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Informal Urban Settlements, Adverse Weather Events and Adaptation: Responses to Incidents of Flash Flooding by Residents in Eerste Fabriek, Mamelodi

Department of Anthropology and Archaeology

Dissertation

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DEDICATION

This work is dedicated to my late Mother (Cynthia Mogotsi),

The last four years have been difficult without you. I am honoured to have been raised by a woman of your calibre. You raised me with love and taught me the importance of education. I live by all your teachings and I hope you're proud of me. I hope you are still resting in peace.

I love you dearly.

Love,

Your lastborn, Dineo

DECLARATION

I hereby certify that this thesis is the result of my own work, except where otherwise indicated and due acknowledgement is given.

Signed: _____ Date: _____

Ms D.A Mogotsi

The student

ETHICS STATEMENT

The author, Dineo Mogotsi, whose name appears on the title of the page of this dissertation has obtained for this research described in the work and proposal, the applicable ethical research approval.

The author, Dineo Mogotsi, declares that she has observed the ethical standards required by the University of Pretoria's Code of Ethics for researchers and the policy guidelines for responsible research.

Signature: _____

Date: 29 November 2024

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To God, Almighty and my ancestors, only you know the plans that you have for me. Thank you for carrying me. Amen!

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ABSTRACT

The adverse impacts of climate change, mainly droughts and floods that affect agriculture activities, are pushing rural households to migrate to urban areas. Through this rural push, people move to the city to search for work, better economic opportunities, and a higher standard of living to mitigate the adverse impacts of climate change-linked weather events. In developing countries, the pace at which people move into urban areas is often faster than the development of formal urban settlements and related amenities. As a result, many who migrate to cities and towns end up living in informal settlements. Some of these informal settlements are built in vulnerable locations where the impacts of extreme climate change-linked weather events such as floods, drought, heatwaves, and severe fires, amongst others, are dire when they manifest. Against this background this study, examines the case of the case of Eerste Fabriek, an informal settlement in Mamelodi, Pretoria, in South Africa, seeking to analyse the community's vulnerability and adaptability to the adverse effects of climate change. This settlement has recently been adversely affected by a series of climate change incidents of flooding. The qualitative study gathered data through key informant interviews, household semi structured interviews, observation and the use of document review. The research found that many of the respondents perceived repeated cases of flooding in the area as a man-made phenomenon, discounting the contribution of climate change to the recent incidents of flooding. This indicates a lack of understanding of the drivers of climate change and its impacts. Noting the likelihood of increased climate change-related extreme weather events, the research recommends an increased intensity of educating people in this settlement and beyond on the drivers, impacts, evidence, and management of the climate change phenomenon.

Keywords: Climate change, informal settlements, urbanisation

LIST OF ACRONYMS & ABBREVIATIONS

COGTA= Cooperative Governance and Traditional Affairs

CoT= City of Tshwane

DID= Department of Infrastructure Development

GBV= gender-based violence

GCROCCRSAP= Gauteng City Region Over-arching Climate Change Response Strategy and Action Plan

GDARD= Gauteng Department of Agriculture and Rural Development

GDP= Gross Domestic Product

IPCC= Intergovernmental Panel on Climate Change

KII= Key Informant Interviews

MEC= Member of the Executive Council

MMC= Member of the Mayoral Committee

NCCAS= National Climate Change Adaptation Strategy

NCCRP= National Climate Change Response Policy

NDP= National Development Plan

RDP= Reconstruction Development Programme

Red Ants= Red Ant Security Relocation & Eviction Services

SA= South Africa

SAWS= South African Weather Services

UN= United Nations

UNFCCC= United Nations Framework Convention on Climate Change

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CHAPTER 1: INTRODUCTION

1.1 Introduction

This study considers urban informal settlement communities and their vulnerability and responses to the impact of climate change. It focuses on an informal settlement community in Mamelodi Township's Eerste Fabriek area which has faced significant flooding in the past. The aim is to analyse the community's vulnerability and adaptability to the adverse effects of climate change. Additionally, the study aims to assess the residents' understanding of climate change and how they explain the adverse climatic events they have experienced. The study adopts a qualitative research design to draw on residents' experiences and perceptions. The study is significant because it contributes to an understanding of the circumstances that exacerbate informal settlement communities' vulnerability to climate change and may be informative to the Gauteng government and non-state actors who wish to increase communities' adaptation capacity for the future, because more adverse weather events are predicted.

This section serves as an introduction to the study and sets out the approach that will be adopted. It defines the research problem and presents the research objectives and questions before outlining the significance of the study. It then indicates the relevant theoretical framework gleaned from a preliminary literature review, before describing the methodology adopted by the study. This proposal concludes with the discussion of the organisation of the dissertation.

1.2 Research problem

Climate change is caused by an increase in the emission of greenhouse gases, such as carbon dioxide. Human activities such as industries, human settlements, deforestation and crude farming techniques (Aparaku et al., 2019) are some of the causes of the current changes to the climate as well as fossil fuels such as coal, oil, and natural gas (Nenweli, 2015), which in turn accelerates climate change. These activities are often identified particularly in urban settings: the literature on climate change has shown that there is a direct link between urbanisation and climate change (Filho et al., 2019). Urban areas are responsible for 80% of the world's anthropogenic greenhouse gases (Filho et al., 2019).

Africa's growing informal settlements are increasingly vulnerable to the risks posed by climate change and are confronted with significant challenges in terms of adaptation. The literature has shown that increased climate change variability creates a problem for those who live in badly built informal housing in urban informal settlements, mainly because their socioeconomic status is a threat to their adaptive capacity (Heath, Parker & Weatherhead, 2012). As part of a vicious cycle, climate change is exacerbated by rapid and unplanned urbanisation which affects low-income urban populations.

Some of the occupants of these informal settlements come from rural backgrounds. In particular, the Gauteng province has seen a great increase in informal settlements because of rural-urban migration (Modiba, 2021). As a result, these occupants have no choice but to live in environmentally risky areas such as floodplains and in buildings built with poor quality materials (Reckien et al., 2017). Occupation of environmentally risky areas reflects the vulnerability of these populations to the impacts of climate change and the need for intervention by state and non-state actors. When they arrive in the city in search of a better life, these migrants face insecure land tenure and cannot afford proper housing (Amoako, 2018).

This study seeks to analyse the community's vulnerability and adaptability to the adverse effects of climate change. It uses the case study of an informal settlement in Eerste Fabriek in Mamelodi Township, Pretoria. This informal settlement occupies a piece of lowland near the Moretele River, which flows through Mamelodi Township. As in most informal settlements in the country, residents occupy temporary and improvised structures which highlight their poverty and vulnerability to adverse weather events.

In December 2019, Mamelodi Township experienced heavy rains, which resulted in flash floods. The informal settlement was inundated, and 700 shacks were destroyed; 1 300 people were displaced (Mitchley, 2019). The damage and destruction due to flooding also highlight the precarious nature of informal settlements, especially as climate change related to weather events increases. The 2019 flood was the third incident of flooding that had taken place in ten years in the area (Mitchley, 2019). The Gauteng Provincial government and the Tshwane Metropolitan City Council have so far done nothing, although the Tshwane Municipality has warned the community several times against occupying the land because it is on a flood plain. Nevertheless, the losses caused by the flood should have been prevented. During its Third Annual Gauteng Climate Change Indaba, the Deputy Director General of the Gauteng

Department of Agriculture and Rural Development (GDARD) made climate predictions for Gauteng that should have led to action. He predicted a drier climate with higher temperatures and longer dry spells, marked with intense but short rainfall events that would lead to flash floods, increased erosion, and heightened pressure on infrastructure and negative impacts on agricultural practices (Odendaal, 2019). Despite these predictions, warnings by the Municipality Council and the fact that the flooding was the third such incident, the makeshift housing structures have been rebuilt, and life has returned to its usual precarious form (Mitchley, 2019).

The third incident, despite previous experiences of flooding and warnings, tells a story of the community's adaptation, or rather, lack of adaptation. Adaptation in the context of this study means "the ability to cope with future climate change stimuli" (Nhuan et al., 2016: 61). This is essentially reflected in socioeconomic differentials "that affect the potential and capability of a household to adapt to climate change stimuli and disasters" (Nhuan et al., 2016: 61). From this definition, lack of adaptation or maladaptation is "a process that exacerbates the negative impacts of climate change on the territory, sector and/or group of people through the exacerbation of existing causes of vulnerability or the creation of new ones" (Magnan et al., 2016: 652). Magnan et al. (2016) further assert that if the main drivers of maladaptation, such as socioeconomic status, culture and governance, are neglected, then it has the effect of increasing vulnerability to climate variability.

The flooding incidents highlight the need for adaptation and mitigation strategies, and the additional stresses caused by the level of poverty in South Africa. This study will focus on the vulnerability of this community, its adaptation strategies, its understanding and knowledge of climate change in general, and in particular, how people explain the occurrence of such adverse weather events. The study will also focus on government and other non-state actors' responses to these incidents.

1.3 Research objectives

This study seeks to understand the vulnerabilities, knowledge and understandings, and adaptation capabilities of an informal settlement community in the Tshwane Metropolitan Municipality. The research explores government and non-state actor responses to such communities following natural disasters. This study aims to depict these incidents as not only unique to the Mamelodi community but in relation to the vulnerabilities and lack of

adaptation capabilities of informal settlement communities in the country in general, as such settlements are often established on vulnerable land – some of it close to rivers. The study seeks to analyse the community's vulnerability and adaptability to the adverse effects of climate change.

Within this broad aim, the study seeks to achieve four specific objectives which focus on specific aspects of the study which are:

- To identify and discuss the vulnerabilities of dwellers in the informal settlement in Eerste Fabriek in Mamelodi Township.
- To explore the knowledge and understanding of climate change and explanations of adverse weather events of residents in Eerste Fabriek, Mamelodi.
- To investigate the responses of residents to adverse weather events that have affected the community; and
- To analyse government and non-state actors' responses to the informal settlement community in Eerste Fabriek, Mamelodi Township.

1.4 Research questions

This study seeks to understand these issues by answering one overarching question:
How vulnerable, adaptive, and knowledgeable are households in an informal settlement in the Mamelodi Township Eerste Fabriek area regarding heightened adverse climatic events?

This overarching question can further be broken down into a series of specific questions addressing specific aspects of the study which are:

- What are the factors that make households of the informal settlement community in Eerste Fabriek in Mamelodi Township vulnerable to adverse weather patterns associated with climate change?
- How do households in this informal settlement understand climate change, and how do they explain adverse weather events and their resultant effects on their community?
- How have households responded to the adverse weather events? What mechanisms do they have in place to adapt to adverse weather events?
- How has the government and non-governmental institutions responded to the informal settlement community's situation in the context of increased climate change vulnerability?

1.5 Significance of the study

Most of the literature (Agyabeng et al., 2022; World Bank, 2022; van Niekerk, 2018) on underdeveloped or developing countries focuses on town planning aspects and policies and their effects on urban areas, rather than on the impact of climate change on urban informal settlement households. The study adds to the literature on climate change adaptation in urban areas with a focus on Mamelodi. It gives an analysis of climate change adaptation with an emphasis on an urban population that resides in an informal settlement. The study provides a household-level analysis of vulnerability to climate change. This study highlights the coping strategies and adaptation of urban households to extreme weather events. The study will assist the government to improve adaptation strategy policies that will support pro-poor populations. This research will also contribute to increasing government awareness regarding the pressing need for affordable housing in impoverished urban communities. The aim is to mitigate the impacts of climate change by discouraging the availability of low-cost accommodations in high-risk areas.

1.6 Structure of the dissertation

The dissertation is organised into six chapters. The first chapter introduces the study, spells out the research problem, contextualises the study, presents the main objective and research questions and significance of the study. The second chapter provides a review of the relevant literature. This literature review is developed into a theoretical framework with terms such as urbanisation, informal settlements, climate change in urban areas and vulnerability and adaptation. Chapter 3 discusses the techniques and methodological approach for conducting the study.

Chapter 4 presents the findings. It begins by providing a background into urbanisation and climate patterns in South Africa. It discusses formal housing and the emergence of informal settlements in South Africa. This is followed by Chapter 5 which presents the data collected. The Chapter provides a profile of the City of Tshwane, Mamelodi and the informal settlement under study. It shows how vulnerable, adaptive, and knowledgeable households in an informal settlement in the Eerste Fabriek, Mamelodi Township are. It presents the socioeconomic statuses of the households and the vulnerabilities experienced by the households because of the extreme weather events. The Chapter provides the perception and knowledge the dwellers have on climate change and the impact of flooding on the

households. Additionally, it presents how they adapt to climate change-related events of flooding by presenting the adaptation and coping strategies of the community, which unpacks the role of state and non-state actors in response to climate change in this community. Finally, Chapter 6 concludes the study by pulling together the themes discussed in Chapters 4 and 5. It re-states the main objective and argument and provides policy recommendations and its implications.

CHAPTER 2: BACKGROUND TO URBANISATION AND CLIMATE CHANGE IN SOUTH AFRICA

2.1 Introduction

This chapter links climate change to rapid urbanisation and the development of informal and illegal settlements. The analytical framework guiding this study brings together key concepts, which are defined in this section: 1) climate change, 2) adaptation, 3) urbanisation, 4) informal settlement, and 5) vulnerability. These concepts are analysed with a view to developing an understanding of the informal community in the Eerste Fabriek area in Mamelodi Township to address the research questions. The framework of analysis is represented in Figure 1. The chapter also discusses the various stages of development in South Africa which provide a roadmap of the rise of urbanisation. An overview of colonialism, capitalism, and apartheid during the colonial era is provided in this chapter.

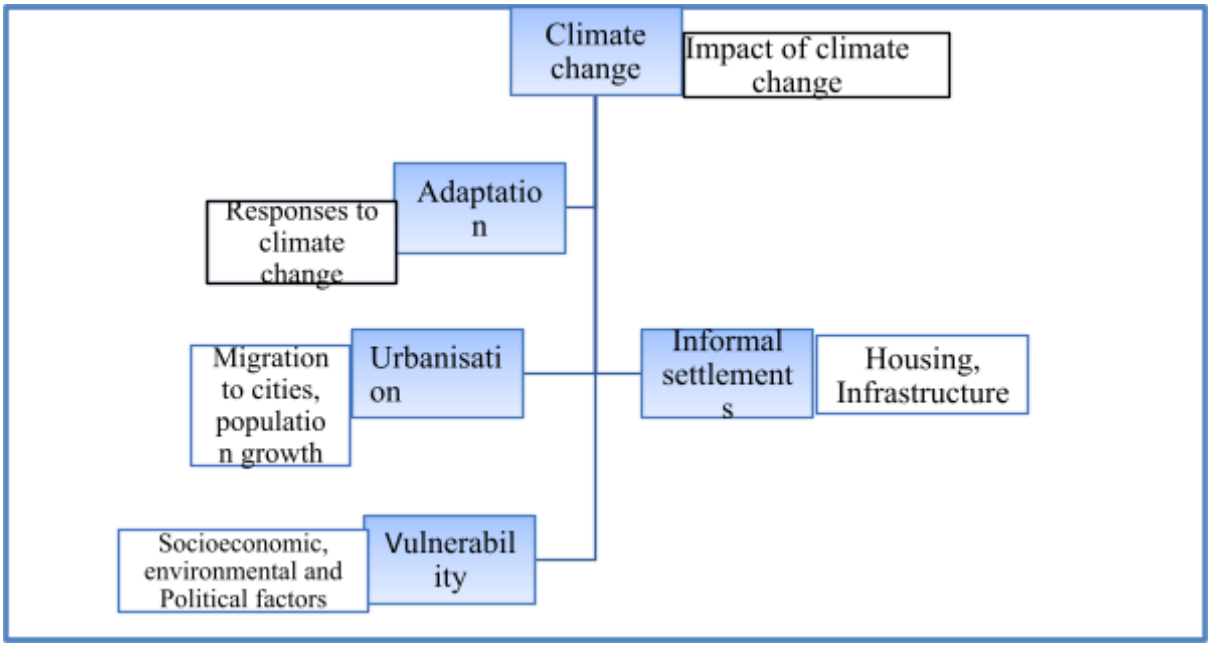

Figure 1: Framework of the study

2.2 Discussion of concepts

The section below discusses concepts that are linked to the study which are climate change, urbanisation, informal settlements, vulnerability and adaptation.

2.2.1 Climate change

Climate change is caused by an increase in the emission of greenhouse gases such as carbon dioxide. The gases are from both natural and anthropogenic processes. Natural processes such as melting sea ice and volcanic eruptions emit lots of carbon dioxide into the atmosphere and have contributed to climate change. Anthropogenic drivers are coal, natural gas, and oil for powering industry, transportation, home heating, electricity generation (United Nations (UN), undated), human settlements, industralisation, deforestation and crude farming techniques (Aparaku et al., 2019). The use of these fossil fuels increased due to industrialisation which to date is energy intensive. These anthropogenic activities account for 71% of greenhousegases with the least-emitting countries only contributing 3% (UN, 2022). These activities are often identified particularly in urban settings: the literature on climate change has shown that there is a direct link between urbanization and climate change (Filho et al., 2019). Urban areas are responsible for 80% of the world's anthropogenic greenhouse gases (Filho et al., 2019).

There is no universal definition or description of the term climate change. Table 1 gives a sample of some of these definitions and descriptions.

