdr.2020.101497>
- Kärkkäinen, K., & Joo UCLA, J. (2021). *FairFace: Face Attribute Dataset for Balanced Race, Gender, and Age for Bias Measurement and Mitigation* (pp. 1548–1558). <https://github.com/joojs/fairface>.
- Karunarathne, A. Y., & Gress, D. R. (2022). The role of organizational networks in ameliorating flood disaster impacts: A case study of flood inundated rural and urban areas in Sri Lanka. *International Journal of Disaster Risk Reduction*, 71, 102819. <https://doi.org/10.1016/J.IJDRR.2022.102819>
- Khartode, B., Sulaiman, S., Shewale, M., & Bhirud, Y. L. (2024). Need and Awareness of Leakages and waterproofing in High rise Building. *E3S Web of Conferences*, 559, 04016. <https://doi.org/10.1051/E3SCONF/202455904016>

- Kousky, C., Palim, M., & Pan, Y. (2020). Flood Damage and Mortgage Credit Risk: A Case Study of Hurricane Harvey. *Journal of Housing Research*, 29(sup1), S86–S120. <https://doi.org/10.1080/10527001.2020.1840131>
- Krongthaeo, S., Piaseu, N., Junda, T., & Wall, B. M. (2021). Community-based flood preparedness for Thai dependent older adults. *International Journal of Disaster Risk Reduction*, 63, 102460. <https://doi.org/10.1016/J.IJDRR.2021.102460>
- Kundzewicz, Z. W., Kanae, S., Seneviratne, S. I., Handmer, J., Nicholls, N., Peduzzi, P., Mechler, R., Bouwer, L. M., Arnell, N., Mach, K., Muir-Wood, R., Brakenridge, G. R., Kron, W., Benito, G., Honda, Y., Takahashi, K., & Sherstyukov, B. (2014). Le risque d'inondation et les perspectives de changement climatique mondial et régional. *Hydrological Sciences Journal*, 59(1), 1–28. <https://doi.org/10.1080/02626667.2013.857411>
- La Loggia, G., Puleo, V., & Freni, G. (2020). Floodability: A New Paradigm for Designing Urban Drainage and Achieving Sustainable Urban Growth. *Water Resources Management*, 34(10), 3411–3424. <https://doi.org/10.1007/S11269-020-02620-6/FIGURES/3>
- Larbi, I. (2023). Land use-land cover change in the Tano basin, Ghana and the implications on sustainable development goals. *Heliyon*, 9(4), e14859. <https://doi.org/10.1016/j.heliyon.2023.e14859>
- Lassa, J., Petal, M., Disasters, A. S.-, & 2023, undefined. (2022). Understanding the impacts of floods on learning quality, school facilities, and educational recovery in Indonesia. *Wiley Online Library*, 47(2), 412–436. <https://doi.org/10.1111/disa.12543>
- Li, X., Stringer, L. C., & Dallimer, M. (2022). The Impacts of Urbanisation and Climate Change on the Urban Thermal Environment in Africa. *Climate 2022, Vol. 10, Page 164*, 10(11), 164. <https://doi.org/10.3390/CLI10110164>
- Li, Y., Ye, H., Sun, X., Zheng, J., & Meng, D. (2021). Coupling Analysis of the Thermal Landscape and Environmental Carrying Capacity of Urban Expansion in Beijing (China) over the Past 35 Years. *Sustainability 2021, Vol. 13, Page 584*, 13(2), 584. <https://doi.org/10.3390/SU13020584>
- Lobo, J., Alberti, M., Allen-Dumas, M., Arcaute, E., Barthelemy, M., Bojorquez Tapia, L. A., Brail, S., Bettencourt, L., Beukes, A., Chen, W., Florida, R., Gonzalez, M., Grimm, N., Hamilton, M., Kempes, C., Kontokosta, C. E., Mellander, C., Neal, Z. P., Ortman, S., ... Youn, H. (2020). Urban Science: Integrated Theory from the First Cities to Sustainable Metropolises. *SSRN Electronic Journal*. <https://doi.org/10.2139/SSRN.3526940>
- Lokot, M. (2021). Whose Voices? Whose Knowledge? A Feminist Analysis of the Value of Key Informant Interviews. <https://doi.org/10.1177/1609406920948775>, 20. <https://doi.org/10.1177/1609406920948775>
- Luan, W., & Li, X. (2021). Rapid urbanization and its driving mechanism in the Pan-Third Pole region. *Science of the Total Environment*, 750. <https://doi.org/10.1016/j.scitotenv.2020.141270>
- Maddux, W. W., Lu, J. G., Affinito, S. J., & Galinsky, A. D. (2021). Multicultural Experiences: A Systematic Review and New Theoretical Framework. <https://doi.org/10.5465/Annals.2019.0138>, 15(2), 345–376. <https://doi.org/10.5465/ANNALS.2019.0138>

- Maheu, A. (2012). *Urbanization and Flood Vulnerability in a Peri-Urban Neighbourhood of Dakar, Senegal: How can Participatory GIS Contribute to Flood Management?* (pp. 185–207). https://doi.org/10.1007/978-3-642-22266-5_12
- Mahtta, R., Fragkias, M., Güneralp, B., Mahendra, A., Reba, M., Wentz, E. A., & Seto, K. C. (2022). Urban land expansion: the role of population and economic growth for 300+ cities. *Npj Urban Sustainability* 2022 2:1, 2(1), 1–11. <https://doi.org/10.1038/s42949-022-00048-y>
- Manawi, S. M. A., Nasir, K. A. M., Shiru, M. S., Hotaki, S. F., & Sediqi, M. N. (2020). Urban Flooding in the Northern Part of Kabul City: Causes and Mitigation. *Earth Systems and Environment*, 4(3), 599–610. <https://doi.org/10.1007/s41748-020-00165-7>
- Marchiori, L., Maystadt, J. F., & Schumacher, I. (2012). The impact of weather anomalies on migration in sub-Saharan Africa. *Journal of Environmental Economics and Management*, 63(3), 355–374. <https://doi.org/10.1016/j.jeem.2012.02.001>
- Markanday, A., Kallbekken, S., & Galarraga, I. (2022). The power of impact framing and experience for determining acceptable levels of climate change-induced flood risk: a lab experiment. *Mitigation and Adaptation Strategies for Global Change*, 27(2). <https://doi.org/10.1007/S11027-021-09989-8>
- Matzak, P., & Hegger, D. L. T. (2020). Flood Risk Governance for More Resilience—Reviewing the Special Issue’s Contribution to Existing Insights. *Water* 2020, Vol. 12, Page 2122, 12(8), 2122. <https://doi.org/10.3390/W12082122>
- Mensah, H., & Ahadzie, D. K. (2020). Causes, impacts and coping strategies of floods in Ghana: a systematic review. In *SN Applied Sciences* (Vol. 2, Issue 5). Springer Nature. <https://doi.org/10.1007/s42452-020-2548-z>
- Mishra, A., Mukherjee, S., Merz, B., Singh, V. P., Wright, D. B., Villarini, G., Paul, S., Kumar, D. N., Khedun, C. P., Niyogi, D., Schumann, G., & Stedinger, J. R. (2022). An Overview of Flood Concepts, Challenges, and Future Directions. *Journal of Hydrologic Engineering*, 27(6), 03122001. [https://doi.org/10.1061/\(ASCE\)HE.1943-5584.0002164](https://doi.org/10.1061/(ASCE)HE.1943-5584.0002164)
- Moller-Jensen, L., Allotey, A. N. M., Kofie, R. Y., & Yiran, G. A. B. (2023). How Does Flooding Influence Intra-Urban Mobility? The Case of Accra. *Sustainability*, 15(20), 14997. <https://doi.org/10.3390/su152014997>
- Moradzadeh, M., & Ahmadi, M. (2024). Unraveling the interplay of human decisions and flood risk: An agent-based modeling approach. *International Journal of Disaster Risk Reduction*, 107, 104486. <https://doi.org/10.1016/J.IJDRR.2024.104486>
- Ndiaye, F., Diop, A., Chabi, J., Sturm-Ramirez, K., Senghor, M., Diouf, E. H., Samb, B., Diedhiou, S. M., Thiaw, O., Zohdy, S., Dotson, E., Sene, D., Diouf, M. B., Koscelnik, V., Gerberg, L., Bangoura, A., Clark, T., Faye, O., Dia, I., ... Niang, E. H. A. (2024). Distribution and dynamics of *Anopheles gambiae* s.l. larval habitats in three Senegalese cities with high urban malaria incidence. *PLOS ONE*, 19(5), e0303473. <https://doi.org/10.1371/JOURNAL.PONE.0303473>
- Nelson, L., & Ahmadpoor, N. (2023). An examination of flood resilience in London Borough of Southwark. *Urban Climate*, 52, 101692. <https://doi.org/10.1016/J.UCLIM.2023.101692>

- Nkonu, R. S., & Antwi, M. (2024). A novel ANN-CA and MCDA integrated framework for predicting urban expansion and its implications on future flood risk, Accra Metropolis. *Environmental Development*, 52, 101061. <https://doi.org/10.1016/J.ENVDEV.2024.101061>
- Nofal, O. M., & van de Lindt, J. W. (2021). High-resolution flood risk approach to quantify the impact of policy change on flood losses at community-level. *International Journal of Disaster Risk Reduction*, 62, 102429. <https://doi.org/10.1016/J.IJDRR.2021.102429>
- O'Donovan, R., De Brún, A., & McAuliffe, E. (2021). Healthcare Professionals Experience of Psychological Safety, Voice, and Silence. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/FPSYG.2021.626689>
- Oduro, C. Y., & Oduro, T. (2025). The Rise of a Peri-Urban Giant from the Shadows of an African Metropolitan Area: A Spotlight on Kasoa, Ghana. *Urban Governance*. <https://doi.org/10.1016/J.UGJ.2025.02.007>
- Oluwatayo, A., & Opoko, A. P. (2014). Trends in Urbanisation: Implication for Planning and Low-Income Housing Delivery in Lagos, Nigeria. *Architecture Research*, 4(1A), 15–26. <https://doi.org/10.5923/s.arch.201401.03>
- Oskorouchi, H. R., & Sousa-Poza, A. (2021). Floods, food security, and coping strategies: Evidence from Afghanistan. *Agricultural Economics*, 52(1), 123–140. <https://doi.org/10.1111/AGEC.12610>
- Owusu, A. B., Adu-Boahen, K., & Dadson, I. Y. (2024). Institutional arrangement for mitigating and adapting to climate change-related flood risk in Greater Accra Metropolitan Area (GAMA). *City and Environment Interactions*, 21, 100129. <https://doi.org/10.1016/J.CACINT.2023.100129>
- Pant, H. B., Batchu, T., Raj, R., Nirupama, A., Agiwal, V., Pant, H. B., Batchu, T., Raj, R., Nirupama, A., & Agiwal, V. (2023). Impact of hands-on training in STATA for data management and data analysis: How much knowledge gained among health-care professionals? *IHOPE Journal of Ophthalmology*, 2(1), 4–8. https://doi.org/10.25259/IHOPEJO_30_2022
- Paprotny, D., Sebastian, A., Morales-Nápoles, O., & Jonkman, S. N. (2018). Trends in flood losses in Europe over the past 150 years. *Nature Communications*, 9(1). <https://doi.org/10.1038/s41467-018-04253-1>
- Perera, D., Agnihotri, J., Seidou, O., & Djalante, R. (2020). Identifying societal challenges in flood early warning systems. *International Journal of Disaster Risk Reduction*, 51, 101794. <https://doi.org/10.1016/J.IJDRR.2020.101794>
- Pérez-Morales, A., Gil-Guirado, S., & Martínez-García, V. (2022). Dasymetry Dash Flood (DDF). A method for population mapping and flood exposure assessment in touristic cities. *Applied Geography*, 142, 102683. <https://doi.org/10.1016/J.APGEOG.2022.102683>
- Pizzorni, M., Innocenti, A., & Tollin, N. (2024). Droughts and floods in a changing climate and implications for multi-hazard urban planning: A review. *City and Environment Interactions*, 24, 100169. <https://doi.org/10.1016/J.CACINT.2024.100169>
- Qi, W., Ma, C., Xu, H., Chen, Z., Zhao, K., & Han, H. (2021). A review on applications of urban flood models in flood mitigation strategies. *Natural Hazards* 2021 108:1, 108(1), 31–62. <https://doi.org/10.1007/S11069-021-04715-8>