Definition/Description	Reference
1. "A change in the state of the climate that can be identified... by changes in the mean and/or the variability of its properties and that persists for an extended period"	Santos & Bakshoodeh, 2021: 1
2. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as change which is closely linked, directly or indirectly, to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable periods.	UN, 1992

	3. A change in the state of the climate that can be identified (e. g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer	GCROCCRSAP, 2020

Table 1: A sample of definitions and descriptions of climate change

The common feature in the definitions above is that climate change is a long-term phenomenon, unlike short-term climate variability. Climate change manifests through “intense droughts, water scarcity, severe fires, rising sea levels, flooding, melting polar ice, catastrophic storms and declining biodiversity” and can cause harm to freshwater, food security and energy” (UN , undated).

Globally, governments are aware of climate change and have taken action to mitigate and adapt to it. In 1992 during the Rio Earth Summit, the United Nations Framework Convention on Climate Change (UNFCC) was adopted to cut down on the emission of greenhouse gases, cut emissions, adapt to climate impact and finances for adjustments used to measure progress on climate action" (UNFCC, 1992). The UNFCCC developed National Adaptation Plans in several states.

The Paris Agreement established at the Conference of Parties 21 (COP) is "a universal agreement which aims to keep a global temperature rise for this century well below 2 degrees Celsius" (Sustainable Development Goal (SDG) Knwoledge Platform, 2022). The increase in temperature was limited to 1.5 degrees Celsius above pre-industrial levels. Sustainable Development Goal 13 (SDG 13) established by the United Nations General Assembly in 2015, focuses on integrating climate change into national policies, improving mitigation and adaptation to climate change through education, increasing awareness and institutional capacity, and lessening the impact and early warnings (SDG Knwoledge Platform, 2022). Climate change adaptation funding in developing countries was doubled at the Glasgow Climate Pact in 2021 at COP 26 (Maizland, 2021). The global adaptation goal is to identify the needs and solutions to climate change.

Due to the higher productivity it accelerates, urbanisation is also contributing to a larger ecological footprint (Mc Granahan & Satterthwaite, 2014). Anthropogenic activities such as these produce greenhouse gases that are overheating the planet, a phenomenon known as global warming (Kabir, Habiba, Iqbal, Shafiq, Farooqi, Shah & Khan, 2023). Global warming drives climate change which is apparent in extreme weather events such as floods, droughts and heatwaves. Climate change and urbanisation have led to the movement of people to low-income countries with weak adaptive capacities.

2.2.2 Urbanisation

Urbanisation is the shift in populations from rural to urban settlements. Increased urban population is shaped by natural population increase, rural-urban migration, and reclassification of some rural areas into 'urban' areas (StatSA, 2006). The Industrial Revolution in Europe in the late 1700s and the period of industrialisation in North America in the 1800s propelled urbanisation (Muzondi, 2014). The rapid expansion of industries in cities brought job opportunities to many people in developed countries. During the 1950s, developed countries began experiencing a decline in the urban pull also known as counter-urbanisation. In response to changing urban conditions such as crime, pollution, retirement, and greater mobility, people moved to rural areas. The city was now accessible by car.

This study utilises the dependency theory as an attempt to explain urbanisation. It argues that in Africa, urbanisation was caused by the introduction of capitalism to Africa as a continent of many developing countries - a product of colonisation. Migration was a means to overcome this inequality. People in rural areas were subjected to poverty and had to migrate to the cities to seek economic opportunities. This resulted in population growth in the urban centres and increased the need for housing (Moloisane, 2018).

One outcome is the unequal relationship between the rural and the urban areas, where corporate capitalism is located (Moloisane, 2018). One of the factors driving rural-urban migration is rainfall patterns. During periods of low rainfall and heavy rains, extreme weather events such as droughts and floods occur. These extreme weather events are a threat to water and food security in rural areas (Nenweli, 2015).

Climate variations negatively impact agricultural activities and output in rural households due to the reliance on natural resources (Nenweli, 2015). Consequently, people living in rural

areas are forced to seek employment in cities. Migration is a job-hunting strategy and there is a belief that there are better standards of living, employment and economic opportunities in the city.

Climate change also interacts with an array of factors, such as changing value systems, which leads to rural households' individuals moving to the city (Nenweli, 2015). This means climate change does not just drive migration on its own but it works alongside social and economic transformations, such as the changing aspirations of rural populations. Together, these forces lead individuals from rural households to move to cities, accelerating urban growth and reshaping the socio-economic landscape. Rural-urban migration can also be caused by political instability and wars. Behavioural decisions such as changing value systems among the youth can lead rural households or individuals to migrate to the city (Nenweli, 2015). People went to secure economic opportunities due to issues of poverty. Since the 1950s, less economically developed countries in Africa and Asia have seen a 17,8% increase in their urban population largely due to rural-urban migration (Zhang, 2016).

In the developed world, urbanisation took place because of the urban pull, which attracted people to professions, jobs and education. In the developing world, urbanisation came about because of the urban push to diversify household income. Before the 1950s, urbanisation was taking place at a high rate in developed countries and has since slowed down. Developed countries have completed their demographic transition as their socioeconomic development has led to lower mortality and fertility rates due to higher income levels (World Bank, 2022). Urban systems such as transportation, power and water supplies are balanced in developed countries with the population decreasing in large cities and increasing in small and medium-sized cities (Zhang, 2016). Developing countries are still transitioning with Sub-Saharan Africa's urban population increasing at a higher rate than any other region. Urban growth in developing countries takes place in the largest cities. 74% of developing states intervened by coming up with policies to reduce migration (Zhang, 2016).

Presently, 56% of the world's population (4,4 billion people) live in cities (World Bank, 2023). It is anticipated that by 2050, nearly 7 out of 10 people in the world will be living in the cities (World Bank, 2023). In addition, climate change will accelerate and spread internal migration. By 2030, "hotspots of internal migration" will emerge and by 2050, about 216 million people will be moving inward (World Bank, 2021). Therefore, in the absence of sufficient urban planning, governance and infrastructure, the consequences of urbanisation

are unemployment, poverty, a lack of alternative adequate housing and social and economic marginalisation (William, Manez-Costa, Sutherland, Celliers, & Scheffran, 2019).

2.2.3 Informal settlements

By 2025, 1.6 billion people are expected to be affected by the global housing shortage (World Bank, 2022). The urban poor have a difficult time choosing where to live as they want to be close to work opportunities, secure tenure, services and protection from extreme events, and cost (UN-Habitat, 2019). Urban populations face challenges such as development control, meagre formal land distribution system and shortages of land (Matamanda, 2020). Consequently, informal dwellers will most likely resort to illegal ways of getting land or housing (Matamanda, 2020).

Globally, informal settlements are now a trend in urban areas because they fill a housing gap and meet the needs the state hasn't met such as land provision (Nenweli, 2015). In 1990 alone, the world had an additional 200 million informal dwellers (Mgushelo, 2018). Informal settlements are unplanned residential areas where houses have been built on land which occupants do not own or occupy illegally (William et al., 2019). They are located on the outskirts of an urban area, on land which is “inexpensive, vacant, underutilised, and/or neglected” (Mgushelo, 2018: 28). People occupy spaces/land not meant for development such as natural wetlands, floodplains or land infills or mining dump sites (Moloisane, 2018), causing insecure tenure (Moser et al., 2010). Residents choose these sites as they are less likely to face eviction, moreover this land is unappealing to developers (Satterthwaite, Archer, Colenbrander & Dodman, 2018).

The physical characteristics of informal settlements include unfavourable land, quality of building materials and lack of access to infrastructures such as piped water, sanitation, effective drains and all-weather roads and paths (Reckien et al., 2017). They are not as solid or insulated as they should be and are seldom built on rocky foundations. The shacks are built with materials described as "of diverse origin and quality" such as "plastics, cardboards, metal tins, zinc sheets and timber" (Muzondi, 2014). They are not built according to the techniques needed to bear natural disaster impacts. Shacks are usually built in confined spaces in overcrowded settlements.

Informal settlements face the following challenges: poor sanitation where an improper sanitation system leads to or exposes residents to floods and infectious diseases. Air pollution

is caused by major industrial sites which used to be located on the urban periphery and are now within the centre of residential areas (Nassar & Elsayed, 2017). Residents are confronted with solid waste like agricultural, animal, municipal and industrial waste because of "poor equipment, maintenance, processing management, lack of waste treatment" and daily waste collection is scanty (Nassar & Elsayed, 2017: 2372). This results in waste disposal practices such as makeshift toilets, dumping and burning which contribute to environmental degradation and pollution (Ngwenya-Bendile, 2021).

Informal dwellers face social exclusion and protection because they are not considered as 'formal' (UN-Habitat, 2018). As a result, they do not have legal recognition and cannot open bank accounts due to not obtaining legal addresses (UN-Habitat, 2018). Informal dwellers are also not part of formal livelihoods, labour markets, formal premises, formal land/property titles and formal housing (and formal land for housing) markets for tenants and owners (Satterthwaite et al., 2018). Additionally, they do not comply with government planning and land use systems (Satterthwaite et al., 2018). They lack access to safe drinking water, healthcare, basic education and infrastructure (UN-Habitat, 2018).

Informal settlements give the urban poor a chance at survival in the city because the informal dwellers can access socioeconomic opportunities at a lower financial cost (Nenweli, 2015) even though they are considered as ‘informal’. Residents of informal settlements contribute enormously to city economies through informal employment. Despite the importance of informal settlements which house the informal labour force, the government still ignores some of the challenges experienced by communities of this nature (Satterthwaite et al., 2018).

Informal settlements are prevalent in underdeveloped countries like Kenya, Tanzania and Ghana. Such informal settlements are located on hazardous land which leaves them susceptible to flooding. Table 2 below gives examples of informal settlements which have experienced flooding in Africa.

Country	**Informal settlements which have experienced flooding in Africa**
Kenya	It was reported that dwellers of informal settlements in fast-growing urban centres in Mombasa & Estelí, Kenya lived on what they call 'riparian' land that is located on the edge of a river or sea which regularly flooded with high tides (Moser et al., 2010:19).

Tanzania	Magomeni Suna is an informal settlement situated in Dar es Salaam, Tanzania, prone to heavy rain and flooding. The informal settlement is bordered by two rivers in the city. This community experienced 'ordinary' floods until 1998 when they experienced a terrible flood caused by El Niño (John, 2020).
Ghana	In Accra, Ghana, flooding is associated with the Odaw drain, which is the main river flowing through the city into the ocean (Kasei, Kalanda-Joshua & Benefor, 2019).

Table 2: Informal settlements in Africa

Adverse weather events are a threat to those who do not live in formal structures (Kasei et al., 2019). Informal settlements and their dwellers who emit the lowest greenhouse gases face physical, economic and social vulnerabilities that make them vulnerable to the negative impacts of climate change (Mc Granahan & Satterthwaite, 2014).

Informal dwellers' access to water is affected as their water is usually delivered in tankers (UN-Habitat, 2018). Water trucks are unable to gain entry to the settlements. In some cases, there is a lack of proper infrastructure to ensure that water does not flow into the houses and a lack of stormwater pipes and drainage systems. Flooding can be made worse by city development, which tends to build over natural drainage systems or fails to maintain drainage channels which are blocked by waste in cases where garbage collection is inadequate (Revi et al., 2014).

2.2.4 Vulnerability

Climate change not only exacerbates pre-existing vulnerabilities but sabotages the efforts of development in urban areas. It affects urban transportation and telecommunication infrastructure. Bridges, tunnels, roads, railways, pipelines, port facilities, data sensors, wire and wireless networks are damaged (Revi et al., 2014). Emergency vehicles and staff may not be able to enter informal settlements thereby hindering disaster response and recovery efforts (Revi et al., 2014).

Most studies on climate change tend to compare vulnerability between poor and rich countries instead of comparing vulnerability between poor people and rich people (Hallegatte & Rozenberg, 2017). This comparison can be achieved through micro-level impacts of climate change on households. Exposure to hazards or risks affects the livelihood and income

levels of households in informal settlements. Extreme weather events prevent residents from going to and losing time from work or school, affecting their livelihoods. For example, residents of an informal settlement in Manica called Bemba in Mozambique prone to flooding could not go to work or receive stock for small businesses. The water levels made it difficult for them to leave their homes and vehicles could not enter the settlement. Some residents lost personal belongings. These effects worsened their low socioeconomic status, posing a threat to their livelihoods (Tadgell, 2017). Therefore, these vulnerabilities reveal and create a vicious cycle where climate change aggravates poverty and social inequality. It also exposes political and economic vulnerabilities. Sanchez-Rodriguez (2009) calls for vulnerability to be studied and addressed as a step towards building adaptive capacity and ensuring adaptation.

Vulnerability refers to the limited adaptive capacity of individuals and/or groups of people (Nenweli, 2015). Adaptive capacity is "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (National Climate Change Adaptation Strategy (NCCAS), 2019: 3). Vulnerability of a community is based on its social and economic status (Malakar & Mishra, 2017), its demographics (Stankuniene, Streimikiene, & Kyriakopoulos, 2020) such as age, disabilities, education (including knowledge and understanding of climate change, weather forecast information and long-range weather forecasts), perception and political environment (Stankuniene et al., 2020) and status. The Rockefeller Foundation's resilience indicators include the unemployment rate and the availability of community facilities (Filho et al., 2019).

There are two studies that portray vulnerability based on socioeconomic factors. Firstly, a study on Australian households found that the households' responses to heat waves were part of daily practices or routines and that these events were not necessarily perceived as an environmental problem that they needed to adapt to (Cornes & Cook, 2018). These findings suggest that these households do not understand the scientific aspect of climate change and its social impacts and undertake adaptive strategies without being aware of the cause of their discomfort. Moreover, such households are robbed or rob themselves of an opportunity to influence adaptation policies against climate change. Secondly, in a study on flooding and vulnerability in informal settlements in South Africa, Musungu, Drivdal, and Smit (2016) highlighted the significance of grasping a community's knowledge and perception of climate

change or extreme weather events if one is to understand the extent and manner of adaptation (Musungu et al., 2016).

Weakley (2013) defines vulnerability as the ability to recognise risk but not be able to mitigate it, thus experiencing its negative impacts. The action taken against risks is determined by the likelihood of certain hazards occurring, the magnitude of the hazard and their vulnerability and exposure to the hazard (Weakley, 2013). The author further states that a misconception that poverty is equal to vulnerability may stem from using socioeconomic factors to determine vulnerability. There is a paradox as not all poor people are vulnerable and those who face risks are not exposed in the same way. Smallholder agriculturalists in Bangladesh and pastoralists in the West African Sahel have displayed great resilience to environmental change (Forsyth, Evans, Natalie, 2013).

On the other hand, those with a higher socioeconomic status can be vulnerable to risks (Weakley, 2013). Perhaps urban populations with higher incomes can be vulnerable to climate change, especially those that live along coastal areas and riverbanks but they may be able to mitigate the risk (Nenweli, 2015). For this reason, Weakley (2013) warns against linking poverty to vulnerability measured by socioeconomic status. This link is only "applicable and founded through case-specific research" (Weakley, 2013).

The above examples of the negative impacts of climate change on informal settlements and brief explanations of vulnerability showcase a need for climate change to be moderated and reduced through better planning and education.

2.2.5 Adaptation

Adaptation is a long-term "shift in practices and behaviours" which can reduce vulnerability (Nenweli, 2015). The macroscale definition of adaptation is:

> adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with climate change. It involves adjustments to reduce the vulnerability of communities, regions, or activities to climatic change and variability. (Smit & Pilifosova, 2003: 881).

On a city level, adaptation is determined by four key factors which are local government capacity; the number of residents supplied with risk-reducing infrastructure and services; the urban population living in housing that meets the health and safety standards and "the levels of risk from climate change's direct and indirect impacts" (Revi et al., 2014: 545). Nonetheless, cities that are doing well have not been able to manage the economic and physical growth which has resulted in a disproportion in the providence of infrastructure and services relevant to climate change (Revi et al., 2014). As a result, it is important to understand how people in informal settlements adapt to extreme weather events without formal structures. Responses to climate change should happen through adaptation and not coping.

Adaptation is "the context of human dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, country) for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity" (Smit & Wandel, 2006: 282). The definition above is more relevant to this study because it describes all the levels at which adaptation occurs, one of which is the household level. Adaptation usually happens at the community level (community actions using social networks) and at the individual household level, mostly influenced by the socioeconomic conditions of families (Amoako, 2018). Different types of adaptation measures exist, including private versus public adaptation, anticipatory versus reactive adaptation and autonomous versus planned adaptation. Below is a discussion the different types of adaptation.

i. Reactive versus anticipatory adaptation

Adaptation can be reactive or anticipatory. Reactive adaptations are proactive measures taken by institutions, individuals, plants and animals to respond to climate change (Smit & Lenhart, 1996). It allows quicker recovery (Nenweli, 2015). An example of reactive adaptation is when a farmer may swap to more drought-tolerant varieties of crops after seeing an increase in the frequency of droughts and households respond to climate change impact after its occurrence (Smit & Lenhart, 1996). For urban centres, "bouncing back" includes the government's capacity to rapidly restore key services and repair infrastructure" (Revi et al., 2014: 549).

Anticipatory adaptation measures rely on early warnings and take place ahead of climate change. According to Smit and Lenhart (1996: 194), "these are taken to minimize or offset the effects of climate change". For instance, seasonal weather forecasting may help communities develop water storage systems or live in a safe location, have a safe house, or risk-reducing infrastructure.