- Rahaman, M. A., Kalam, A., & Al-Mamun, M. (2023). Unplanned urbanization and health risks of Dhaka City in Bangladesh: uncovering the associations between urban environment and public health. In *Frontiers in Public Health* (Vol. 11). Frontiers Media SA. <https://doi.org/10.3389/fpubh.2023.1269362>
- Reu Junqueira, J., Serrao-Neumann, S., & White, I. (2021). Managing urban climate change risks: Prospects for using green infrastructure to increase urban resilience to floods. In *The Impacts of Climate Change: A Comprehensive Study of Physical, Biophysical, Social, and Political Issues* (pp. 379–396). Elsevier. <https://doi.org/10.1016/B978-0-12-822373-4.00013-6>
- Ringo, J., Sabai, S., & Mahenge, A. (2024). The status of response to the flood early warnings in Kilosa District, Tanzania. *International Journal of Disaster Risk Reduction*, 113, 104838. <https://doi.org/10.1016/J.IJDRR.2024.104838>
- Roald, T., K ppe, S., Bechmann Jensen, T., Hansen, J. M., & Levin, K. (2021). *Why Do We Always Generalize in Qualitative Research?* <https://doi.org/10.1037/qup0000138>
- Rufat, S., Fekete, A., Armaş, I., Hartmann, T., Kuhlicke, C., Prior, T., Thaler, T., & Wisner, B. (2020). Swimming alone? Why linking flood risk perception and behavior requires more than “it’s the individual, stupid.” *Wiley Interdisciplinary Reviews: Water*, 7(5). <https://doi.org/10.1002/wat2.1462>
- Ryan, B. (2018). Establishing information seeking pathways in slow and flash floods. *International Journal of Disaster Risk Reduction*, 31, 9–19. <https://doi.org/10.1016/J.IJDRR.2018.04.005>
- Sawaneh, I. A., Fan, L., & Sesay, B. (2024). Investigating the influence of residents’ attitudes, perceptions of risk, and subjective norms on their willingness to engage in flood prevention efforts in Freetown, Sierra Leone. *Nature-Based Solutions*, 6, 100143. <https://doi.org/10.1016/J.NBSJ.2024.100143>
- Shaban, A., Kourtit, K., & Nijkamp, P. (2020). India’s urban system: Sustainability and imbalanced growth of cities. *Sustainability (Switzerland)*, 12(7). <https://doi.org/10.3390/su12072941>
- Shah, A. A., Ajiang, C., Khan, N. A., Alotaibi, B. A., & Tariq, M. A. U. R. (2022). Flood Risk Perception and Its Attributes among Rural Households under Developing Country Conditions: The Case of Pakistan. *Water (Switzerland)*, 14(6). <https://doi.org/10.3390/w14060992>
- Shah, A. A., Ye, J., Shaw, R., Ullah, R., & Ali, M. (2020). Factors affecting flood-induced household vulnerability and health risks in Pakistan: The case of Khyber Pakhtunkhwa (KP) Province. *International Journal of Disaster Risk Reduction*, 42, 101341. <https://doi.org/10.1016/J.IJDRR.2019.101341>
- Sharma, S. E. (2023). Urban climate resilience under racial capitalism: Governing pluvial flooding across Amsterdam and Dhaka. *Geoforum*, 145, 103817. <https://doi.org/10.1016/J.GEOFORUM.2023.103817>
- Shrestha, A., Shrestha, S. K., Shrestha, A., & Shrestha, S. K. (2024). *Shifting Tides: Unraveling the Sociological Fabric of Climate Change*. <https://doi.org/10.5772/INTECHOPEN.1005071>
- Singh, A. S., & Masuku, M. B. (2014). *International Journal of Economics, Commerce and Management Sampling Techniques & Determination of Sample Size in Applied Statistics Research: An Overview*. <http://ijecm.co.uk/>

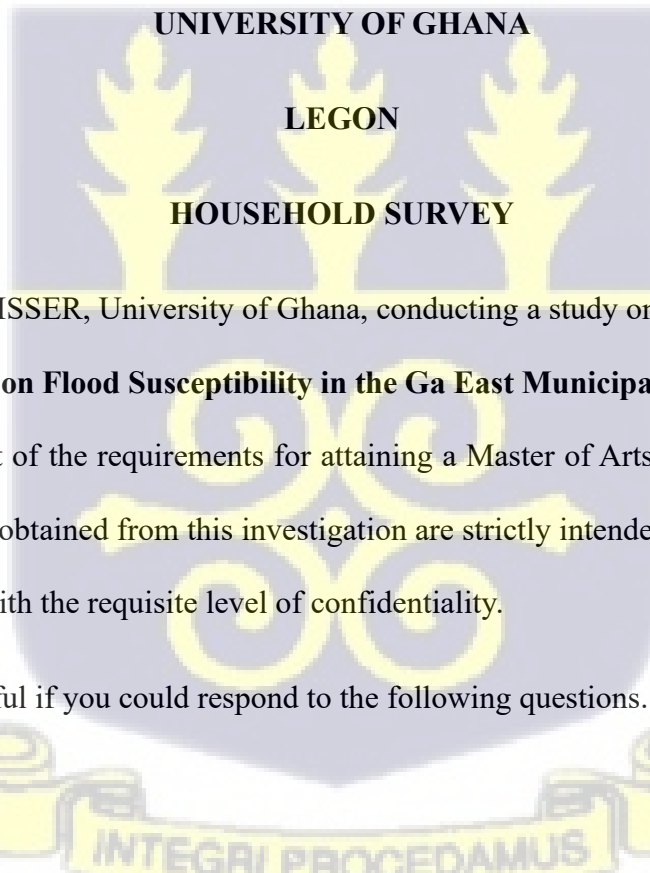
- Sitas, N., Selomane, O., Hamann, M., & Gajjar, S. P. (Sp). (2021). Towards Equitable Urban Resilience in the Global South Within a Context of Planning and Management. In *Cities and Nature: Vol. Part F337* (pp. 325–345). Springer Nature. https://doi.org/10.1007/978-3-030-67650-6_13
- Son, C. H., Lee, C. H., & Ban, Y. U. (2023). Analysis of the impact and moderating effect of high-density development on urban flooding. *Heliyon*, *9*(12), e22695. <https://doi.org/10.1016/J.HELIYON.2023.E22695>
- Subramaniam, P., & Villeneuve, M. (2020). Advancing emergency preparedness for people with disabilities and chronic health conditions in the community: a scoping review. *Disability and Rehabilitation*, *42*(22), 3256–3264. <https://doi.org/10.1080/09638288.2019.1583781>
- Sukanya, R., & Tantia, V. (2023). Urbanization and the Impact on Economic Development. <https://Services.Igi-Global.Com/Resolvedoi/Resolve.aspx?Doi=10.4018/978-1-6684-9261-1.Ch019>, 369–408. <https://doi.org/10.4018/978-1-6684-9261-1.CH019>
- Tabe-Ojong, M. P., Boakye, J. A., & Muliro, M. (2020). Mitigating the impacts of floods using adaptive and resilient coping strategies: The role of the emergency Livelihood Empowerment Against Poverty program (LEAP) in Ghana. *Journal of Environmental Management*, *270*. <https://doi.org/10.1016/j.jenvman.2020.110809>
- Tacoli, Cecilia., McGranahan, Gordon., Satterthwaite, David., & International Institute for Environment and Development. (2015). *Urbanisation, rural-urban migration and urban poverty*. IIED.
- Taherdoost, H. (2022). What are Different Research Approaches? Comprehensive Review of Qualitative, Quantitative, and Mixed Method Research, Their Applications, Types, and Limitations. *Journal of Management Science & Engineering Research*, *5*(1), 53–63. <https://doi.org/10.30564/jmser.v5i1.4538>
- Tiepolo, M., & Galligari, A. (2021). Urban expansion-flood damage nexus: Evidence from the Dosso Region, Niger. *Land Use Policy*, *108*, 105547. <https://doi.org/10.1016/J.LANDUSEPOL.2021.105547>
- Timans, R., Wouters, P., & Heilbron, J. (2019). Mixed methods research: what it is and what it could be. *Theory and Society*, *48*(2), 193–216. <https://doi.org/10.1007/s11186-019-09345-5>
- Toure, S. I., Stow, D. A., Clarke, K., & Weeks, J. (2020). Patterns of land cover and land use change within the two major metropolitan areas of Ghana. In *Geocarto International* (Vol. 35, Issue 2, pp. 209–223). Taylor and Francis Ltd. <https://doi.org/10.1080/10106049.2018.1516244>
- Tschirley, D., Bricas, N. S., Christine, R., & Thomas. (2020). *Feeding Africa's Cities Opportunities, Challenges, and Policies for Linking African Farmers with Growing Urban Food Markets*.
- Turhan, N. S. (2020). Karl Pearson's Chi-Square Tests. *Educational Research and Reviews*, *16*(9), 575–580. <https://doi.org/10.5897/ERR2019.3817>
- Turok, I., & McGranahan, G. (2013). Urbanization and economic growth: The arguments and evidence for Africa and Asia. In *Environment and Urbanization* (Vol. 25, Issue 2, pp. 465–482). <https://doi.org/10.1177/0956247813490908>