Adaptation plans, programmes or strategies can be both reactive and adaptive. Anticipatory adaptation requires foresight and planning, while planning is not essential for reactive adaptation, but it may require some (Fankhauser, Smit & Tol, 1999). The government of the Netherlands responded to the floods of the Meuse and the near floods of the Rhine through "a long programme of flood protection improvement that included climatic change in its design" (Fankhauser, Smit & Tol, 1999: 69). It cannot be proven that climate change was entirely the cause of the Meuse floods, however, if that was the case then the state would have participated in anticipatory adaptation. If it considered current and past flooding events, then it would have been fully reactive (Fankhauser, Smit & Tol, 1999).

ii. Autonomous versus planned adaptation

Autonomous adaptation is "adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems" (Forsyth & Evans, 2013: 4). This includes migration of species to new locations because of climate change. It implies that individuals, households, and communities can respond to climate change without the government or any other actor's intervention. Planned adaptation is "the use of information about present and future climate change to review the suitability of current and planned practices, policies, and infrastructure" (Füssel, 2007: 268). Families near rivers can find alternative accommodations to avoid the impact of climate change during the rainy season. Research projects to improve extended weather forecasting are planned adaptations.

Autonomous adaptation can be perceived as planned (Fankhauser, Smit & Tol, 1999). Governments may consider migration to alternative accommodation as autonomous. In contrast, households may perceive it as planned due to information

regarding current and future climate change. Planned adaptation can influence autonomous adaptation by other actors (Fankhauser, Smit & Tol, 1999).

iii. Private versus public adaptation

According to Nenweli (2015), private adaptation is "spontaneous" and happens without planning. Initiatives and actions are taken by individuals, households and non-state actors. Some non-state actors push their interests. Public adaptation is "planned actions that are deliberately conducted by public agencies" (Nenweli, 2015: 70). The actions are determined at a national level and not at a city level (Filho et al., 2019). Most current city-level adaptation policies are designed for upper-middle-income countries which can adapt better to climate change because they have the capital to implement such policies (Filho et al., 2019). Government policies and aid designed in such scenarios are likely only to benefit populations with a higher income (Filho et al., 2019). In other words, policies which are usually top-down are often too generic and fail to cater for the unique needs of rural and urban areas according to their specifications.

iv. Transformative adaptation

Sanchez asserts that the inequalities in the adaptive capacity of different cities can be addressed through transformative adaptation. It is relevant to this study because it is inclusive of an individual/household/community's and government's capacity to participate in anticipatory adaptation and reactive adaptation (Sanchez-Rodriguez, 2009). This is a "reflection on the sociology and politics of daily life and its reconfiguration under climate change" (Ziervogel, 2020: 2). It integrates development, disaster risk reduction and adaptation policies and investments inbound the comprehension of "the need for mitigation and sustainable ecological footprints" (Revi et al., 2014: 549).

In the past, a distinction has been made between coping and adaptation in climate change responses. While adaptation is long-term, coping is a short-term response to a risk or hazard and its mechanisms do not address the main causes of vulnerability (Nenweli, 2015). This comprises emergency responses to protect livelihoods against climate change. Since the response is short-term, there is a high probability that the negative impacts of the climatic events will be the same. In this case, different actors react to climate change with limited resources and low adaptive capacity. Social and economic differences such as "community structures, age, livelihoods, gender and social entitlements that include access to land"

(Nenweli, 2015: 65), influence coping in such contexts. Coping transpires through temporary migration and using existing social networks (Nenweli, 2015). It is subject to social and cultural norms and policies created by the government (Nenweli, 2015).

The examples of the negative impacts of climate change on informal settlements and brief explanations of vulnerability showcase a need for climate change to be moderated and reduced through better planning and education.

2.3 Development of South Africa

This section starts by outlining how colonisation happened in South Africa. It then moves on to look at national capitalism followed by apartheid.

2.3.1 Colonisation

The Dutch (Netherlands) invaded South Africa between (1652–1795 and 1803–1806) (Mgushelo, 2018). These settlers "launched raids into African lands and violently displaced Africans through the barrel of a gun and cannons for over 150 years (Mgushelo, 2018). Around the eighteenth and nineteenth centuries, this violent expropriation resulted in an "economic exchange" where Africans who owned land became agricultural labourers or servants (Morris, 1976). This was a surplus extraction via rent. It can be argued that this period cannot be seen as the introduction of capitalism as it went against the capitalist mode of production of surplus extraction through labour. The heavy taxation of the African peasantry, the closing of their access to means of production (land), the inequalities in access to transport for the marketing of their produce, the forcible eviction of squatters - in short, the destruction of their competitive production base, forcing the male members to supplement their family subsistence by means of wage labour. (Morris, 1976: 284).

The Dutch lost colonial control to the British during the Napoleonic Wars of 1803 – 1815 (Mgushelo, 2018). British rule in South Africa was formalised in 1884 at the yearlong Berlin conference where fourteen European powers claimed African territory (Mgushelo, 2018:30). This was known as the 'Scramble for Africa' which took place between 1876 and 1913 (Mgushelo, 2018). Great Britain ruled in the years 1795–1803 and 1806–1961 until South Africa gained its independence in 1961. British rule launched industrial capitalism through agriculture and mining which set in motion the trajectory of urbanisation and industrilaisationin South Africa (Morris, 1976).

2.3.2 The imperialist export enclave and rise of capitalism and migration

Globally, capitalism began in the 1800s when Britain led industrial capitalism through the formation of the bank rate and gold as a standard of world trade. Countries had to follow suit to supply whatever "backed upgold, or they risked "issuing a national scrip that was worthless in international exchange" (Hart & Padayachee, 2013). During the late nineteenth century, the mining revolution propelled capitalism in SA. Under British control, South Africa became a key contributor or a primary commodity exporter of gold and other minerals to the global economy. The capital gains from the gold standard were used to finance white commercial agriculture and later manufacturers (Hart & Padayachee, 2013).

The global economy then took a definitive turn, which assumed a racial character (Hart & Padayachee, 2013). In this phase of capitalism, the global economy favoured those who got paid more. Whites got paid more than the Asians (Hart & Padayachee, 2013). Fifty million Europeans migrated to the United States and a similar number of Indians and Chinese were sent to colonies to be indentured labourers (Hart & Padayachee, 2013). For South Africa, it marked the advent of the migrant labour system and/or migration. Indians migrated to South Africa as indentured labourers on sugar plantations in KwaZulu Natal (Hart & Padayachee, 2013). Since then, South Africa's economy has been mired "between its origin as an imperialist export enclave" and its desire to become a modern industrial economy driven by constant reliance on cheap labour (Hart & Padayachee, 2013). Thereafter, the Anglo-Boer War ensued from 1899 to 1902. White people had an objective to free themselves from British rule.

2.3.3 National capitalism

World War I was a turning point for South African capitalism as South African Afrikaaner nationalists wanted to move from the imperialist export enclave to 'national capitalism' (Hart & Padayachee, 2013). This would foster economic growth for all South Africans. As a result, the Afrikaaner nationalists and English-speaking groups unified to form The Union in 1910. The Union developed a national bank to support the growth of local manufacturing capacity (Hart & Padayachee, 2013). Afterwards, the Pact Government which consisted of The National Party (NP) and Labour Party was formed by the national bourgeoisie with support from the white working class and the rural petty bourgeoisie, to resist the dominant imperial capital by diverting the profits gained from mining towards local industrialisation (Morris, 1976). Moreso, it was more of a capitalist competition of who could benefit the most

from the exploitation of black labourers (Morris, 1976). The South African government introduced the 1913 Land Act as a "legal robbery" (Mgushelo, 2018) which dispossessed all Africans of their land and had them removed from their homes. Farm evictions and land acquisitions decreased households in rural areas and certain areas. This period accelerated urbanisation and migration in South Africa.

Black families on non-reserve farms residences could no longer cultivate crops and run cattle which encouraged households to export labour to other markets (Mabin, 2003). Similarly, the farms themselves "became more and more substantial importers of short-term migrant or even commuter labour to perform non-mechanised and mechanisation-altered tasks" (Mabin, 1988). Black South Africans were now seen as labour exporters. Since 1913, most black South Africans lived as either tenants or squatters even inside the reserves (Mabin, 2003). Black labourers resided in reserves that were meant to fulfil their housing needs. The compounds were in isolation, close to the mines and had high surveillance to avoid diamond smuggling (Vosloo, 2020). Moreover, the compounds were used to guard "the white communities against the perceived threat of thousands of black male mineworkers staying in close proximity to them" (Vosloo, 2020). As early as 1923, the system of municipal controlled passes under the Natives (Urban Areas) Act, was in jeopardy (Mabin, 2003).

After World War II, South African capitalism had taken the absolute surplus value route which exploited cheap labour (Hart & Padayachee, 2013). The Pact government had laid the foundation of preferential employment for white people (Morris, 1976). In this route, white people acquired skills whilst African people were restricted to the supply of cheap labour to make profits for enterprises in mining and agricultural industries. White control/power in the country shaped urbanisation (Smith, 2005). Restrictions on African urbanisation also took place through discriminatory political legislation to control the black working class from accessing urban areas (Morris, 1976).

2.3.4 Apartheid

The Nationalists won power in 1948 and the Apartheid revolution began. Apartheid was focused on racial segregation based on the foundation laid by colonialism. Apartheid was a preservation of colonialism which protected white interests (Mgushelo, 2018) and maintained their control of the country. The Apartheid government restructured the labour migrant

system and allocated labour to various sectors. A greater proportion of Africans began moving to urban areas.

Africans were placed in border towns "Bantustans" (Rahiiga, 2014), previously known as native reserves. Native reserves were turned into homelands to separate the ethnic groups of SA as part of a separate development plan (Mgushelo, 2018). Residential districts were established according to ethnic composition, mirroring those in rural areas to prevent "working-class organisation and mobilisation in urban areas" (Soni, 2003). The inflow of black people into towns was controlled and supported by laws such as the Group Areas Act 1950, Prevention of Illegal Squatting Act 1951, and Black Homelands Citizen Act 1970, amongst others. This meant that Africans, who formed the majority of SA, only owned 7% of the country's land which was later increased to 13% after the Land Act was amended in 1936 (Mugushelo, 2018).

2.4 Housing provision pre and post 1994 in South Africa

This section discusses the provision of housing pre and post 1994. The first section looks at housing pre-1994 followed by housing and the rise of informal settlements pre-1994. The next section is a discussion on housing challenges post-1994.

2.4.1 Housing pre-1994

An additional number of ex-farm households began moving to the city in the '60s (Mabin, 1988). An increasing number of households, both in and outside of Bantustans, stopped independently participating or had little involvement in agricultural activities. They became dependent on wages from those working in towns and industries.

The Apartheid system created or made the 'urban pull' appealing to rural people who migrated to the city to secure jobs that were already available in the industries. On the other hand, poverty generated by the lack of agricultural activity in the rural areas resulted in an 'urban push' due to the income disparities between Bantustans and broader South African rural areas. The salary-wage gap between rural and urban areas became evident. Migrants from rural areas became primary producers of household reproduction in urban areas. However, this system was disrupted by the disappearance of a substantial labour market in rural areas for many blacks due to the decreasing amount of labour and job creation (Mabin, 2003).

2.4.2 Housing and the rise of informal settlements pre-1994

Migrant labourers lived in hostels reminiscent of the compounds under colonial rule. Hostels, a key legacy of this system, were forms of housing built to isolate labourers from their families- to separate the rural from the urban (Vosloo, 2020). Hostels were situated away from the urban centre, in other words away from the white urban population (Vosloo, 2020). The housing was unfit for humans. Vosloo describes them as "large, brutal, impersonal structures that resemble face-brick prisons or barracks." (Vosloo, 2020). People had limited access to facilities such as toilets and were provided a bucket or open pit toilet. Hostels were mired by issues of physical and social separation from their surroundings. They were exposed to violence, slum-like living conditions and low-quality housing (Vosloo, 2020).

While migrant labourers were subjected to hostels, other Africans lived in the Bantustans and had to pay for the provision of housing and services to the state. The Apartheid government sustained control of the struggle for housing. In this way, the state financed black housing and reduced the fiscal burden on local and national government by regaining the money through rental or purchase schemes (Soni, 2003). However, there was a shortage of housing by the beginning of the 1950s. The housing backlog resulted in the introduction of home ownership.

In addition to the housing backlog, black people struggled to access wealth in the cities and wanted to create an urban space for themselves. Besides, the state was unwilling to build black people houses. It excluded 'illegals" from official entry into townships (Mabin, 2003). Due to poverty and desire to access the urban economy, a new form of urbanism surfaced. Africans built meagre houses, such as shacks, for themselves in the absence of government approval. Bantustans panned out as townships and informal settlements. Semi-urban settlements were established close to "minor or minor, long-established, formal cities" (Mabin, 1988).

Informal areas geographical location varied "… from fairly close proximity to city centres (like Crossroads) to hundreds of kilometres from the metropolitan cores" (Mabin, 1988: 397). These areas were classified as 'informal' because they participated very little in agriculture, had inadequate basic services such as water and electricity and were overcrowded. Surveys found that there were up to 17-20, even 30 people per 4-room house due to shacks built in backyards or on any site. This was contradictory to the official assumption that there were only 7 people per house (Goodlad, 1996).

Mabin (1988) states that households decided to reside in informal settlements because they wanted access to land;. not for agricultural purposes or rural production but they needed a place to live and have a sense of security. Those who experienced farm evictions failed to find alternative agricultural land and chose resettlement areas or residential sites allocated through tribal authorities (Mabin, 1988). Furthermore, urbanisation in South Africa is rooted in a complex history of state policy, household organisation of labour and of struggles to create and sustain communities (Mabin, 1988). People move to closer cities to put their families in better positions to gain an income.

The struggle of households to create an urban space for themselves began in the Western Cape but was met by fierce resistance from the state. This did not only take place in bantustans but also on non-reserve land like churches. Africans were offered 'eviction-free' squatting on church land (Mabin, 2003). Squattercamps such as Modderdam and Unibel were demolished by state bulldozers between 1977-1978 (Mabin, 2003). Africans protested over the demolition of the housing they built. However, crossroads grew:

> It did so at exactly the time at which state officials had to face both their inability to impose full control on the urban population and the new, unapproved, unintended concentration of population in unserviced areas. (Mabin, 2003: 19).

Informal settlements or non-formal urbanisation in Pretoria (Tshwane) began during Apartheid in Ga-Rankuwa and Mabopane which were part of Bophuthatswana, currently North West (Mabin, 1988). In this case, Africans resided on privately owned small-land holdings with low rentals (Mabin, 2003). Additionally, Mabin explains that families from Swartbooistat and Makapaanstat in the Moretele 1 district of Bophuthatswana, not far from Pretoria, have moved from Sekhukhuneland to their current residence which places them within close range to casual labour markets in Pretoria and the Witwatersrand (1988). Cities such as Witwatersrand and KwaNdebele went from having no population to rapid population growth in the 1970s (Mabin, 2003). Similarly in Durban, Africans established KwaMashu and Umlazi in the early 1950s.

Soni (2003) states that the struggle for housing continued into the 1960s and 1970s . The state no longer had control over the growing urban population. On 31 March 1960, the ANC scheduled an Anti-Pass Day campaign where Africans would leave their passports at home.

The state retaliated by opening fire on 5000-7000 people (Soni,2003). During this period parties such as the ANC and PAC (Pan African Congress) were banned. The Apartheid government overcame this by tightening the Bantu Areas Act of 1952, which became the Bantu Laws Amendment Act of 1963. The amendment meant that the state had complete control over Africans in urban areas. From 1968, the state decentralised black working classes by suspending lease tenure and renting. Development was directed to homelands (Soni, 2003).

From the 1970s, government actions in the last few decades resulted in unrest. The housing struggle affected the economy (Soni, 2003). According to Soni, more investments were made to improve the standard of living in the township (2003). The apartheid government tightened the leash through laws which required the removal of all squatter camps. Instead, shortages in housing increased and squatter camps grew rapidly (Soni, 2003). With the increasing demand for labour, the government was forced to reduce restrictions on African urban dwellers. The apartheid ideology of separate development was revised to meet the needs of capital (Soni, 2003). The reform of black urban reform was witnessed through the Community Council Act (1978) and the Bantu Laws Amendment Act (1978) (Soni, 2003).

Following the Soweto Uprising in 1976 and the increased demand for labour, the government had to amend its separate development policies. Black urbanisation was constitutionalised to create a stable labour force. The state distanced itself from the provision of housing for Africans. According to Goodlad (1996), the state replaced protest with participation. Instead of extending rent subsudization in townships, the state offered assistance through sponsoring site and service schemes (Parnell, 2003).

The 1980s marked the development of an elite African housing market. The state invested in housing under privatisation. Individuals, employers, and financial institutions had more control over the funding of housing. Africans became a permanent urban populous. However, these changes were not beneficial to Africans. Nothing changed for Africans. Their supply was constant. Many Africans were employed in the city and lacked accommodation. This gave rise to ± increased 40% of Soweto houses having shacks in their backyards (Parnell, 2003). Nonetheless, the government still had control as it provided housing subsidies and infrastructural investments for those with incomes of less than R1000,00 per month (Parnell, 2003). In 1983, the state publicised and administered the ‘Great Sale’, where houses were

sold at discounted prices. Parnell asserts that by 1989, only 39% of the coloured, 77% of Indians, 37% of whites and 34% of blacks owned houses (2003). The sale did not go as planned due to income restrictions. The above concessions did not lead to a home-owning black middle class as housing struggles continued in democratic South Africa (Parnell, 2003).

Apartheid has left an ineradicable mark on a country with an urban policy made up of "distorted and fragmented" urban areas, and residential patterns (Rahiiga, 2014). Apartheid caused spatial inequalities that moved black people to homelands (bantustans) in the townships and white people remained in the suburbs. Moreover, the majority of the land is in the hands of the White minority and millions of Africans are confined along industrial and mining belts (Mgushelo, 2018). Townships remain neglected and situated in the periphery, which to this day, the government finds hard to resolve (Moloisane, 2017). The preceding events have contributed immensely to the neoliberal economy of South Africa where housing favours those who with higher income.