- Twerefou, D. K., Owusu, E. A., & Dovie, D. B. K. (2023). Correlates of flood preparedness in urban households: Evidence from the Greater Accra Metropolitan Area of Ghana. *Environmental Challenges*, 11, 100706. <https://doi.org/10.1016/J.ENVC.2023.100706>
- UNDP. (2021). *Evaluation Of Undp Strategic Plan 2018–2021*. Independent Evaluation Office.
- urbanisation — *European Environment Agency*. (n.d.). Retrieved March 25, 2024, from <https://www.eea.europa.eu/help/glossary/eea-glossary/urbanisation>
- Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Berry, H., Bouley, T., Boykoff, M., Byass, P., Cai, W., Campbell-Lendrum, D., Chambers, J., Daly, M., Dasandi, N., Davies, M., Depoux, A., Dominguez-Salas, P., Drummond, P., Ebi, K. L., ... Costello, A. (2018). The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. *The Lancet*, 392(10163), 2479–2514. [https://doi.org/10.1016/S0140-6736\(18\)32594-7](https://doi.org/10.1016/S0140-6736(18)32594-7)
- Xue, Q., Wang, Z., Liu, S., & Chang, P. (2022). Hedging, vertical integration and firm value: Evidence from the oil and gas industry. *Fuel*, 310, 122349. <https://doi.org/10.1016/J.FUEL.2021.122349>
- Yaro, J. A., Teye, J., & Bawakyillenuo, S. (2015). Local institutions and adaptive capacity to climate change/variability in the northern savannah of Ghana. *Climate and Development*, 7(3), 235–245. <https://doi.org/10.1080/17565529.2014.951018>
- Yin, Q., Ntim-Amo, G., Ran, R., Xu, D., Ansah, S., Hu, J., & Tang, H. (2021). Flood disaster risk perception and urban households' flood disaster preparedness: The case of accra metropolis in Ghana. *Water (Switzerland)*, 13(17). <https://doi.org/10.3390/w13172328>
- Yu, W., Zhang, Y., Zhou, W., Wang, W., & Tang, R. (2019). Urban expansion in Shenzhen since 1970s: A retrospect of change from a village to a megacity from the space. *Physics and Chemistry of the Earth, Parts A/B/C*, 110, 21–30. <https://doi.org/10.1016/J.PCE.2019.02.006>
- Zhang, J., Yu, Z., Yu, T., Si, J., Feng, Q., & Cao, S. (2018). Transforming flash floods into resources in arid China. *Land Use Policy*, 76, 746–753. <https://doi.org/10.1016/J.LANDUSEPOL.2018.03.002>
- Zheng, J., Chen, X., Kawaike, K., Yamanoi, K., Koshiha, T., & Huang, G. (2024). Response of urban flood resilience to climate change: An exploration with a novel performance-based metric considering the socioeconomic impacts of damage costs. *Journal of Hydrology*, 132260. <https://doi.org/10.1016/J.JHYDROL.2024.132260>
- Zhong, J., Hao, L., Sajinkumar, K. S., & Yan, D. (2024). Changes of ecological vulnerability in areas with different urban expansion patterns— A case study in the Yanhe river basin, China. *Journal of Environmental Management*, 370, 122607. <https://doi.org/10.1016/J.JENVMAN.2024.122607>
- Zhong, S., Yang, L., Toloo, S., Wang, Z., Tong, S., Sun, X., Crompton, D., FitzGerald, G., & Huang, C. (2018). The long-term physical and psychological health impacts of flooding: A systematic mapping. *Science of The Total Environment*, 626, 165–194. <https://doi.org/10.1016/J.SCITOTENV.2018.01.041>
- Zulfa, K. I., Faure Walker, J., & Yore, R. (2024). Factors affecting household evacuation decision making in response to disaster: Case study from the 2021 South Kalimantan floods, Indonesia. *International Journal of Disaster Risk Reduction*, 113, 104864. <https://doi.org/10.1016/J.IJDRR.2024.104864>

APPENDIX A: QUESTIONNAIRE



INSTITUTE OF STATISTICAL, SOCIAL AND ECONOMIC RESEARCH (ISSER)



I am a MA student at ISSER, University of Ghana, conducting a study on **“Assessing the Effects of Urban Expansion on Flood Susceptibility in the Ga East Municipal Assembly”**. This study is in partial fulfilment of the requirements for attaining a Master of Arts degree in Development Studies. The findings obtained from this investigation are strictly intended for academic purposes and must be treated with the requisite level of confidentiality.

I would be very grateful if you could respond to the following questions.

Thank you.

SECTION A: DEMOGRAPHIC INFORMATION OF RESPONDENT

1. Have you lived in Dome longer than 5 years? 1. Yes 2. No

2. Respondent ID:

3. Date:

4. Sex of Respondent: 1. Male 2. Female

5. Age of Respondent:

6. Are you the Household Head? 1. Yes 2. No

7. Level of Education of Household Head:

1	No formal Education	4	SHS/SSS/O-Level/A-Level/Technical/Vocational
2	Elementary/Primary Education	5	Tertiary Education
3	JHS/JSS/Middle School	6	Other (Specify)

8. Employment Status of Household Head? 1. Employed 2. Unemployed

9. If employed (8), occupation of Household Head:

10. Number of Household Members:

11. Level of Income of Household Head: (Select range)

a) Less than 500

b) 500 - 999

c) 1000 - 1499

d) 1500 - 1999

e) 2000 - 2499

f) 2500 and above

11. What is your residential status? 1. Owner 2. Tenant 3. Care-taker 4. Squatter

12. If tenant (9), how much do you pay as rent monthly? (Select range)

a) Less than 100

b) 100 - 199

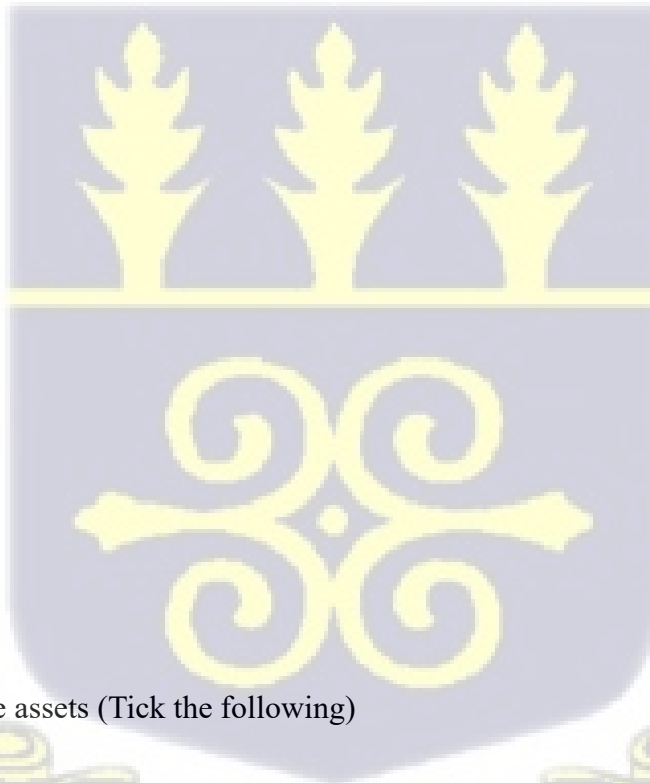
c) 200 - 299

d) 300 - 399

e) 400 - 499

f) 500 - 999

g) 1000 and above



13. Household durable assets (Tick the following)

Assets	Yes	No
TV		
Refrigerator		

Smartphones		
Car		
Bicycle		
Motorbike		

14. What is your household's primary source of drinking water? 1. Piped water (inside dwelling) 2. Piped water (outside dwelling) 3. Borehole/well 4. Spring
5. Other (please specify)

15. What is your household's primary source of energy for cooking and heating? 1. Electricity
2. Gas/LPG 3. Charcoal 4. Firewood 5. Other (please specify)

16. How many children under the age of 18 reside in your household? 1. None 2. 1
3. 2 4. 3 or more

17. What is your household's primary mode of transportation? 1. Personal vehicle (car, motorcycle)
2. Public transportation (taxi, "trotro", uber etc) 3. Walking 4. Cycling 5.
Other (please specify)

18. Have you or your household members experienced flooding in the last five years? If yes, how frequently? 1. Yes, frequently 2. Yes, occasionally 3. No

19. Are there any natural or artificial water bodies (e.g., rivers, lakes, canals) near your residence?
1. Yes 2. No

20. What is the approximate distance between your residence and the nearest water body?
1. Less than 500 meters
 2. 500 meters - 1 kilometre
 3. More than 1 kilometre
 - 4.

Not applicable

21. What types of early warning systems for floods can you access? (Select all that apply)

1. Local government alerts (e.g., text messages, emails)
2. Weather service alerts (e.g., meteorological department updates)
3. Community warning systems (e.g., sirens, public address systems)
4. Mobile apps (e.g., weather apps, disaster alert apps)
5. Broadcast media (e.g., TV, radio announcements)
6. I do not have access to any early warning systems
7. Other (Please specify)

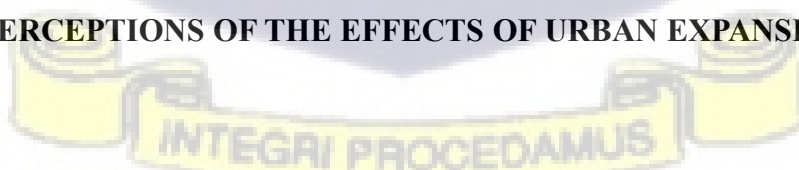
22. Are you aware of any flood mitigation measures implemented by local authorities in your area?

1. Yes
2. No

23. If yes, please specify the measures you are aware of:

.....

SECTION B: PERCEPTIONS OF THE EFFECTS OF URBAN EXPANSION ON FLOOD RISKS



24. Have you noticed any significant urban expansion or development in your area over the past decade?

- a) Yes, a lot of expansion b) Yes, moderate expansion c) No, very little expansion
d) No expansion at all

25. What type of urban expansion have you observed in your area? (Select all that apply)

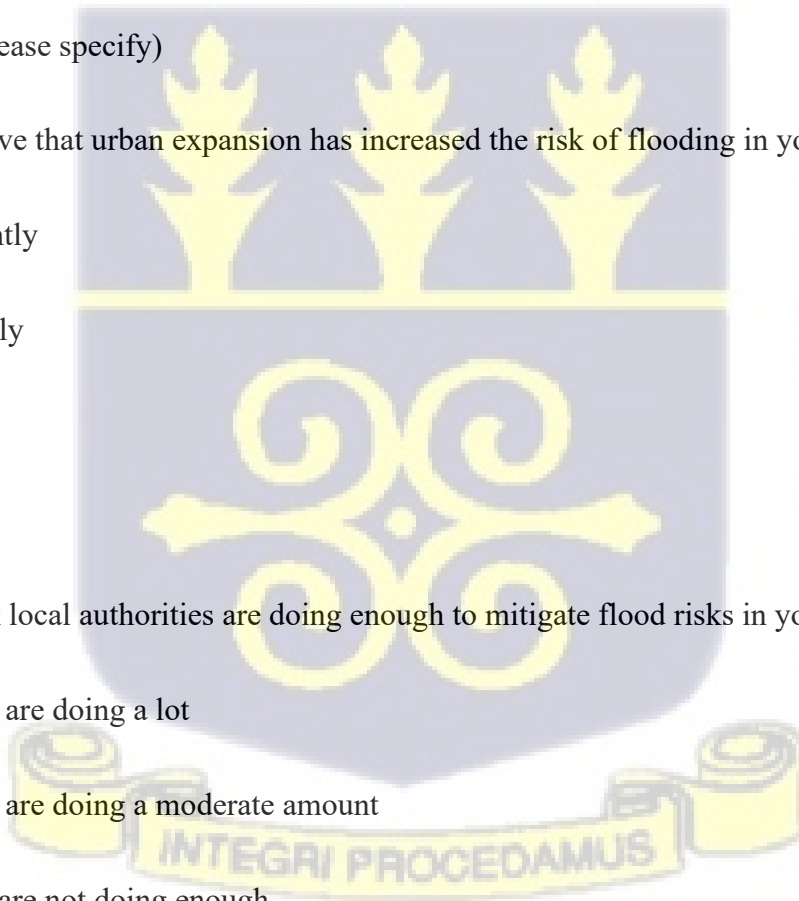
- a) Residential development
b) Commercial development
c) Industrial development
d) Infrastructure development (roads, bridges, etc.)
e) Other (please specify)