2.4.3 Housing post-1994

Since 1994, there has been in-migration, urbanisation and population growth. People have been moving to urban areas in greater numbers as they now have greater access to areas that they were restricted from entering and staying in under Apartheid segregation laws. Two out of three people live in urban areas, until now, mainly due to rural-urban migration (Muzondi, 2014). The growth of urban areas has been uneven between the different cities, the most rapid being in Gauteng (Johannesburg & Tshwane) (Turok & Borel-Saladin, 2014). There are several reasons to account for the migration to crowded settlements in peri-urban areas and informal settlements. Firstly, people had greater access to areas that they were restricted from entering and staying in under Apartheid segregation laws. Secondly, like in the 1960s, the poverty levels particularly in rural areas, stimulated migration to urban areas because developing countries had a low income per capita at a national level as compared to developed countries (StatSA, 2006). People hoped to find better living conditions and economic opportunities (Muzondi, 2014). Secondly, the past labour migration system, influx control, pass laws and homelands stimulated temporary migration (StatSA, 2006). People moved to the city and used their income to benefit their rural households instead of investing in their residence in the urban setting (StatSA, 2006). They also have "socio-cultural" links with their homesteads so migrants would rather live in informal settlements or rent cheap

accommodation because they will most likely move back home upon retirement or retrenchment (StatSA, 2006).

2.4.4 Housing provison challenges post-1994

The post-apartheid state proceeded to prioritise "the provision of housing, water, electricity and other socio-economic services to the poor" (Darky & Visagie, 2013: 302) in Section 26 of the Constitution. The African National Congress (ANC) introduced several policies such as the Reconstruction Development Programme (RDP) to redress the land issue stemming from apartheid but did not expect an influx of people in the cities caused by urbanisation and population growth. Additionally, the promise to provide everyone with free and affordable housing when the ANC government took charge has spawned an "impetus for self-help" (Marutlulle, 2021). People moved from rural areas and farms in the hopes of free house delivery.

There has been significant progress, although the government has experienced vast challenges in supplying formal housing to the urban poor (Moloisane, 2017). So far, ±3 million houses have been built since 1994 (Nenweli, 2015). And an additional 2.2 million houses still need to be built (Moloisane, 2017). Although the government has made significant progress in providing housing over the last 29 years, it has not been able to reduce poverty in townships as informal settlements and the population continue to grow (Darky & Visagie 2013). A number of reasons hindering the provision of housing include urbanisation, corruption, administrative issues and limited state resources.

Like apartheid, informal settlements increase as the provision of formal housing does not happen at the same rate as urbanisation, and then people start being impatient. During apartheid, races classified as black (Africans, Asians and Coloured) were deprived of owning property and land. In democratic South Africa, land grabbing is described as “the process in which South Africans (black and white, men, women and children) are dispossessing the state and private businesses of land (Beukes, 2022). Subsequently, people occupy spaces/land not meant for development (Moloisane, 2018), causing insecure tenure (Moser et al., 2010). The authorities call this 'riparian' land, defined as "hazardous land located on the edge of the sea/river …" (Moser et al., 2010: 19).

Residents choose these sites as they are less likely to face eviction, moreover this land is unappealing to developers (Satterthwaite et al., 2018). Shacks are built with low-quality

materials such as plastics, cardboards, metal tins, zinc sheets and timber making the quality of the houses substandard (Muzondi, 2014). These settlements do not have access to basic municipal services such as water and sanitation, electricity and stormwater pipes (Muzondi, 2014). The physical characteristics of informal settlements have environmental and health impacts on the dwellers (Muzondi, 2014). This creates environmental inequality/injustice where poor people who live in slums and inferior settlements are subjected to the slow and intense impact of "long-term trends in increasing severity of weather" (Moser et al., 2010). The low standard of housing and infrastructure is a threat to the community members, as these are recurring weather events (Moser et al., 2010). Since informal settlements are known to be a harbour for those in poverty, as most dwellers are unemployed (Muzondi, 2014), their adaptive capacity would be constrained, making them vulnerable to extreme weather events.

The socio-economic status of people in townships has not changed since 1994 as unemployment has doubled (Darky & Visagie, 2013). The adoption of neoliberal policies worsened the economic and social inequalities between those in the centre of the city and those living in the periphery. This triggered informal settlements due to the high costs of land and housing. It has been an obstacle to providing better-located housing (housing near the city). Money for housing is only beneficial to local government officials, politicians and developers who are contracted.

Furthermore, unemployment worsend afterward and poverty increased. Many of South Africa's townships and informal settlement areas account for 80% of SA's gross add value (GVA) and show high levels of poverty and inequality which is a major social challenge (Habitat III, 2014). Income restrictions resurface as poor household heads cannot afford to rent or buy houses, therefore, opt to move into informal settlements due to having the largest natural growth. Affordability "refers to the relationship between income and house prices" (Marutlulle, 2021: 28). Over 70% of households which live in shacks have an income of less than R3500,00 per month (Marutlulle, 2021). Moreover, these households do not have access to bond financing. Banks adhere to a criterion which favours those in formal employment, with above-average incomes. This aggravates urban inequality.

Contrary to apartheid, in contemporary South Africa, housing challenges are intensified by administrative issues like mismanagement, corruption and incompetence in municipalities (Marutlulle, 2021). Local governments stand in the way of money/ budgets that are allocated

to housing. In 2019 about 12,7 % of South Africans lived in informal housing with Gauteng having 18,7% households residing in informal settlements (StatsSA, 2019). In questionable tenders with private companies, high-level officials failed to account to junior-level employees (Marutlulle, 2021). The contractors whom the tenders for housing are awarded do not use quality materials as new houses and infrastructure are low quality and are simply weak and need regular maintenance (Goebel, 2007). Corrupt municipal officials allocate houses to people who are not on the waiting list (Marutlulle, 2021). Corruption takes place when low-income households register for access to a house on a false list (Goebel, 2007).

During colonisation and apartheid, the absence of agricultural activities due to racial segregation and land dispossession made people move to the city. The state provided accommodation through compounds/reserves near workplaces to avoid theft. In contrast, in democratic SA, the pursuit for survival and livelihoods continued as Africans moved to the city. The harsh, exclusionary laws from apartheid fell away and Africans had more access to urban areas as pass laws were abolished. However, the struggle for housing and informal settlements continues to rise. This depicts that post-apartheid state policies perpetuate inequality and exclusion through evictions, demolition of informal structures and relocation of the urban poor to the periphery. This offers limited economic opportunities and destroys livelihoods and social networks. More effort by the government is needed to overcome socio-economic issues (Moloisane, 2017).

2.5 Climate change in South Africa

According to the United States Agency for International Development (USAID) (2023), the net emissions in 2017 were estimated at 512 metric tons of CO2 equivalent (tCO2e), an increase of 14 percent from 2000. South Africa is the world's 15th top greenhouse gas emitter due to its dependence on coal for electricity (USAID, 2023). The greenhouse gas emissions are caused by anthropogenic activities in sectors such as agriculture, energy, industrial processes, and land uses. Carbon dioxide, methane, nitrous oxide (N2O), perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs) are trapped in the atmosphere and proliferate global warming, which drives climate change.

This is evident in South Africa's increasing and extreme temperatures which strongly correlate with global temperatures. According to the National Climate Change Information System (NCCIS) (2018), by 2080, it is projected that the temperatures in South Africa will

rise by 4 degrees Celsius. Further, there are uncertainties regarding rainfall projections, which indicate that South Africa will "experience drier conditions overall" and "extreme rainfall events may increase over the interior" (NCCIS, 2018).

Despite this, South Africa has already been affected by climate change, with provinces in the interior warming at a much greater rate than coastal provinces such as KwaZulu Natal, the Western Cape and the Eastern Cape (Department of Forestry, Fisheries & the Environment (DFFE), 2023). In the last few decades, Mbokodo et al. (2023) state that heatwaves, droughts, and flooding have been the most common natural disasters in South Africa. This section presents an overview of South Africa's climate conditions based on the DFFE Fourth South African Climate Change Tracking Report. Further, the impact on human settlements, specifically informal settlements, is depicted.

2.5.1 Heatwaves

Increasing temperatures have led to frequent heatwaves. According to The Conversation (2021), heatwaves are “Extreme temperature events that can be defined by the maximum temperature, the deviation from the norm, or the length of time of above-threshold temperatures”. Southern Africa has witnessed an increase in these phenomena in the last few decades. Dry spells and heat cause stress on human beings’ health, animals, vegetation, and plants. Its impact is felt through water availability as well as causing wildfires. For example, South Peninsula, Cape Town, was affected by fires in 2000. Similarly, between 2020 and 2021, the Gauteng City-Region Observatory conducted a Quality of Life survey to obtain the lived experiences of Gauteng residents amid climate change (Evans, 2021). Out of the 13 616 people who were surveyed, 39% were affected by heatwaves (Evans, 2021). People are at risk of heat-related illnesses such as heat stress and respiratory illnesses (World Bank, 2021).

2.5.2 Drought

South Africa is classified as semi-arid or arid, making it the 5th most water-scarce country in sub-saharan Africa (World Bank, 2021); irrespective of climate change, the country will run out of water. From 2012, the entire country experienced “below normal rainfall”. The Eastern and Western Cape have the highest incidences of drought (DFFE, 2023). Drought is “defined as a significant and prolonged departure from mean rainfall totals” (The Conversation, 2021). Drought is not only caused by climate change but also by climate patterns and the country’s topography. Notably, conditions were even drier in the 2015/2016 period due to El Niño and

not climate change. National Geographic (2023) defines El Niño as "a climate pattern that describes the unusual warming of surface waters in the eastern tropical Pacific Ocean. El Niño is the "warm phase" of a larger phenomenon called the El Niño-Southern Oscillation (ENSO)". Dry spells become a challenge as South Africa is dependent on rain-fed agriculture basically, total annual rainfall is essential to agriculture and water availability.

Water scarcity has an impact on food security and livelihoods. One of the factors causing rural-urban migration is water security and not climate change (Hassan & Tularam, 2018). The rural population is affected by water scarcity because they participate in subsistence farming. Due to high levels of poverty and low adaptive capacity, people migrate to urban areas to seek jobs and stable livelihoods. Chapter 2 established that rural-urban migration explicitly due to climate change is rare (Nenweli, 2015). Nevertheless, climate change is likely to aggravate water insecurity in areas that are already water-stressed. The City of Cape Town experienced recurrent severe droughts in recent years (2002-2005) and from 2015 to 2018. Besides below-average rainfall, the drought was also caused by the urban sprawl, increasing population and water usage. As a result, reservoir levels began dropping, with the prediction that they would be approaching 13,5% by 2018, known as Day Zero:

> "The dam levels continued to drop over 2018, with Day Zero approaching where the dams would have reached 13.5% capacity and the government would've turned off access to taps for 40 million people." (Byrne, 2020).

Byrne states that informal settlements suffered the most, as they are subject to water shortages and share a community tap. This showcases the historical, gross, racial injustices, and inequality in the city (Byrne, 2020). On the other hand, rainfall improved for provinces like Gauteng, North West, Mpumalanga and Limpopo while some remained dry (DFFE, 2023). All provinces are at risk of droughts and flooding with Gauteng being an exception.

2.5.3 Flooding

Since 1995, cities in Africa have witnessed multiple extreme floods, while in South Africa, flooding incidents started increasing in the mid-90s (Mwazvita et al., 2017). Those living along coastlines, informal settlements and marginal groups based in rural areas are the most vulnerable to adverse weather events (Olorunfemi, 2011). Flooding in informal settlements is central to this study.

“Increasing economic and social impacts of extreme rainfall events can be the result of both increases in the intensity and frequency of rainfall events, as well as increasing exposure and vulnerability.” (DFFE, 2023: 22). Extreme rainfall results in negative climate impacts like flooding, loss of life, damage to infrastructure and disruption of transport and economic activities, amongst others (DFFE,2023). South African provinces such as Gauteng, Western Cape and KwaZulu Natal have experienced flooding in informal settlements. Informal settlements were negatively impacted because of their location on precarious land and the lack of formal engineering in the construction of informal settlements. This leaves informal dwellers vulnerable and exposed to the impacts of climate change.

Informal settlements are prone to disasters because low-income migrants in the city occupy the most vulnerable land and live in cheap housing where they are met with challenges of overcrowding and dilapidation. Vulnerable land includes wetlands, slopes, flood plains and other environmentally sensitive areas.

These are some of the flooding events that have transpired in informal settlements over the years:

- **Cape Town:** For the residents of the Cape Flats, flooding has become a reality. They are vulnerable to flooding due to "high groundwater and the presence of wetlands, ponds, and other flood-prone natural features" (Jozipovic, 2015: 44). Other informal settlements in the City of Cape Town such as Joe Slovo, Sweet Home, and Nonqubela K-Section in Khayelitsha have also been exposed to flooding.
- **Gauteng:** The Gauteng Provincial government published weather predictions in the Gauteng City Region Over-arching Climate Change Response Strategy and Action Plan (2020). It predicted that Gauteng would experience a "warmer wetter future" with warmer years. Between 2040 and 2060, temperatures would have reached 2 degrees Celsius higher than they have in the past, resulting in frequent and intense summers. This intensified heat will enhance moisture transportation into the province and slightly increase annual rainfall totals. Convective rainfall events will occur more intensely resulting in localised flooding and damage (GCROCCRSAP, 2020). Before this prediction was made, in December 2019, the Gauteng province in South Africa experienced floods which negatively affected the Sjwetla informal settlement situated along the Jukskei River in Alexandra and the one under study. Thousands of people were left destitute while some lost their lives.

- **KwaZulu Natal:** Quarry Road West informal settlement is positioned on the narrow floodplain of the Palmiet River in Durban, KwaZulu Natal. The riverbanks tend to break after heavy rainfall, causing flooding (Williams, Máñez Costa, Celliers & Sutherland, 2018). In April 2022, Durban also experienced "record-breaking" rains. Houses, infrastructure, land and livelihoods were washed away. 19,113 households with 128,743 people were affected by the disaster (IFRC, 2022). Informal settlements took the hardest knock due to their location and weak buildings. Businesses, livelihood and critical infrastructure were impacted.

2.5.4 Impact of climate change: Vulnerability

The climate phenomena and its effects brings to the fore a key concept in this study-vulnerability. According to Greenpeace, South Africa is ranked 96 out of 182 countries with regards to climate change vulnerability (Igamba, 2023). In Chapter 2 (3)(1), it was established that climate change hinders development efforts and increases inequality. Climate change will further widen the gap between the rich and the poor as those who are disadvantaged will be exposed and vulnerable to climate change-related phenomena. According to Igamba (2023), since 1980, there have been 86 weather-related disasters, which have affected more than 22 million people and have cost more than R113 billion in losses.

South Africa is one of the most unequal societies in the world, mired by poverty and unemployment. Households in informal settlements remain at risk to climate change-related weather events. These communities fail to adapt to the extreme weather events, which results in loss of homes, lives and assets. Climate change-related phenomena exacerbates their low socioeconomic status and perpetuates poverty. Whilst the National Development Plan (NDP) aims to "eliminate poverty, deliver the impact of climate change phenomena environmental protection and promote economic development by 2030", the government must incorporate climate change into these goals so that communities and infrastructure are resilient to future climatic events (NCCAS, 2019). Previous studies have identified the need to combine research on climate change and development in South Africa.

2.6 Chapter summary

This chapter gave a review of the literature on the concepts relevant to this study. The concepts that enhanced an understanding of the research topic were discussed. This chapter sheds light on the inception of urbanisation which stems from industrialisation. It showed

how urbanisation took place in developed and developing countries. The outcome of urbanisation in developing countries is a lack of provision of housing and infrastructure by the government. Subsequently, people establish informal settlements located on vulnerable land.

Another outcome of urbanisation is global warming which drives climate change and manifests as extreme weather events. Climate change has adverse impacts on informal settlements which are already faced with physical, social, economic, and political vulnerabilities. While increasing attention has been paid to the vulnerabilities that informal settlements face because of urbanisation the impacts of climate risks and coping strategies in these urban informal settlements are poorly understood (Johannessen, Punjabi & Johnson, 2018). This chapter proposes a need for climate change adaptation to reduce and moderate the negative impacts of climate change on informal settlements. It links adaptation, vulnerability, and adaptive capacity where one cannot be studied in the absence of the other.

The chapter also provided the trajectory of South Africa's development and the changes in its economy. It provided a discussion on each stage of development SA underwent. Colonialisation induced the dispossession of land from Africans which they depended on for survival. The reduction in agricultural activities created a shift in which African rural people went from farmers to wage labourers. People no longer participated in agricultural activities but in rural-urban migration to sustain their livelihoods as they were ensnared by poverty. Urbanisation began as people moved to the city to look for jobs. With these changes issues of housing became evident. The state had to accommodate the growing urban populous.
To this day (post-apartheid), an urban push takes place where rural to the city as people strive to alleviate poverty in their rural households. People migrate to urban areas to find jobs in the industries. Additionally, the promise of free formal housing by the post-apartheid government pushed people to the city. This placed the government in a predicament as it has failed to provide housing due to rapid population growth and other administrative issues. People cannot afford accommodation in the city, hence, the rise in the establishments of informal settlements on hazardous land. Therefore, this chapter concludes that the introduction of urbanisation was not caused by climate change but by the emergence of colonisation, capitalism and Apartheid.