26. Do you believe that urban expansion has increased the risk of flooding in your area?

- a) Yes, significantly
b) Yes, moderately
c) No, not much
d) No, not at all

27. Do you think local authorities are doing enough to mitigate flood risks in your area?

- a) Yes, they are doing a lot
b) Yes, they are doing a moderate amount
c) No, they are not doing enough
d) No, they are not doing anything at all



28. If you answered "Yes" to the previous question, what are some of the things the local authorities are doing to mitigate flood risks? (Select all that apply in order of importance)

- a) Improving drainage infrastructure
- b) Implementing stricter regulations on urban development
- c) Increasing public awareness and education about flood risks
- d) Investing in nature-based solutions (e.g., green spaces, wetlands)
- e) Other (please specify)

29. In your opinion, what factors associated with urban expansion have exacerbated flood risks in GEMA? (Select all that apply)

- a) Increased impermeable surfaces (e.g., concrete, asphalt)
- b) Encroachment on natural waterways and drainage systems
- c) Reduction of green spaces and natural vegetation
- d) Inadequate urban planning and zoning regulations
- e) Poor infrastructure maintenance (e.g., blocked drains, culverts)
- f) Climate change and extreme weather events
- g) Sanitation issues
- h) Other (please specify)

30. In your opinion, what measures do you believe should be taken to reduce flood risks associated with urban expansion in GEMA? (Select all that apply in order of importance)

Measures	Select (in order of importance)
Improved drainage infrastructure	
Better urban planning and land use regulations	
Preservation of green spaces and natural waterways	
Public awareness and education campaigns	
Enforcement of building codes and regulations	
Other (please specify): _____	

SECTION C: SOCIOECONOMIC EFFECTS OF URBAN EXPANSION-INDUCED FLOODING

31. How has flooding caused by urban expansion affected your household's financial situation? 1.

- Significant financial strain 2. Moderate financial strain 3. Minor financial strain
 4. No noticeable impact 5. Improved financial situation

32. Have you experienced any property damage or loss as a result of flooding caused by urban expansion? 1. Yes, severe damage or loss 2. Yes, moderate damage or loss 3. Yes, minor damage or loss 4. No, no damage or loss incurred

33. How has flooding influenced property values in your neighbourhood as a result of urban expansion? 1. Decreased property values significantly 2. Decreased property values moderately 3. No noticeable change in property values 4. Increased property values moderately 5. Increased property values significantly

34. To what extent has flooding caused by urban expansion affected your ability to access essential services (e.g., healthcare, education, transportation)?

1. Significantly limited access
2. Moderately limited access
3. Slightly limited access
4. No noticeable impact on access
5. Improved access

35. How has urban expansion-induced flooding impacted your employment or business opportunities in GEMA due to?

1. Loss of employment/business opportunities
2. Reduced employment/business opportunities
3. No noticeable impact on employment/business
4. Increased employment/business opportunities
5. Improved employment/business stability

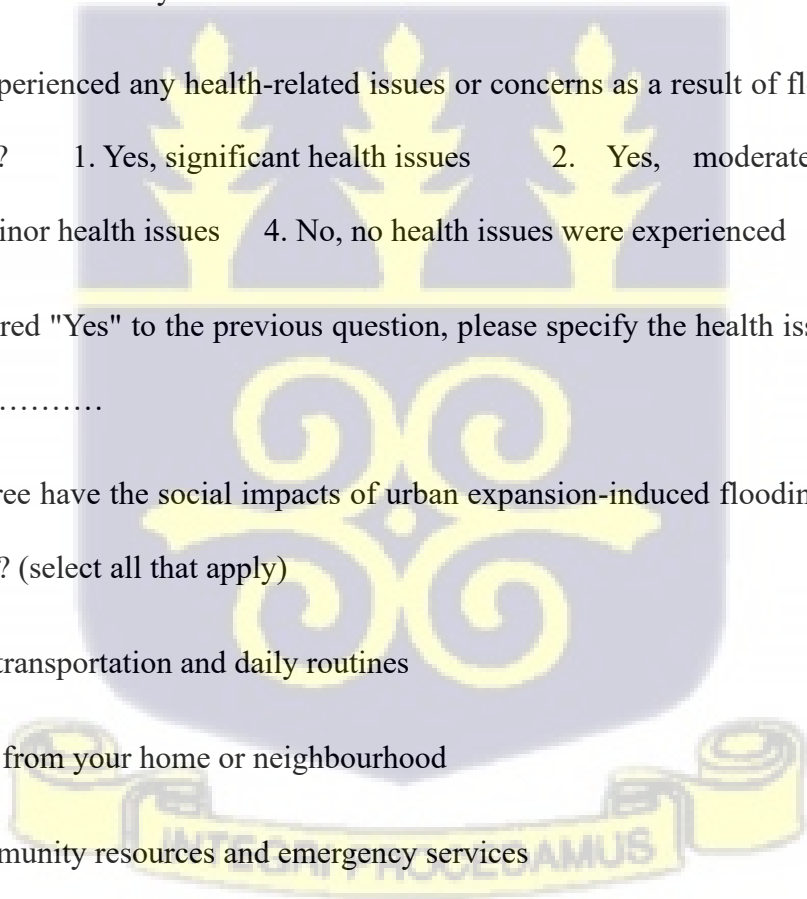
36. Have you experienced any health-related issues or concerns as a result of flooding caused by urban expansion?