CHAPTER 3: RESEARCH METHODOLOGY AND APPROACH

3.1 Introduction

This study was motivated by climate change related weather events and their impact on informal settlements in South Africa. Field research was carried out in an informal settlement in Mamelodi, Eerste Fabriek which has experienced flash floods numerous times. The main objective was to conduct an in-depth investigation on the understanding of climate change of the community and how the members in the community explain such realities from their perspectives. To explore the impact of climate change, it was important to not only use quantification of the demographics or geographic issues but also to get the views of the residents, who are central to this study.

The methodology was prompted by the research questions that informed the data collection techniques. This chapter describes the research design and approach that was adopted in the study of climate change impact and adaptation in the urban informal community under review. It discusses the data collection techniques that were followed. Finally, the approach adopted to analyse the qualitative data that was collected, ethical issues involved, and fieldwork challenges encountered are presented. The research fieldwork on the community leaders and households was conducted between 13 August 2022 and 18 September 2022.

3.2 Research design and approach

A qualitative design was chosen as it consists of empirical methods to investigate and explain the causes and effects of climate change in urban informal settlements. A qualitative approach may be defined as "a holistic understanding of complex realities and processes where even the questions and hypotheses emerge cumulatively…the aim is to understand differing and often competing 'subjectivities' in terms of very different accounts of 'facts', different meanings, different progress, and perceptions" (Mayoux, 2016: 117-118).

The research design adopted by the study was guided by the focus of the study. Seeking perspectives from a particular group of population required an in-depth study to be carried out. For that reason, I conducted semi-structured interviews with the questions solely acting as a guideline. Key information to provide an understanding of the impact of climate change on households was acquired during this investigation.

3.3 Research area: Mamelodi, Eerste Fabriek '77 Bufferlake'

Eerste Fabriek informal settlement is situated in Mamelodi. Mamelodi is a township within the City of Tshwane Municipality. The informal settlement is referred to as '77 Bufferlake' by its occupants. This community occupies vulnerable land – a floodplain adjacent to the Moretele River. The situation of this community on the floodplain and its proximity to Moretele River leaves residents vulnerable to occasional flooding. The community lives in a state of poverty, as most residents are unemployed or survive on wages from semi-skilled labour. I selected 77 Bufferlake because of the recurring flooding incidents which have been well documented over the years. The 2019 floods was chosen specifically because it was highly publicised since it was a year of elections in SA. The community had also experienced floods in 2017 but that did not receive as much coverage as the 2019 floods. The community has experienced three flooding incidents due to intensive rainfall attributed to climate change, including the floods in 2019. In all flooding incidents, many shacks were destroyed and people were displaced and some deaths were recorded. The government has since promised to relocate the dwellers to a safer location (Mitchley, 2019). Mamelodi township has a population of approximately 337, 577 people, according to StatsSA (2016) community survey. Ninety percent of the people in Mamelodi are black Africans, 2.2 % are whites, 2.1 % are Asian/Indian, and 6.6 % are coloured (mixed race). Of this population, 79 % are of working age, and 21 percent are dependents (StatsSA, 2016). Eerste Fabriek is located along the banks of the Pienaarsrivier, which is a seasonal river that flows through the area and has

an estimated population of 1,700 people (Mabona, 2022)

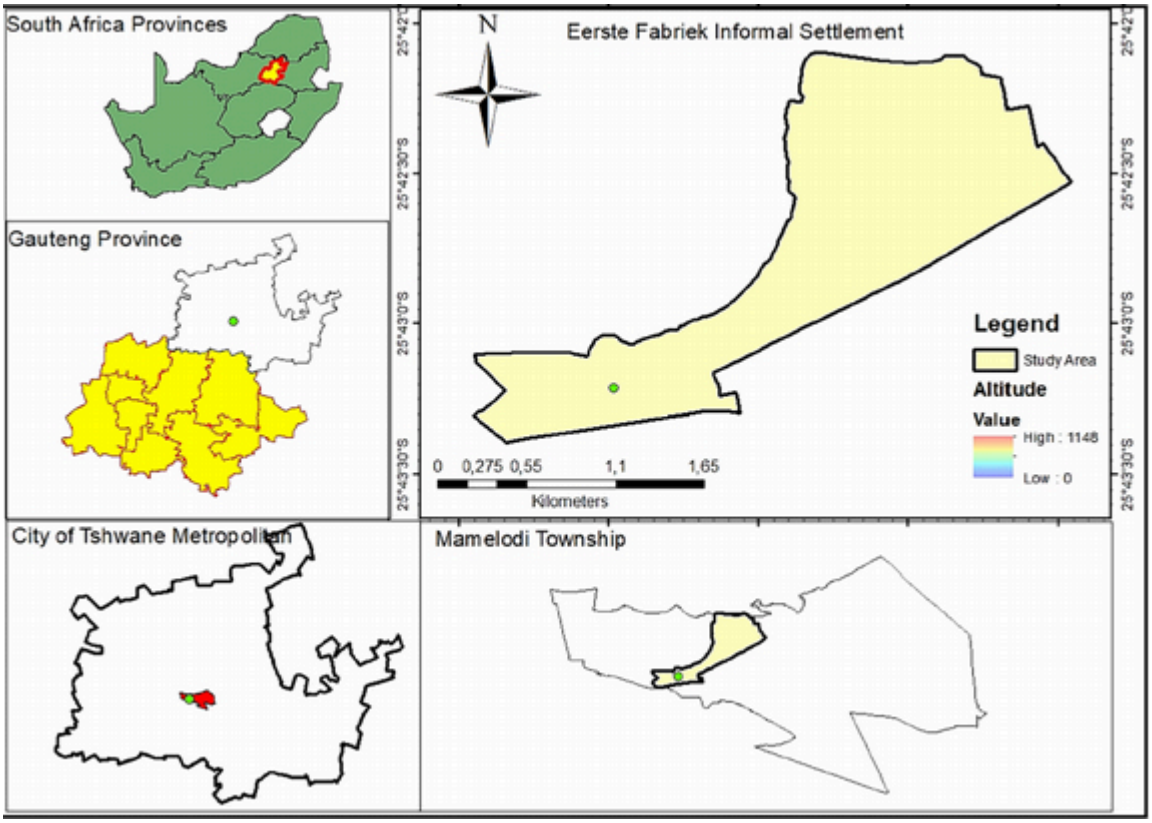

Figure 2:Map of Eerste Fabriek informal settlement in Mamelodi

3.4 Data collection

The study was divided into two parts. The first part focused on investigating households' perception and understanding of climate change and its impact. Data was collected through key informant interviews with eighteen households. This method allowed an analysis into the experiences of the households during the 2019 December floods and how they understand climate change and why they continue occupying vulnerable land. Furthermore, observations were conducted with some community members and the community leaders to supplement the key informant interviews.

The second part studied the response of households to extreme weather events. This was an inquiry on state and non-state actors' assistance that the community received. Besides the data from secondary sources such as policy documents/ papers on national climate change adaptation, reports and programmes from the various government websites and mass media, it was important to assess the implementation of these state initiatives in such cases. The data was also drawn from key informant interviews with community leaders and households.

3.4.1 Key informant interviews

Key informant interviews allow for an in-depth discussion with people who have special knowledge about the issue (Taylor & Black, 2015). This method empowers and raises awareness and interest around a specific topic (Taylor & Black, 2015). Key informant interviews took place with two community leaders from a sample of twenty households.

A purposive sampling approach was utilised to select the participants for the interviews. Etikan et al. (2016: 2) describe this sampling approach as "judgment sampling, [which] is the deliberate choice of a participant due to the qualities the participant possesses". My plan was to interview the councillor of the ward, Ms Joyce Seelane. However, she explained that she did not have a clear background/ understanding of the issues at hand as she was not yet elected when the community was established. Ms Seelane advised that I interview and work alongside the community leaders of the informal settlement. I interviewed two community leaders who had overall knowledge about the informal settlement, community and the flooding incidents. They have an interest in the situation of and conditions under which the people live and have different perspectives to share – the official perspective and that of concerned citizens. They were elected by community members and were not aligned or served based on the mandate of any political party. In addition, their role is holistic and not restricted to climate change-related events and relocation. They resolve any other issues such as gender-based violence (GBV) or crime to ensure harmony within the community.

I met with one of the community leaders who interacts regularly with the informal community and works closely with the councillor and that gave me an opportunity to be introduced to the community. The community leader provided a comprehensive background of the community during the interview. This community leader introduced me to other community leaders who also shared their thoughts on issues of governance during our the interview. The community leader accompaned me into the informal settlement and I used the opportunity to select households that were present during the 2019 flooding incident and who were willing to be interviewed.

The interviews were conducted on days when the community leader was available to accompany me. Households that had been in the settlement for a long time and those that were present during the 2019 flood were also interviewed. To determine vulnerability, households headed by women and the elderly were also selected. For ethical reasons, the heads of child-headed households (individuals under the age of 18) were not interviewed.

Both key informant interviews were semi-structured. I was able to assess the socio-economic status of the households and investigated their knowledge and perception of climate change and the impact of the climate change-related event on the households. In all instances, participants were helpful because they provided detailed information relating to the environmental, social, political and economic issues within their community.

3.4.2 Semi-structured interviews

According to O'Leary (2004: 164), semi-structured interviews are "neither fully fixed nor fully free and are perhaps best seen as flexible". Participants are allowed to share information that may provide a better understanding of the realities of these communities. Twenty households and their heads were selected. The interview allowed a free-flowing conversation that I could control through an interview guide. It also gave me the opportunity to pursue the development of new information in the interview process. I did not rush the interview so that I would have enough time to focus on a particular aspect at a particular time. When a participant did not understand a question, I was able to revise the question on the interview schedule to ensure a better understanding of the question and the correct response. The questions were open-ended andt covered issues as well.

The community leaders' interviews took between 30 minutes to an hour. The results of the interviews with the community leaders focused on issues pertaining to governance and the assistance the community received from the spheres of government, businesses and NGOs. The household interviews took more than 30 minutes but not over an hour. The interviews searched for information about household origin, period of stay in the settlement, livelihoods, experiences with flash flooding, household responses after flooding, and views on government or non-governmental support. All interviews, except for one, were recorded on the researcher's cell phone as the participant did not feel comfortable being on record.

3.4.3 Observations.

In the quest for research participants, the community leader, along with one of the community members gave me a tour of the informal settlement, its geographical landscape, settlement patterns, housing structures and infrastructure that has been put in place to mitigate flooding in the community. The walk took an hour and 20 minutes. I was shown the spatial planning of the settlement and households that were affected by floods. This observation gave the a chance to supplement the information provided in the key informant interview. The walks

induced discussions with community members about what I had encountered. I took photographs of the geographical landscape and the shacks to depict the vulnerability of those who lived close to the riverbank and those who did not. Photographs of individuals weren't taken. I also had the opportunity to carry out observation on the physical impact of floods on when I was inside shacks during household interviews I examined the state of the shacks and their contents such as furniture and appliances which were damaged in the flood.

3.5 Data analysis, research ethics & limitations

This section demonstrates the data analysis process and the ethical considerations in this study. It states the limitations or challenges faced during the study. This is significant as it demonstrates that the study was not compromised in any way.

3.5.1 Data analysis

According to Averii (2014), qualitative data analysis begins after the data has been collected from multiple sources. The data must be organized, sorted and documented (Averii, 2014) and this includes backing up the data to prevent damage, corruption to files or loss (Denscombe, 2010). I used content analysis approach (Denscombe, 2010: 28) which "involves linguistic 'quantification' where words and text are units of analysis that are tallied" allowing me to look for a hidden message.

In this approach, I began by carefully listening to the recordings and transcribed the interviews to make them presentable and easy to understand. I ensured that the data did not lose its authenticity. This process involved translating most of the interviews to English. I analysed the data word for word and added notes (annotations) about observations I made during the fieldwork in the margin. I also noted the interpretation and meaning of the data.

I engaged in hybrid coding which involves both deductive and inductive coding. This assisted me not to exclude valuable data insights (Crosley, 2020). I began with deductive coding then moved to inductive coding. Deductive coding includes the creation of codes before interacting with the data (Crosley, 2020). These codes stem from the research questions and can help one discover relevant data quickly. Inductive coding is creating codes based on what one finds in the data (Crosley, 2020). This type of coding allows new information to resurface and contributes to the subject matter. I used some of the data in its raw sense using quotations.

I went on to derive codes that helped me categorise the data collected. Based on the number of times the codes occurred, I grouped them into different categories making it more manageable to analyse the data. The research question guided the categories in which the codes were grouped, but some were drawn from the coding process. I was able to find a relationship between the data and patterns. As a result, I was able to create themes that would be discussed later based on the number of times these units appeared. The categories would be interpreted, answer the research questions and draw conclusions. Moreover, the categories were also identified in the literature review and categories contributed to policy recommendations and solutions which fulfilled the objectives of this study.

3.5.2 Ethical considerations

Ethical considerations such as honesty, integrity and accountability were at the core of the study. I ensured that the dignity and integrity of the participants are considered and always maintained (Denscombe, 2010). I had to ensure that there were equal power relations during the research process and that the participant is protected and not overpowered (O'Leary, 2004). Important ethical practices such as voluntary participation and confidentiality were applied when conducting the research. The participants were assured of confidentiality and were asked to sign a consent form before any key informant interview or basic interview was conducted.

Authorisation and ethical clearance

I obtained ethical clearance from the Research Ethics Committee of the University of Pretoria before undertaking the field research and conducted the study as set out in the research proposal submitted. Information was obtained through interviews with members of the community, so I had to provide a consent form before conducting the interviews.

I also obtained permission to conduct fieldwork from the municipality where the informal settlement is located. I contacted the City of Tshwane and asked for the councillor, Ms Seelane's contact details. The researcher proceeded to call and send the councillor an email explaining the study and requested a permission letter to conduct the study in Ward 28. The councillor agreed to sign the permission letter but was held up in councillor's meetings. The Chief Whip of the council signed on her behalf.

Informed consent

I garnered support by contacting the community leaders first before commencing the study in the hope of gaining support for the study. Before all the interviews, I explained the study in detail to the residents and potential participants were asked to give informed consent by signing a consent form (Babbie, 2020). Consent to record the interview was included in the form. Only adults (individuals over 18) were asked to participate.

Volunteerism and rewards

I made it clear that participation was voluntary (Babbie, 2020) and that no remuneration would be offered. I was completely open about the purpose of the research that it is for academic purposes and was not for bringing them any funding or projects even though it might fall on the hands of policy makers. I did not promise to bring them any developments. Participants were made aware that they were free to withdraw from the research at any point, without giving an explanation, and without any negative consequences.

Anonymity and confidentiality

I gave participants the option to use a pseudonym but many preferred to use their real names. I chose confidentiality as it implies that the responses will not be shared publicly (Babbie, 2020). The participants' responses will only be used for the purposes of this dissertation. I assured the participants that their personal information and responses would be kept safe (Babbie, 2020).

Storage and distribution of information

I assured the participants that their personal information and responses will be kept safe (Babbie, 2020). The data and notes from the field is stored on my cell phone which is password protected. This will also bebacked up on Google Drive which is also password protected. r my supervisor and I only have access to the raw data which will be stored securely for 15 years, in accordance with the data storage policy of the University of Pretoria. The results could be produced in the form of a dissertation or scientific paper or presented at both local and international forums like workshops and conferences. Participants may request a summary of the findings (which will not identify individual participants) upon completion of the study.

Limitations

I questioned the authenticity of the responses from the community members. The issue of flooding is one that the community members are in the process of resolving, having discussed it multiple times in their meetings. One could say that their responses could be grounded on the collective decisions taken during community meetings. I combatted this by shifting the questioning to how the floods affected the participants as individuals.

Some community members did not want to participate because replaying the events that took place in 2019 brought back or triggered their trauma. I did not interview any elderly household heads because they refused to participate. I then substituted those who did not want to participate with those who were willing to. On the other hand, some respondents wanted to know how participating in the interview would benefit them to solve the issue but I explained that the study was for academic purposes.

Fieldwork was delayed and took longer than planned because I, at some point during the data collection period got ill. On some days, the community leader had personal matters or work that he had to attend to, thus fieldwork would be briefly halted. Nonetheless, I was diligent and communicated regularly with the community leader to ascertain when we could resume. Lastly, I did not adhere to the Covid-19 regulations because before fieldwork commenced, the South African Health Minister, Joe Phaahla announced the lifting of the use of masks and restrictions on gatherings (South African government, 2022).

3.6 Chapter summary

This chapter presented the methodology chosen and followed by the researcher. The research methods presented formed most of this chapter. They informed the themes identified, arguments for the selection of methodology and conclusions drawn. The structure of the chapter was given at the beginning. It is structured to answer the research question and indicates that specific research questions were used to guide and extract questions for the interviews. The subsections define the study area, the research design, research method and the sampling techniques used in this study.

A qualitative research design meant I had an array of sampling techniques to choose from to identify the key respondents to gather research from. So, a purposive sampling technique was used to identify different households from the sample and select key individuals. This chapter also described the research methods that were employed to gather data in detail, namely, semi-structured key informant interviews, transect walks and observations with

community leaders and households of the community. The last sections of the chapter explain the data analysis procedure which involved a content analysis. Finally, it gives details of the ethical considerations and limitations of the study.

CHAPTER 4: CLIMATE CHANGE IN THE EERSTE FABRIEK INFORMAL SETTLEMENT

4.1 Introduction

The previous chapter provided a methodology used for the study. This presents the findings from the fieldwork that was conducted in the Eerste Fabriek informal settlement. Interviews with informal dwellers and their community leaders forms the basis of this chapter. It aims to depict the vulnerability, knowledge and adaptability to climate change of the informal settlement. The first half of the chapter provides the setting. It begins with a profile of the metropolitan municipality, the City of Tshwane (CoT). It goes on to give an outline of Mamelodi, a township under CoT where the Eerste Fabriek informal settlement is situated. The next section profiles the Eerste Fabriek informal settlement itself.

This chapter presents the socioeconomic status of the community to measure vulnerability and the knowledge of climate change and adaptation in the community. Although we are aware that the informal settlement community is already vulnerable because of their location, this chapter explores the reasons behind the occupation of a floodplain. This paper presents the physical vulnerabilities faced by the informal settlement community because of the relationship between poverty, the state, and struggle for housing and land since post-apartheid South Africa. Furthermore, it shows the various types of housing structures within the informal settlement.

This is followed by a narration of the events leading up to the 2019 flooding and the day of the actual incident. This chapter also presents the community's knowledge and perception of climate change. It provides the different types of flooding that the community perceives as a risk and expects to affect them as they live near a river. It presents the main causes of flooding according to the participants. The last half of the Chapter depicts the social, economic, and physical impact of the flood on households in the informal settlement. The last section provides insight into how the community responded to the flood and the role of the state and non-state actors.

4.2 Providing the setting: City of Tshwane Municipality

The research was conducted in Eerste Fabriek in the Mamelodi Township, located in the City of Pretoria, Gauteng Province. The City of Pretoria is also known as the Tshwane Metropolitan City or City of Tshwane. It was established on the 5th of December 2000 and is

one of the largest metropolitan municipalities in Gauteng. The CoT is the country's administrative capital, which houses all government departments and the Union Buildings, which is the official seat of the state and houses the president's office. It is situated about 70 km from the country's industrial hub, Johannesburg. The metropolis serves as a gateway to the provinces to the north and beyond the northern borders to countries such as Zimbabwe, and to the west, the Republic of Botswana, Mozambique and Swaziland to the east. The CoT is the only metropolitan that borders three provinces, namely Limpopo, Mpumalanga and North West. Administratively, the area is in Region 6, to the west of the city, where most of the city's population can be found.

By 2017, its population had risen to 3 555 741 million, of which 50,5% of the population were women (COGTA, 2020). About 49% of the population is between the ages of 20-49 years, with the median age being 49 years. The city has a total number of 1 136 876 million households, with around 16.4% located in informal dwellings (COGTA, 2020). Since 2016, the number of households has increased by 3,21% due to in-migration into the city, mainly from the rural areas, while we cannot rule out migration from other countries. Migrants from other countries are found in Metropolitan cities, where there are available job opportunities, although some migrants of course are found in farm areas (Rutherford and Addison, 2007). Metropolitan areas such as Tshwane are also popular with migrants because of the dominance of hospitality industry which prefer to employ migrants (Bloch, 2010).

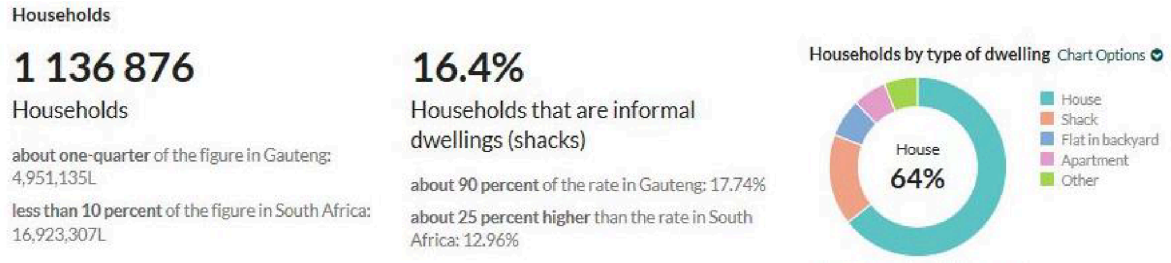

Figure 3: Households in CoT

Source: COGTA 2020

The city comprises of 3762 household heads who are under 18 years of age. About 30% of these households can be found in informal settlements. This rate is 20% higher than Gauteng's and more than double the rate of the country. 37,5% of households are female-headed.

Inequality is evident in the northern suburbs, townships, informal settlements, and merging regions in the CoT (Modiba, 2021). 31,1% of people live below the poverty line of R1 077 per month. The Gini coefficient of the city was 0,62 in 2019. The 2016 Community Survey presented the unemployment rate at 16% with only 51% of the population as economically active.

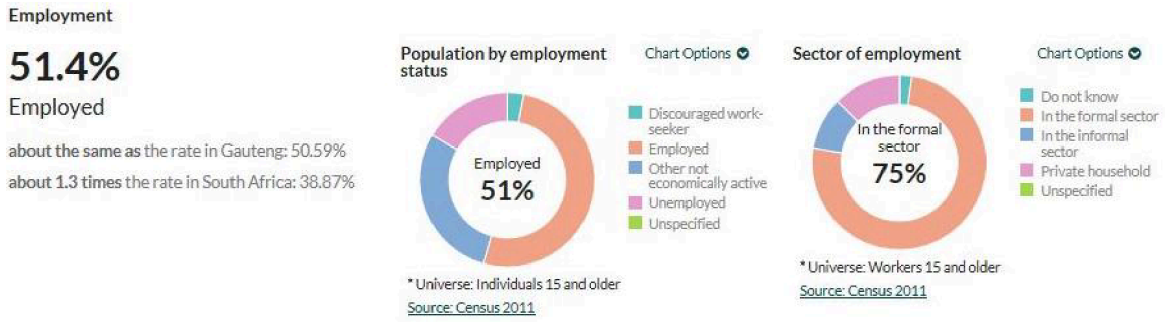

Figure 4:Employment rate in CoT.

Source: COGTA, 2020

As for its climate, CoT is in the Southern Hemisphere with its summer months starting from December, January, February, and March. Its climate is warm and temperate with the most rainfall occurring in summer compared to winter. The average annual temperature is 18,4 degrees Celsius (Climate data, undated). The city experiences the highest temperatures in January, on average at 22,4 degrees Celsius and the coldest in July, on average at 12 degrees Celsius (Climate data, undated). The wettest month is December.

As an urban centre, the CoT drives climate change but is said to be the most vulnerable to the effects of global warming (Ngwenya-Bendile, 2021). The CoT faces numerous environmental challenges caused by climate change and maladministration. CoT residents are warned of depleting water resources usually caused by drought, which is driven by climate change. But water insecurity is also caused by poor water management by the municipality in the form of aging and unmaintained infrastructure (Ngwenya-Bendile, 2021). One notable case is water pollution related to the Temba Water Treatment Plant which services one of the townships called Hammanskraal. Water from this plant is contaminated by sewage sanitation. The community has been receiving unclean water, contaminated by sewage.

Additionally, wetlands are disappearing due to the urban sprawl and reduced rainfall. This is contributing to water insecurity because wetlands are a natural infrastructure that provides clean water, food resources and medicinal plants (Ngwenya-Bendile, 2021). CoT residents

experience noise pollution from economic activities that take place through business, factories and warehouses. A dense urban space will experience noise pollution. Informal settlements are subjected to this because a lack of land results in households that are built quite closely to one another. The city is exposed to air pollution because of poor waste management. Informal settlement households are denied waste collection services, hence they burn waste. This depicts Tshwane as an unjust space with informal settlements resorting to informal systems to survive daily. Population growth and people's increased spending habits leads to larger waste generation (Ngwenya-Bendile, 2021). The city needs to keep up with this changing consumer culture and improve waste management practices.

Flooding has become intense in the last few years, especially in December 2019 and February 2020. Flooding has caused serious damage in the city. The poor and those residing in informal settlements were negatively impacted. They lost their homes with Eerste Fabriek reported as needing the most assistance (Ngwenya-Bendile, 2021). More so, the CoT experiences sinkholes as part of 25% of Gauteng that is underlain by dolomite. Aging infrastructure such as burst pipes also causes sinkholes. Sinkholes have occurred mainly in formal spaces such as Centurion and Laudium (Ngwenya-Bendile, 2021). The informal settlements are most vulnerable to these challenges because they lack access to resources such as water, housing, and energy. These environmental challenges affect urban sustainability, the economy and society at large.

4.2.1 Mamelodi township

The CoT is home to Mamelodi township. When industrialisation spread to Africa, townships like Mamelodi were described as the first communities to be industrialised with the establishment of Eerste Fabrieke in 1882 (Rekord East, 2018). On June 6, 1883, the Eerste Fabriek Hatherley Distillery was opened (Orton, 2010). After facing liquidation in 1891, in 1892, the manufacturing of alcoholic beverages was permitted and transferred to Eerste Fabrieke Hatherley Distillery Limited as a public company (Orton, 2010). Between 1895 and 1896 several factories such as the South African Fruit & Meat Preserve Works and the Pretoria Glass Works were created at Hatherley (Orton, 2010). Mamelodi was an industrial community. This was one of the ways it contributed to the emission of greenhouse gases in the past.

In the 1940s, the Apartheid government went on to establish Mamelodi as a township for black workers near the train station at Eerste Fabrieken (Gottsmann & Osman, 2012).

Mamelodi "is a residential suburb approximately 25km² in area and was originally established to provide cheap labour for the above-mentioned industries in Pretoria and the greater Gauteng region" (Moloisane, 2017: 226). This fostered an urban push where people moved from rural areas to Mamelodi for job opportunities they were certain were available. These settlements lacked proper infrastructure and had issues with service delivery (Gottsmann & Osman, 2012). Mamelodi has grown massively since independence as the postcolonial government developed more settlements and expanded existing ones for previously disadvantaged communities. Labourers who lived on the "erratic" edge of the settlement moved into the new formal housing or joined the newer immigrants and relocated again to the "shifting outskirts of the township" settlements (Gottsmann, 2012).

Mamelodi developed further to the East beyond the Pienaars Rivier also known as the Morelete River. Alongside the old and new settlements, unplanned settlements including the one under study have mushroomed informally, and now form part of the township landscape. Informal settlements in Mamelodi are known for their ability to absorb older ones within its new composition, simultaneously, giving rise to new informal settlements (Gottsmann, 2012). Most informal settlements are situated in the East of Mamelodi and have shaped the formal urban composition of the township (Gottsmann & Osman, 2012).

Post-apartheid, most residents in townships like Mamelodi and informal settlements had high expectations for better lives (Darky & Visagie, 2013). The post-apartheid government (the African National Congress) introduced several policies such as the Reconstruction & Development Programme (RDP) to remove the legacy of apartheid. However, the housing demand is high, and they have fallen behind. People cannot obtain or purchase neither housing nor land. Informal dwellers continue to suffer from issues such as lack of proper infrastructure and service delivery mirroring those from apartheid (Gottsmann & Osman, 2012).

Now, Mamelodi has become one of the largest townships in the Tshwane Metropolitan District. Mamelodi was described by the United Nations as one of the 'underserviced townships' - a perpetuation of the spatial segregation experienced during apartheid (COGTA, 2020). Tshwane has experienced issues of rapid urbanisation which has resulted in the formation of illegal informal settlements (Modiba, 2021). Mamelodi is a preferred destination for migrants due to its convenient proximity to economic opportunities in the

central business district and industrial areas to the east and north-east of the city centre(Moloisane, 2018). There are roughly 227 informal settlements in the city which account for 18% of the houses in the city (Moloisane, 2018).

In a survey conducted in 2011, Mamelodi had a total population of 334 577 (StatSA, 2022). 98.8% of the population is African. 48% of the population is female and 52% is male. The township comprises of 110 703 households. 18,7% of the households have no income, and 3,6% have an income between R1,00 and R4800,00. Only 9,5% of the population completed tertiary education and 38,4% have matric.

Group	Percentage
No Schooling	4,3%
Some Primary	7,8%
Completed Primary	3,5%
Some Secondary	36,5%
Matric	38,4%
Higher Education	9,5%

Figure 5: Education

Source. Census 2022

4.3 Vulnerabilities of Eerste Fabriek informal settlement

The establishment of the squatter camp was driven by grievances regarding the presence of non-residents in the existing informal settlement known as Marikana, situated behind 77 Bufferlake. This situation led to a demand for land allocation specifically for residents of Mamelodi who did not have access to stands (a plot of land used for residential purposes). Housing is a human right. The founders expressed that invading a floodplain was one way to

'get the land back' and provide housing for people in Mamelodi as the government has made it almost impossible to own land. This is known as 'land grabs'. Land grabs have been trending in South Africa. They are illegal land occupations on which people establish informal settlements (Beukes, 2022). They are rooted in colonialism and Apartheid which happened in South Africa. In both cases, Africans were forcefully removed from their homes and dispossessed of their land. A community leader shared this sentiment:

> The goal of every informal settlement, from inception is to get a permanent stand. The reason for squatter camps and land invasion is to get the land back. It belongs to black people, but they do not have possession of it. The only way to get land is to qualify for a bond at the bank. Most black people do not qualify. Fixing this place is useless, it cannot be permanent. The constitution of SA says the land should be shared, but we have not seen that happening. Instead, a certain race is benefitting from land they did not buy but dispossessed. The law is making black people dependent on them. The Government promised so much in 1994 but is failing to deliver. (Interview. Sihle, 15 August 2022)[1]

The informal dwellers settled on the floodplain as there wasn't any vacant land in the far east of Mamelodi, where most informal settlements can be found. Additionally, the floodplain is close by to the centres of the township such as taxi ranks and malls. The informal settlement community has experienced flash floods numerous times since inception but continues with life on the floodplain.

The informal settlement is dominated by people from Limpopo, Mpumalanga, and Gauteng. 9 out of the 20 residents who were interviewed have been living in the settlement since its inception in 2016. It makes sense why most of the dwellers originate from these provinces because the CoT, as noted in section 5(2), is the only city which borders Limpopo and Mpumalanga through the N1 and N4.

Many residents decided to migrate to Gauteng for several reasons. They range from the search of better standards of living,job opportunities and work purposes. For residents who are originally from Gauteng, specifically Pretoria, living in the informal settlement was an opportunity to move out of their family homes which were either crowded or became discordant to live in and it was a quest for independence. Some felt that the centrality of the

[1] Interview with Sihle, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.

informal settlement to shopping malls, adjacent affluent areas, and taxi ranks, would be lighter on their pockets.

Ben who is in his late twenties and hails from Mpumalanga explained that he wanted independence.

> I have been living in Mamelodi for years. I have family in Tsakane (not far from Eerste Fabriek), however, I wanted to work, grow and be independent. Although this place is dangerous, we are aware. We just want our own homes and independence. But it is not that bad, at least I have shelter. I do not live like a hobo (homeless person). It is not home but for now it is a home to me. (Interview. Ben, 15 August 2022)[2]

Unlike Ben, Ntate Jacob, 48 was forced to move from Hamanskraal to Mamelodi after a fight with his neighbours. He lives alone and is one of the first people who moved to the floodplain in 2016. He explained:

> I moved to my father's side of the family in Mamelodi West(B3) because I fought with one of the neighbours back home. So, my mother suggested I move to this side. I met a lawyer within the family who introduced me to Gavin (one of the founders of this settlement) so I could get my own place because I was destructive and not contributing much at home. They were tired of supporting me [financially]. (Interview. Ntate Jacob, 15 August 2022)[3]

Ntate Jack, 50, moved from Limpopo to Pretoria as he needed to be close to work. The company he worked for changed location to Silverton, Pretoria. He needed a place to stay and Mamelodi was the nearest. On the other hand, Ntombi moved from Mamelodi West (D2) to the Eerste Fabriek informal settlement because she incurred increased transport costs when travelling from D2 to Waterkloof, where her employer is based. It saves costs as she does not have to catch a taxi to the rank. The informal settlement is closer, and the distance allows her to walk there. This is an excerpt from the interview conducted with her.

[2] Interview with Ben, Eerste Fabriek informal settlement, Mamelodi, 16 August 2022.
[3] Interview with Ntate Jacob, Eerste Fabriek informal settlement, Mamelodi, 16 August 2022.

I decided to move here because my employer transferred me to Waterkloof, so in D2, I incurred transport costs. Currently, I am the breadwinner as the father of my child is unemployed. (Interview. Ntombi, 18 August 2022)[4]

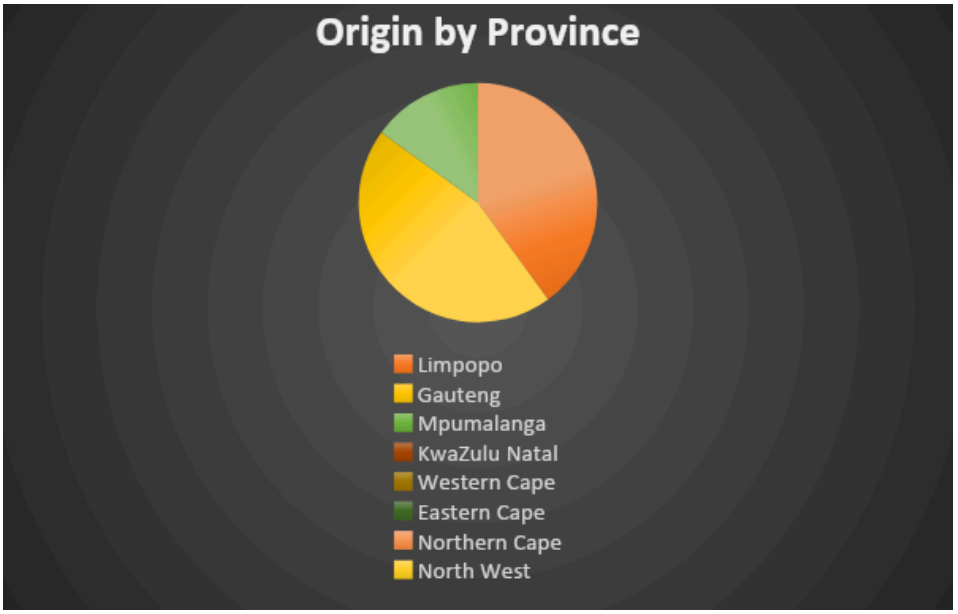

Figure 6:Participants' Origin

But the underlying reason as to why many chose to live in an informal settlement when there are different accommodations present to them in the city is affordability. They cannot afford to rent or secure a bond in Pretoria. Thus, living in a squatter camp was their last option. For example, Ntate Ernest, had been renting for ± twenty years.