1. Yes, significant health issues
2. Yes, moderate health issues
3. Yes, minor health issues
4. No, no health issues were experienced

37. If you answered "Yes" to the previous question, please specify the health issues experienced:
.....

38. To what degree have the social impacts of urban expansion-induced flooding affected you or your community? (select all that apply)

- a) Disruption to transportation and daily routines
- b) Displacement from your home or neighbourhood
- c) Strain on community resources and emergency services
- d) Mental health or emotional distress
- e) No significant social impacts



f) Other (please specify):

39. In your opinion, which socioeconomic group is most vulnerable to the impacts of flooding in urban areas? (Select one)

a) Low-income households

b) Elderly population

c) People with disabilities

d) Informal settlement residents

e) Other (please specify):

40. Do you believe that the socioeconomic effects of flooding have worsened due to urban expansion in your area? a) Yes, significantly b) Yes, moderately c) No, not much d) No, not at all

SECTION D: COPING STRATEGIES TO MITIGATE THE EFFECTS OF URBAN EXPANSION-INDUCED FLOODS

41. What measures have you taken to protect your property from flooding caused by urban expansion? (Select all that apply)

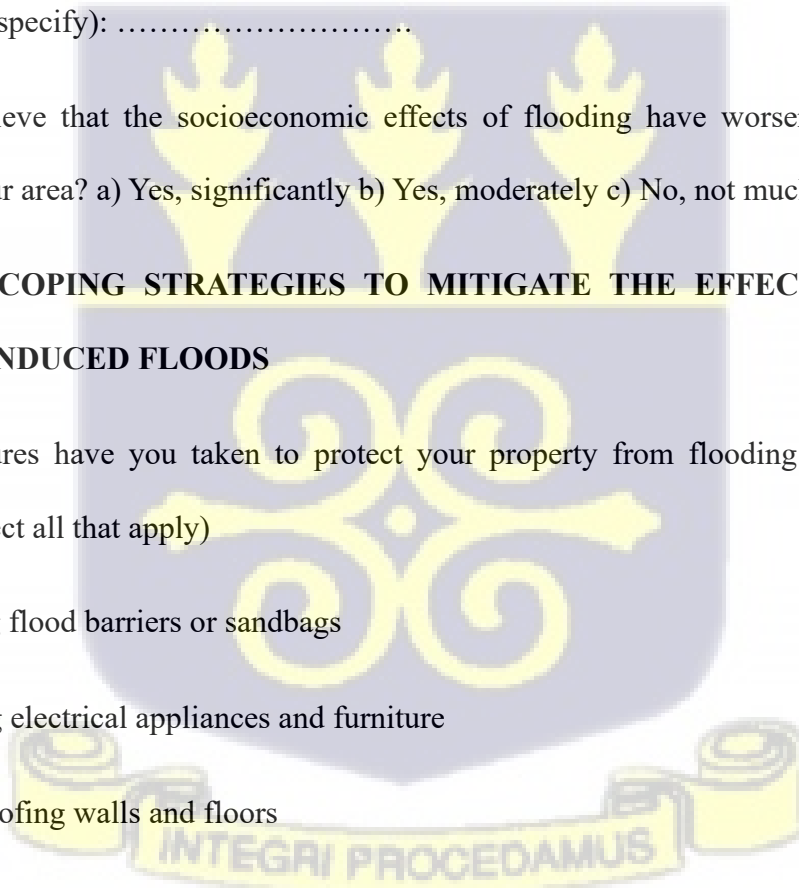
a) Installing flood barriers or sandbags

b) Elevating electrical appliances and furniture

c) Waterproofing walls and floors

d) Implementing landscaping measures (e.g., rain gardens, permeable paving, NBS)

e) Other (please specify)



42. Have you purchased flood insurance to mitigate potential losses from flooding?

1. Yes, comprehensive flood insurance coverage 2. Yes, partial flood insurance coverage
3. No, I do not have flood insurance

43. How do you stay informed about potential flood risks and warnings in your area? (Select as applicable)

- a) Monitoring weather forecasts and warnings
- b) Subscribing to emergency alert systems
- c) Following local news updates
- d) Participating in community flood preparedness programs
- e) Other (please specify)

44. Do you have an emergency evacuation plan in place in case of flooding? 1. Yes, a detailed evacuation plan for my household 2. Yes, a basic evacuation plan for my household
3. No, I do not have an evacuation plan

45. Have you invested in home improvements or modifications to reduce flood risks? (Select as applicable)

- a) Yes, upgrading drainage systems
- b) Yes, installing sump pumps or backflow valves
- c) Yes, raising electrical outlets and appliances
- d) No, I have not made any home improvements for flood mitigation

46. Are you involved in any community initiatives aimed at reducing flood risks?

1. Yes 2. No

47. If yes, what type of initiatives are you involved in? (Select all that apply)

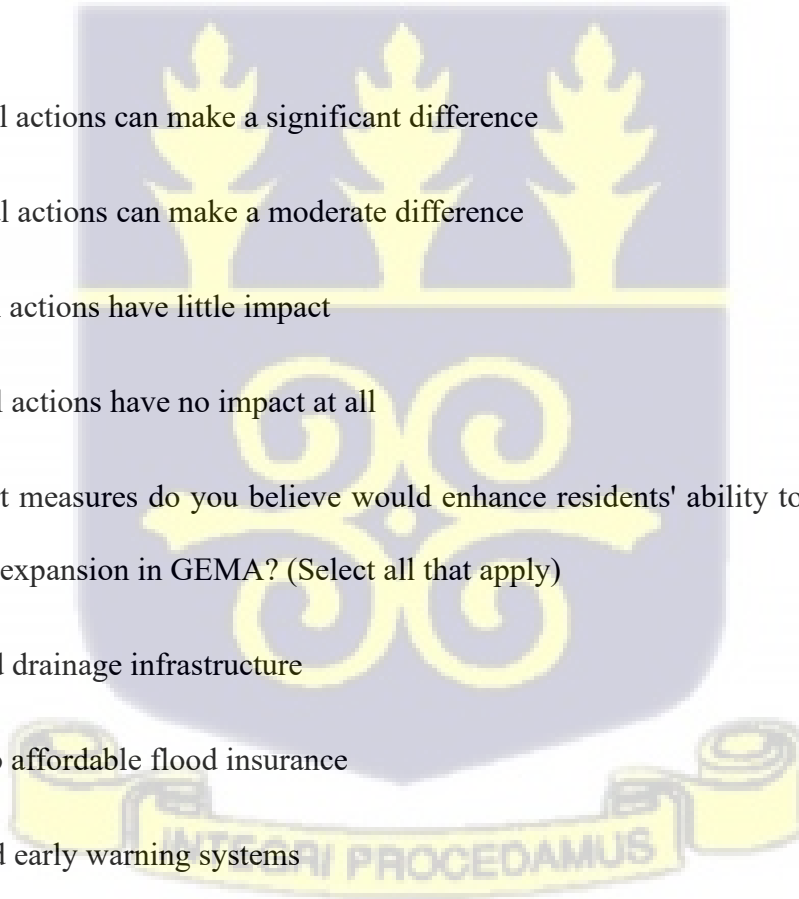
- a) Community clean-ups
- b) Advocacy and awareness campaigns
- c) Collaborating with local authorities
- d) Other (please specify)