I had been renting for 20 years, so I decided to change my life and move to Eerste Fabriek. (Interview. Ntate Ernest, 18 August 2022)[5]

While others stressed the high costs of renting or buying a house in the city, Tshwarelo (34), a father to one, lives alone and felt that besides being costly, renting restricted him and his family's freedom.

We don't live here because we like it, but it is because of our situation (socioeconomic status). You need to bear in mind that a lot of young people in SA are unemployed and as a young person, you realise that eventually you need to start a family (wife and children). We came here because we cannot afford to rent. The only way to avoid rent is

[4] Interview with Ntombi, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.
[5] Interview with Ntate Ernest, Eerste Fabriek informal settlement, Mamelodi, 18 August 2022.

> by living in a squatter camp. It is not a good place to reside, others say we do not want to leave, however that is a lie. If I am renting with my kids, the owners complain because the kids waste water. (Interview. Tshwarelo, 18 August 2022)[6]

The informal dwellers have tried other avenues to secure shelter in the city. For example, multitudes of people have applied for state housing that was promised by the post-apartheid government through the Reconstruction and Development Programme . They have not received RDP houses because of perceived corruption and maladministration, Josephine expressed her frustrations.

> Some of us have since filled in Form C but have still not been allocated a house. We're still waiting. (Interview. Josephine, 18 August 2022)[7]

Moreover, the inability to afford rent or to buy a house is one of the reasons why the informal dwellers decided to live on the informal settlement. In this case, unemployment, income, and the type of job one has, has an influence on housing. Chapter 4(3) explains that to qualify for a bond, one needs to be in formal employment. Those who hold low/semi-skilled jobs are excluded from the housing market. Ntate Jack shared this view:

> I think that unemployment is the cause of informal settlements. Most of us work in the private sector. The amount of money people earn is not enough, so they cannot afford to rent a flat or buy a house. The living wage that was proposed by the president amounts to R 3000,00 and signed by the labour union is too little for most of us. If I earn R3000 per month and rent is R1500, I'd rather opt for a vacant space, use the R1500 I would have paid rent with to build a shack. (Interview. Ntate Jack, 15 August 2022)[8]

The reasons for migration vary. Unlike other studies on climate change, the participants did not move to the city due to climate variations which affected agriculture and subsistence farming but rather moved to seek financial freedom through economic opportunities presented in the city. Moreso, many chose to live in an informal settlement due to the housing debacle South Africans face and the economic stature in the country where even the employed cannot afford to rent accommodation or buy a house.

[6] Interview with Tshwarelo, Eerste Fabriek informal settlement, Mamelodi, 18 August 2022.
[7] Interview with Josephine, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.
[8] Interview with Ntate Jack, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.

Though the residents have been successful in setting up the informal settlement, at one point the Red Ants (a private eviction and security company notorious for their violence) were instructed to demolish the community's structures. Thereafter, the dwellers rebuilt their houses. To the community, it appears as if government is denying them access to land. They feel that the municipality must not evict them but should find land suitable for residents. Granted that this is land invasion, the community leader stresses that government has never warned them, even before the 2019 flood, to move away from the flood plain. He shared:

> This is a land invasion. We invaded a wetland, the most dangerous in Mamelodi. We were not warned numerous times, that is a lie. The Red Ants came and demolished our shacks, we rebuilt to show the importance of this land to our community. If the municipality has safer land, they must give it to us. But if they tell us to move, where will we go? Rent is expensive and some of our parents' houses are not in Gauteng. (Interview. Community leader, 15 August 2022)[9]

The study confirmed the physical vulnerability the community faces. Modiba described it as "…not strong enough to handle the shock…" (2021:79). Most of the shacks are made with salvaged corrugated iron/zinc and only a small percentage are brick houses. The shacks have at least three windows and one entry point (door). Upon observation, the researcher found that the residents either bought the building materials or scavenged them from scrap metal yards. There were disparities in the way residents built their shacks, with some building theirs using big wooden logs as frames. These residents believed that this was the reason the shacks weren't swept away.

The area lacks sanitation infrastructure, and those who dwell in the shacks share these resources (Mitchley & Schatz, 2020). They also do not have access to basic services such as waste collection. The informal dwellers resort to makeshift pit toilets, dumping and burning waste. These waste disposal methods are considered as major contributors to pollution and environmental degradation (Ngwenya-Belinde, 2021).

Nonetheless, the researcher noted that resilience to climate change-related events was based on where your shack was situated in the informal settlement, not the types of building materials used. Buildings with brick structures were mostly businesses such as tuckshops.

[9] Interview with community leader, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.

During the transect walk the researcher noted that there was a compound of brick buildings next to the riverbank. The owner runs a recycling business.

Figure 7:Shacks situated near the river and remained

4.3.1 Socioeconomic status

The socioeconomic status or state of poverty of the households can be used to measure vulnerability to climate change. It draws from Chapter 2(5) which states that socioeconomic status can be a determinant of vulnerability, only through case-specific research. The socioeconomic status of the participants is based on demographics and socioeconomic factors such as age, gender, origin, marital status, income levels and employment status. The participants consisted of households that experienced flooding.

The participants interviewed were between the ages of 20-60, majority being between 40-49. The age of a household head influences adaptive capacity and determines how the household deals with the effects of the flood (Modiba, 2021). However, this study does not prove this assertion. Community members rely on each other because their coping strategies are determined on a community level and not by individual households. Age, food security, and natural disasters have a negative correlation (Modiba, 2021).

Thirteen males and seven females were interviewed. Based on the gender disparity in various studies, Modiba (2021) concluded that females perceive flood risk "acutely" and worry about natural disasters. It was observed that male participants were more descriptive of the coping measures taken to survive the floods than females. In his approach, Modiba (2021) states that perception did not equate to "higher levels of protective behaviour" but rather that male participants were more likely to be proactive in developing risk reduction measures.

There was one disabled person who participated in the interview. The participant suffers from epilepsy which was ruled a disability by his medical practitioner. Medically, disability is defined as "the result of an individual medical or biological condition" (Gutnik & Roth, 2018). Climate change presents a double burden for the disabled because they must face climate change related events as everyone else and the "challenge of operating in a disrupted and resource-limited context with a disability" (Gutnik & Roth, 2018: 6).

17 participants are single and only 3 are married, divorced, and engaged, respectively. Even though it was discovered that married couples may have a better approach to flooding and preparedness such as contributing money (Modiba, 2021), the cohesion in the Eerste Fabriek community played a great deal in flood preparedness and prevention. The community possesses social capital which allows the community members to assist each other when the flood happens. Even though most of these dwellers live far from their relatives, their coping mechanisms are not individualistic. Additionally, they are open to assisting each other regardless of income differentials. This does not mirror the classical sociological theories about urban spaces that reveals the lack of "social bonds' ' that rural communities possess (Drivdal, 2016). The love and unity (harmony) in the community contributed to tackling emergencies such as natural disasters and crime.

The community has few nuclear family structures as majority of the participants were single. Most of the participants have children but of the 16, only 5 live with their children, some are single parents. Their children either remained back home or resided with the other parent and others do not have contact with their children at all. The household heads expressed different reasons for not living with their children. They felt that they were putting their children's lives in danger. The significant reduction in household sizes was caused by the migration of children after the 2019 flood.

The education level of most of the residents is not lower than grade 10 but not higher than matric. Two females pursued tertiary studies but did not complete. Most of the community members are unemployed. The employed are semi-skilled workers, such as security guards, shop assistants, or factory workers. Only one participant is self-employed. They rely on various sources of income such as the Social Distress Relief Grant introduced in 2020, the Child Grants their children receive. Both grants are issued by the state. The rest survive on piece jobs/hustles or temporary work.

Education levels have a direct relationship with employment. Employment is higher in communities that have human capital (tertiary qualifications) (Modiba, 2021). Lower education levels and high unemployment justify the low-income levels in a community. The high level of unemployment hinders the development of adaptation and coping strategies in households (Modiba, 2021). In other words, the adaptive capacity of a household head decreases when he/she is unemployed compared to an employed household head (Modiba, 2021). Moreover, the household head's income discourages the development of adaptation strategies if there's any.

EDUCATION LEVEL	
Matric	8
High school	7
Incomplete tertiary Qualification	2
Unclear	3

Table 3: Education Level

EMPLOYMENT STATUS	
Employed	6
Unemployed	12
Self-employed	1
Pensioner	1

Table 4: Employment Status

There aren't many foreign nationals in the settlement. The researcher encountered one Lesotho national who started living in the informal settlement in 2022. The rest consisted of Somalians who own tuck shops in the area. Most have moved their tuckshops from the inner parts of the informal settlement where floods have a greater impact and have built on the periphery of the informal settlement. They are not relevant to the study because only households were being interviewed.

Some of the participants touched on how they experienced different weather patterns on the floodplain as opposed to the rest of the township. During winter it is cold. Summer is a rainy season; therefore, the dams will be filled over capacity to a point where the sluice gates might

be opened to release water into the river. The informal dwellers dread this because their shacks become flooded. The community experiences frequent changes in weather throughout the day. It is difficult to predict whether the day will be hot or cold. Ntate France said the weather was unpredictable.

> The mornings are cold, and in the afternoon, I must wear long pants. The weather is unpredictable as it changes now and again. Living on a floodplain is unsuitable for humans because it has got water. It is fit for animals. (Interview. Ntate France, 20 August 2022)[10]

4.3 Households knowledge and understanding of climate change and adverse weather events

According to the Fourth Climate Change Tracking Report, development challenges are also described as 'characteristics of society' that determine how people prepare and respond to climate change (DFFE, 2023). The way issues like gender inequality and low levels of education contribute to climate change vulnerability tends to be complicated (DFFE, 2023).

Socioeconomic factors such as education and income level play a role in the knowledge and perception of climate change. In a study carried out between 2007 and 2008 in 119 countries, it was concluded that education is the biggest predictor of climate change awareness (Ballew, Pearson et al., 2019). Ballew et al. (2019) also assert that education propels climate change mitigation and adaptation. On the basis that the community repeatedly suffers the terrible impacts of climate change, the study sought to assess the knowledge and perception of climate change among the residents. This was done by asking questions around what they thought caused the flooding in the settlement. However, before discussing these perceptions, the section begins by detailing the flooding incident of 9 December 2019, and the community's responses.

4.3.1 December 9th, 2019, flooding incident in 77 Bufferlake

It is of interest to this study that the community of Eerste Fabriek informal settlement was informed and warned about possible flooding, and people were advised to vacate the area. It is also of interest to this study that this community did not act or respond to the warning, and neither did people take precautionary measures. What emerges from this brief account is

[10] Interview with Ntate France, Eerste Fabriek informal settlement, Mamelodi, 20 August 2022.

significant in our attempt to understand the situation and vulnerability of this informal settlement community in particular, and other informal settlements in South Africa in general.

It had been raining for two weeks before the flooding in Eerste Fabriek, Mamelodi took place. On the 8th of December, helicopters with the then-councillor, Mr Zitha on-board, announced the opening of the Vaal Dam sluice gates, which would release more water, and that residents needed to urgently vacate the floodplain. Mr Zitha, accompanied by the rescue team, made the announcement using a loud speaker for everyone to get the message. His message was simple and clear:

> Please vacate your premises as there's water coming to this site. The dams will be opened as they are full. If we do not open the dams, they will burst and affect many other lives, so some water must be released. (Interview. Mr Zitha, 01 September 2022)[11]

Despite this warning and clear message, the communitydid not respond to the warning.. Residents cited the late hour and lack of alternative accommodations as reasons for their failure to evacuate. The community leaders also failed to respond appropriately to the warning. Their only strategy was to gather the community and alert them of the possible flooding. The action adopted was explained by one community leader:

> As neighbours we gathered and agreed to look out for each other, in case the situation became worse. (Interview. Community leader, 02 September 2022)[12]

The situation worsened as residents woke up to find rainwater flooding their surroundings the next day. By 9 am and 10 am, the water level had increased and started seeping into the shacks.. Despite the residents' belief that the rainfall in 2019 was not as intense, they still experienced the usual flow of water that flooded their shacks. However, they remained hopeful that the rain would eventually cease which would give them an opportunity to clean their shacks afterwards.

Ben who was active in helping trapped residents said that:

[11] Interview with Mr Zitha Fabriek informal settlement, Mamelodi, 15 August 2022.
[12] Interview with community leader, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.

> The water level slowly rose. After 30 minutes, the water was up to chest-level and the settlement was flooded. The water flowed into the informal settlement with great power and the current was quite strong. (Interview. Ben, 04 September 2022)[13]

The residents tried to utilise buckets and brooms to keep the water out of their shacks without success. The water inflow became uncontrollable, reaching a critical point around 12 pm. The water level and current became strong enough to sweep away their shacks, resulting in severe flooding. Vusi, the community leader, described this turn of events as shocking.

> People watched everything they worked hard for being taken by the water. About 300 shacks were swept away. Only the floors remained. About 200 shacks were flooded and damaged. From the 9th, people had nowhere to go. They were desperately in need. (Interview. Vusi, 05 Septmebr 2022)[14]

Some residents considered themselves fortunate as they were either at work or away from the area for various reasons, allowing them to seek temporary accommodation elsewhere. However, they still experienced the loss of personal belongings and damage to their assets.

The next section presents the knowledge and perception of climate change in the community. The causes of flooding were grouped into natural, man-made and beliefs.

4.3.2 Flooding caused by the runoff of surface water

It is expected that when rainfall hits the earth, it either evaporates or infiltrates the soil or run over the surface. The type of ground such as open spaces (lawns, golf courses, parks) generally covered with grass, streets and roads, paved parking lots, houses and residential areas, offices and business areas and shopping centres determine the magnitude of these actions. It can occur when rain falls on rainproof (impervious) areas such as roadways. In the absence of proper local drainage, when water does not evaporate, infiltrate the ground, or surface run-off, it accumulates, therefore, certain communities may experience localized flooding. Alternatively, through certain channels, the water might run off into a river or stream (FEMA, 2023).

Urbanisation driven by a gowing urban population has resulted in the expansion of impervious areas due to increased construction and pavement development. These buildings

[13] Interview with Ben, Eerste Fabriek informal settlement, Mamelodi, 04 Septmeber 2022.
[14] Interview with Vusi, Eerste Fabriek informal settlement, Mamelodi, 05 September 2022.

reduce natural ground needed for water absorption, increasing the amount of surface runoff generated. If not controlled this runoff will flood structures and roadways.

Ntate Eddie, one of the community leaders, believed flooding could only occur from surface runoff. He expressed it in this manner:

> Let's say it rains for a week then you can see the water level gradually increase. But the water that causes our flooding comes at high and intense speed from somewhere. I am not sure what the intention is. (Interview. Ntate Eddie, 06 September 2022)[15]

All the participants agreed that they experienced flooding in their community and perceived it as a risk. Most of the dwellers' knowledge of what caused the flood were based on a rumour that floods are caused by water coming from the Vaal Dam. 11 participants believed that the water comes through the bridge dividing Nellmapius and Eerste Fabriek, onto the floodplain, into the river. Nellmapius is a community near Mamelodi comprised of residents that were removed from informal settlements into RDP houses. The residents acknowledge that heavy rain can cause the dams to exceed their capacity, but they do not believe that the floods in the area are solely a result of heavy rain. They attribute the floods to human activities, as they have never witnessed such occurences throughout their existence . In their responses, they described three distinct types of floods as 'natural' and perceived them as potential risks.

4.3.3 Overbank flooding

Overbank flooding is defined as "the increase in volume of water within a river channel and the overflow of water from the channel onto the adjacent floodplain" (FEMA,undated: 7). This type of flooding is what most people associate floods with. For some, floods cannot occur without an overflowing river. According to Ntate Jack, the Moretele River was not overflowing, hence flooding was not supposed to take place.

> The floods are not caused by the river overflowing. People living near the riverbank are not affected. Certain spaces on the floodplain are not designed for residence. (Interview. Ntate Jack, 15 August 2022)[16]

To validate the above, Humbulani, who lives beside the river shared her experience. She mentioned that her shack has never been flooded, but other areas of the settlement such as the

[15] Interview with community leader, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.
[16] Interview with Ntate Jack, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.

entry and exit points have been prone to flooding. Based on this, the community seems to miscomprehend the cause of the flood as it is not through an overflow of the river. Overbank flooding is befitting as it is presuumed to be more natural/ "normal". .

4.3.4 Man-made or natural causes for flash floods?

Flash floods are defined as "sudden local flood of great volume and short duration which follows within (usually less than six) hours of heavy rain or excessive rainfall, or due to dam or levee failure, or the sudden release of water impounded by an ice log jam" (AFPM, 2007:13). The average time threshold varies from country to country (FEMA, undated). The Eerste Fabriek informal settlement community experiences flash floods.