48. Do you believe that individual actions can make a difference in reducing flood risks in urban areas?

- a) Yes, individual actions can make a significant difference
- b) Yes, individual actions can make a moderate difference
- c) No, individual actions have little impact
- d) No, individual actions have no impact at all

49. What support measures do you believe would enhance residents' ability to cope with floods caused by urban expansion in GEMA? (Select all that apply)

- a) Improved drainage infrastructure
- b) Access to affordable flood insurance
- c) Enhanced early warning systems
- d) Financial assistance for flood-resistant home improvements
- e) Community-based flood preparedness training



f) Other (please specify)

50. Do you have any additional information or comments that you would like to provide regarding the study on the effects of urban expansion on flood susceptibility in the Ga East Municipal Assembly?

a) Yes

b) No

51. If “Yes” in 50, specify:



APPENDIX B: INTERVIEW GUIDE FOR GEMA OFFICIAL



INSTITUTE OF STATISTICAL, SOCIAL AND ECONOMIC RESEARCH (ISSER)

UNIVERSITY OF GHANA

LEGON

SECTION A: GENERAL INFORMATION

1. Respondent's position:
2. Name of institution:
3. How long have you worked in this institution?
4. Level of education:

SECTION B: PERCEPTIONS OF THE EFFECTS OF URBAN EXPANSION ON FLOOD RISKS

5. Do you believe residents perceive urban expansion as a contributing factor to increased flood risks? Why or why not?
6. Are there any specific areas or developments that residents identify as problematic in terms of increasing flood risks?

7. From the assembly's perspective, how significant is the issue of urban expansion contributing to flood risks?

8. What measures, if any, does the assembly take to communicate the risks associated with urban expansion to the residents?

SECTION C: SOCIOECONOMIC EFFECTS OF URBAN EXPANSION-INDUCED FLOODING

9. How has flooding due to urban expansion affected the economic activities of residents in GEMA?

10. What are the observed social consequences of urban expansion-induced flooding on the community (e.g., displacement, health issues)?

11. How has the flooding influenced public infrastructure and services (e.g., transportation, schools, healthcare)?

12. Are there any long-term plans or policies in place to address these socio-economic effects?

SECTION D: COPING STRATEGIES TO MITIGATE THE EFFECTS OF URBAN EXPANSION-INDUCED FLOODS

13. What strategies or measures have residents adopted to cope with and minimize the impact of flooding?

14. Are there any community-driven initiatives aimed at flood risk reduction or management?

15. What support or resources does the assembly provide to help residents cope with flood risks?

16. How effective do you think these support mechanisms have been in reducing the impact of flooding?

17. Are there any policies or urban planning initiatives currently in place to mitigate the impact of future floods?



APPENDIX C: INTERVIEW GUIDE FOR COMMUNITY LEADERS AND RESIDENTS



INSTITUTE OF STATISTICAL, SOCIAL AND ECONOMIC RESEARCH (ISSER)

UNIVERSITY OF GHANA

LEGON

SECTION A: GENERAL INFORMATION

1. Respondent's position:
2. Name of institution:
3. How long have you held this position?
4. Level of education:

SECTION B: PERCEPTIONS OF THE EFFECTS OF URBAN EXPANSION ON FLOOD RISKS

5. What is your perception regarding urban expansion and its impact on flood risks?
6. Do you believe residents perceive urban expansion as a contributing factor to increased flood risks? Why or why not?

7. Are there any specific areas or developments that residents identify as problematic in terms of increasing flood risks?

8. Do residents express concern about urban expansion increasing flood risks? Can you share any specific instances or common sentiments?

9. How do you, as a community leader, educate or inform residents about these risks?

SECTION C: SOCIOECONOMIC EFFECTS OF URBAN EXPANSION-INDUCED FLOODING

10. How has the economic well-being of residents been impacted by flooding linked to urban expansion?

11. Can you give examples of individuals or groups who have faced significant economic challenges due to these floods?

12. What social challenges have arisen in the community as a result of urban expansion-induced flooding (e.g., displacement, health issues)?

13. How has the flooding affected daily activities and the quality of life for residents in GEMA?

14. What long-term social effects do you foresee if flooding continues at its current rate?

SECTION D: COPING STRATEGIES TO MITIGATE THE EFFECTS OF URBAN EXPANSION-INDUCED FLOODS

15. What actions or strategies have community members taken to cope with flooding?

16. Are there any notable community-led projects or initiatives aimed at mitigating flood impacts?

17. What kinds of support (financial, technical, or other) do residents receive from external sources (e.g., government, NGOs) to deal with floods?

18. What role do you and other community leaders play in helping residents cope with and prepare for flooding?

19. How do you collaborate with other stakeholders (e.g., government, NGOs) to enhance flood resilience in the community?



APPENDIX D

Table 4.6: Effects of Urban Expansion on Finances, Health and Properties of Residents

Financial Impact of Flooding						
Urban Expansion	Minor financial strain	No noticeable impact	Moderate financial strain	Significant financial strain	Total	
No expansion at all	0	7	1	6	14	
No, very little expansion	1	4	16	8	29	
Yes, moderate expansion	8	15	8	20	121	
Yes, a lot of expansion	15	44	9	53	51	
Total	24	64	40	87	215	
Chi-square value (χ^2) = 49.0381, P value = 0.000						
Health Impact of Flooding						
Urban Expansion	No, no health issues were experienced	Yes, minor health issues	Yes, moderate health issues	Yes, significant health issues	Total	
No expansion at all	7	0	2	5	14	
No, very little expansion	18	2	1	8	29	
Yes, moderate expansion	25	8	12	6	51	
Yes, a lot of expansion	32	25	36	28	121	
Total	82	35	51	47	215	
Chi-square value (χ^2) = 27.6155, P value = 0.001						
Impact of Flooding on Properties						
Urban Expansion	No, no damage or loss incurred	Yes, minor damage or loss	Yes, moderate damage or loss	Yes, severe damage or loss	Total	

No expansion at all	6	0	1	7	14
No, very little expansion	15	0	7	7	29
Yes, moderate expansion	9	6	19	17	51
Yes, a lot of expansion	10	14	45	52	121
Total	40	20	72	83	215
Chi-square value (χ^2) = 49.0381, P value = 0.000					

Source: Field Data, 2024