The community members were told or heard that when the reservoirs are filled up, the Vaal Dam sluice gates are opened, and water is automatically released. Nomthandazo, one of the first people to occupy the informal settlement, said that this process depicts flooding as a man-made phenomenon.

> However, I do not think it was natural. It is man-made. The dams are automated, so when the reservoirs are full, the water releases itself. (Interview. Nomthandazo, 06 September 2022)[17]

The dwellers feel that the flood is man-made because they do not understand how the municipality opens the sluice gates knowing very well that there's an informal settlement on the floodplain. Josephine (37) who has formed her understanding of climate change based on rumours, believes that government lacks empathy towards the situation.

> I do not know how to explain the cause. I do not understand why they do not think of the people that live here before the dams are opened. (Interview. Josephine, 06 September 2022)[18]

Ntate Eddie also strongly felt that the flood was man-made because nobody occupied the floodplain before 2019. According to his knowledge, the kind of flooding that took place in 2019 was last experienced in the 1980s. Currently, flooding has become a norm in the informal settlement area.

In addition, these perceptions are driven by the fact that residents living close to the riverbank do not experience flooding. Ntate Jacob who lives on the same side of the settlement said:

[17] Interview with Nomthandazo, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.
[18] Interview with Josephine, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.

> The floods do not affect me at all because the water does not flood my surroundings or shack. I could say, I live on an island. No flooding incident has ever affected me. (Interview. Ntate Jacob, 06 September 2022)[19]

Other community members contradicted themselves because even though they believed the water from the dam caused the flooding, they understood the risk of living on hazardous land where flooding was inevitable. They persistently express this when asked about their living conditions. Molebogeng said:

> Living on a floodplain is risky. It's too dangerous. It is not appropriate for occupation. We experience flooding. (Interview. Molebogeng, 06 September 2022)[20]

Whereas Ntate Stevens described the informal settlement as an environment that is not conducive for residence.

On the contrary, some participants believed that the flooding was caused by natural factors. They based their assertions on their knowledge that heavy rainfall for extended periods of time causes flooding. One of the four participants who believed this is Refilwe .

> For me, the rumours about dams being opened and the water being opened do not stick. Floods are simply caused by heavy rain. (Interview. Refilwe, 07 September 2022)[21]

Lina, who is originally from Dennilton, Mpumalanga said:

> Floods are caused by heavy rain that goes on for days. If it rains for more than eight days, then we know it is going to be flooded. They are going to open the dams. (Interview. Lina, 07 September 2022)[22]

The next subsection unpacks the dominant perception that the flooding is man-made and caused by dams.

4.4.5 Vaal dam as the cause of flash flooding in 77 Bufferlake

With all the perceptions presented, one finds that it is true that the water coming from the Vaal Dam is released and is the cause of flash flooding in the community. However, residents lack a comprehensive understanding of why dams are opened and how it relates to weather events associated with climate change.

[19] Interview with Ntate Jacob, Eerste Fabriek informal settlement, Mamelodi, 06 Septmeber 2022.
[20] Interview with Molebogeng, Eerste Fabriek informal settlement, Mamelodi, 06 September 2022.
[21] Interview with Refilwe, Eerste Fabriek informal settlement, Mamelodi, 07 September 2022.
[22] Interview with Lina, Eerste Fabriek informal settlement, Mamelodi, 07 September 2022.

SANCOLD (undated) states that a reservoir/dam is used to “control the amount of water flowing in a river after heavy rain.”. This water can be from snowfall or heavy rain. The water tends to flow over riverbanks or walls, causing flooding which affects human settlements (property), farmland or loss of lives (SANCOLD, undated). The reservoir is a mechanism used to control the amount of water flowing in a river after heavy rain. (SANCOLD, undated). While an influx of water is advantageous and ensures water security, it can be harmful to the infrastructure (Staff Reporter, 2022).

The Committee asserts that the water level of a dam is stored at a low during rainy periods, however, this is dependent on the size of the flood. With small to medium floods, it is low, during heavy rains, the reservoir is filled up with large floods, and then the rest of the water is passed "downstream to the river" (SANCOLD, undated). Floodgates are used on top of spillways which transmit the water safely or through the dam. Floodgates are occasionally opened to control the amount of water released into the river downstream.

In South Africa, the Department of Water and Sanitation (DWS) said they needed to open twelve sluice gates to ease pressure on to the Vaal and Orange River systems (South African Goverment, 2023). This is after continuous heavy rains caused an overflow in the Vaal and Orange River. Many homes were destroyed, and business negatively affected. Residents maintain that the flooding was man-made. They felt the sluice gates were opened negligently. However, DWS highlighted that they followed protocol (Sikhakhane, 2023).

Figure 8:Morete River flowing at the border of the informal settlement.

For example, in 2021/2022, climatic phenomenon called La Niña, and "above normal rainfall" were predicted for summer (January, February, March, April and May) (Roffe, 2022). The Department of Water and Sanitation spokesperson explained that four sluice gates were opened to control and manage the inflow of water earlier that year (Ash, 2022). More releases were predicted for later that year. The spokesperson went on to warn people living close to the dams or on down streams (mouth of the river) to be careful and take caution (Ash, 2022).

Ultimately, as per the prediction, the city experienced flooding in January 2022. The informal settlement was not the only community that was affected by heavy rains. Formal areas like Centurion, a suburb between Pretoria and Midrand (Johannesburg) also experienced flash floods that lead to sinkholes (Ncwane, 2022). The CoT Emergency Services spokesperson explained that "part of the reason for the sinkholes was that flash floods as a result of extreme rainfall sometimes exceeded the capacity of infrastructure such as stormwater drainage to deal with the resulting run-off (Ncwane, 2022). Since 1979 till 2012, Centurion has experienced 119 sinkholes (Oosthuizen & Rooy, 2019). This has led to the demolition of seven houses and other structures. Landowners lost money and three people lost their lives during the rehabilitation of a sinkhole (Oosthuizen & Rooy, 2019).

The community holds the belief that even non-floodplain areas like Centurion experience floods, indicating that inadequate infrastructure is the primary cause of flooding rather than heavy rainfall or residing on a floodplain.. To validate his view that the floods are man-made, Bonang compared 77 Bufferlake to Centurion.

> Look at Centurion, it is highly infrastructured but suffered from floods. It was chaos. So, we cannot just say just because we live near a river, it only affected us. (Interview. Bonang, 08 September 2022)[23]

This view suggests that poor urban planning by government, an issue in many African cities, is the cause of the flooding. Therefore, it is man-made.

Another comparison, much closer to home, are other areas situated near the floodplain, known as Moretele View & Naledi. The households have never been affected by floods.

[23] Interview with Bonang, Eerste Fabriek informal settlement, Mamelodi, 08 September 2022.

Before the houses were built, the land was slightly elevated above the floodplain to mitigate flooding whenever water from the dams would be released into the Morelete River. The above portrays the high inequalities in the township (Drivdal, 2016), more so, the income disparities of the households in Mamelodi. Those who afford well-built bond housing reside near the floodplain but do not experience the floods, nor their impact

Figure 9:Bonded houses just behind the informal settlement community

This information on how dams operate during low and heavy rain stresses the physical vulnerability the community faces and gives an understanding into why the floodplain is not ideal for residence. It was a mitigation strategy by urban planners. The Vaal Dam supplies most of Gauteng with water. The water from the Vaal Dam flows into the Moretele River to avert the water from affecting many households in Mamelodi. So, adaptation to climate change would not be necessary. The Eerste Fabriek informal settlement dwellers bear the brunt of the flooding because they are occupying hazardous land meant to mitigate flooding for the greater Mamelodi community.

4.3.5 Link between african spirituality and christianity to adverse weather events

Meanwhile, one of the participants, who lives close to the riverbank and was not affected by the flood, believed that the flooding was caused by Mma Mogashoa a water goddess. He believes that Mma Mogashoa is fond of him because of his connection to his ancestors, hence he did not suffer any damage to his shack.

In African spirituality, the god of water who rules the Earth is closely related to those that have crossed over to the spiritual realm (ancestors). Mma Mogashoa's natural habitat is in rivers and the ocean. Residents of Mamelodi believe that the water goddess lives in the Moretele River and possesses divine powers. It is alleged that it can transform itself into objects, animals, or human beings.

People from Mamelodi believe that adverse weather events take place when:

1. Mma Mogashoa moves from one river to another,
2. there iss commotion near her habitat or unwarranted activity taking place close to the river, for example, a floodplain then her discontent is shown through strong winds.

One of the dwellers shed light on Mma Mogashoa's powers. He explained that after the community had settled in, an individual unknown to the community (who was believed to be Mma Mogashoa as she could allegedly change from a human being to any object), visited the community on several occasions. This individual came to warn them to move away from the floodplain as the area already had an “owner”. The individual also described what was beneath the floodplain as "a deep hole, like a cave".

The residents were warned that one day the floodplain would collapse together with the residents and their shacks. This is known as sinkholes which can be triggered by prolonged flooding or a build-up of pressure on the ground. According to Interesting Engineering (2022), sinkholes form when water seeps into the ground below where it can get trapped. Rainwater ends up accumulating underground, especially in areas where there is no form of natural drainage (Interesting Engineering, 2022). As rainwater sinks, it reacts with carbon dioxide and decaying vegetation, giving it a slightly acidic quality. Areas with karst terrains consist of carbonate rocks susceptible to sinkholes. As acidic water accumulates over time, the karts process begins, or the rock begins to dissolve leading to the formation of sinkholes and caves. The acidic water gradually dissolves and breaks up soluble rocks underground creating cavities (Interesting Engineering, 2022). These cavities gradually grow as more rock is dissolved. Once enough of these cavities form, the ground gives way and sinks into the cavity. Sinkholes can be caused by climate change as there is a correlation between rising global temperatures and sinkholes. For every 0,1 Celsius rise in global temperature, the number of sinkholes increases by 1%-3% (Interesting Engineering, 2022). The fluctuation of global temperature can temper with rainfall patterns. In areas that experience intense and

increased rainfall the water table can rise, leading to more rock dissolving and greater chances of collapse.

Additionally, a sinkhole can be triggered by human activity such as heavy construction or digging holes for boreholes on hazardous land (Interesting Engineering, 2022). This is supported by one of the participants, Elias and his neighbour who dug a deep hole which the water would flow into, in case of flooding. It was their attempt to avert the water from entering their houses. However, when the flood took place, they questioned the depth of the ground because the water swept away their shacks, but the hole remained empty.

While Ntate Jacob's knowledge and perception was based on African spirituality, Kedibone's (50) perception was on inadequate urban infrastructure and the Christian Bible.

> Floods are caused by improper development. But the Bible's New Testament states that all of us are going to be swept away by floods and a new generation will be born. Whether one does good or bad. We are impure. (Interview. Kedibone, 08 September 2022)[24]

Hagan's approach elucidates on the spiritualisation of water and rain amongst Africans. Essentially, Hagan describes this as a mindset and conviction that establishes a connection between all living things and God/higher power (Hagan, undated). Generally, Africans believe that extreme weather events are caused by human moral and spiritual offences against nature and the Supreme Being (Hagan, undated). For instance, the nation thinks that drought, unfavourable rainfall patterns and other extreme weather events are triggered by the actions and sins committed by individuals against God (Hagan, undated).

The study found that some of the dwellers describe different types of floods that they think should affect the community, based on their knowledge. The latter was grounded on the different opinions of how flooding should occur. The informal dwellers are unfamiliar with climate change as an environmental problem and the scientific explanations of it. This is seen through their knowledge that it is possible that flooding can be caused by heavy rains. But that the flash floods that they experience from the dam levee are man-made. This is contradictory and it seems the dwellers need more information about climate change. If flooding becomes a regular occurrence in the community, climate change must be raised as a concern, requiring an educated community to reduce risk and adapt (Modiba, 2021).

[24] Interview with Kedibone, Eerste Fabriek informal settlement, Mamelodi, 08 September 2022.

4.4 Adverse weather effects and household response strategies

Natural disasters bring disruption, loss, and hardships into communities (Hrabok, Delrome & Agyyapong, 2020). In Chapter 2 (3) we see that communities/people who are underprivileged or socially vulnerable tend to have lower disaster preparedness. This is seen in the negative impacts that they experience during adverse weather events. They are at a disadvantage due to geography, poverty, gender, age, disability, or ethnic or cultural groups and bear the brunt of climate change (Hrabok et al., 2020). Certain studies have shown that flooding can make some people poor by destroying their property, houses, infrastructure, livelihoods, and productive capital (Modiba, 2021).

According to some of the dwellers, life on the floodplain was safe until they began experiencing flooding. Sibulele, who has been living in the informal settlement since its inception, described life before the floods as "good".

> In the beginning, life in this settlement was good. It's just that we are affected by the floods. It is a suitable area to live in, but the water… it is not good. (Interview. Sibulele, 10 September 2022)[25]

Linah shared the same sentiment:

> Living here is great! We live harmoniously. We all get along. If there wasn't any flooding, we wished to stay here and vouch for the informal settlement to be developed. (Interview. Linah, 10 September 2022)[26]

We have already established that the community under study has a low socioeconomic status which makes them vulnerable to the floods. Even though the real cost of the flood damage/impact is difficult to measure due to the lack of insurance in informal settlements (Kasei, Kalanda-Joshua & Benefor, 2019), this section presents the extent of vulnerability or the resultant effects, being the impact of the floods on the households based on their lived experiences. It is important to point out that although all the participants were affected by the flood, the extent was dependent on where their shacks were built in the settlement.

4.4.1 Emotional/social impact

The social impact of floods changes the approach to life, work, play, and relations and how people cope and fulfil their needs (Modiba, 2021). The study found that climate change and

[25] Interview with Sibulele, Eerste Fabriek informal settlement, Mamelodi, 10 September 2022.
[26] Interview with Bonang, Eerste Fabriek informal settlement, Mamelodi, 08 September 2022.

its related events have a significant impact on the dwellers' mental health. Hrabok et al. (2020), state that the psychological responses from climate change related weather events manifests as acute stress which is fear, hypervigilance, guilt or flashbacks . These are 'normative' and 'predictable' (Hrabok et al., 2020). The dwellers continue to experience emotions such as anxiety, fear, wrath, frustration, sadness, and loss (Modiba, 2021). Ntate Stevens, whose epilepsy was ruled by the doctors as a disability, said that watching the movement and flow of water was a danger to his health as that can trigger his condition.

Post-disaster, anxiety (post-traumatic stress disorder) and depression are some of the common diseases in areas such as informal settlements. It is prevalent in households with a low socioeconomic status, are unemployed or have pre-existing mental health disorder (Hrabok et al., 2020). Residents who were affected by the flood expressed that it left them with trauma. They do not find pleasure during the rainy season because they know disaster might ensue. Even light rain showers spark anxiety in Ntate Eddie who says he always expects the worst to happen.

> I compare it to being involved in a car accident. If something disturbs your movement while driving a car, you'll rush to think it's an accident. You live in fear. (Interview. Ntate Eddie, 08 September 2022)[27]

The link between extreme weather events such as floods, forest fires, heat waves and cyclones has been well-established (Hrabok et al., 2020). Rates of anxiety increase when extreme weather events occur. This is known as eco-anxiety or solastalgia which is emotional distress caused by environmental change (Hrabok et al., 2020). It is propagated by the threat of an uncertain future. Some cannot sleep or an appetite when it rains. Elias seems to have never recovered from the 2019 flood and explained the effects.

> Life stops. I cannot sleep. Imagine coming home to find everything you left gone. It is tough. You cannot think of anything else. You lose your appetite because of stress. In 2019, I was at Marikana when Vusi's (community leader) mother called to ask where I was. I got home to find that my shack had lost its structure. It was skewed. The car was covered in water, I could not even see it. I am still fixing some of the goods that were

[27] Interview with Ntate Eddie, Eerste Fabriek informal settlement, Mamelodi, 08 September 2022.

> damaged in the 2019 flood. I took the car to the mechanic and to this day, I am paying so that it can be fixed. (Interview. Elias, 09 September 2022)[28]

Others were anxious or worried about the safety of those that remained in the settlement as they were not able to assist with evacuation. Some expressed that when they are at work and it starts raining, they dread that they could find their belongings and shacks swept away. Some expressed that it affected their self-esteem because people judged and made fun of them for occupying a floodplain. Ntombi said:

> It affects me because my colleagues make jokes about the floods but I do not take them seriously. They make remarks such as 'who said you should live there?'. However, I do not like living here. My situation forces me to. (Interview. Ntombi, 08 September 2022)[29]

Extreme weather events also affect the household size by reducing it. Kutlwano, who was in the settlement when the flood took place, said the area is not ideal for children.

> If you live with children here, you will not be free. The parents were not home because of work. Children were crying as the water level increased so those[adults] who were available had to help them evacuate and take them to a place of safety. (Interview. Kutlwano, 08 September 2022)[30]

Household size is reduced due to adaptive capacity which is propelled by ecoanxiety among the youth and adolescents. According to Nenweli (2015), this happens because households have restricted capabilities to recover from the impacts of climate change and take care of their dependents. Molebogeng mentioned this:

> I have two kids whom I lived with but now fear living here. I moved them after the 2019 flood, and they now live in a one-bedroom I am renting. (Interview. Molebogeng, 08 September 2022)[31]

Youth are influenced by how well the family copes with the impact of extreme weather events (Hrabok et al., 2020). For example, even though Stanley's (44) children managed to

[28] Interview with Elias, Eerste Fabriek informal settlement, Mamelodi, 08 September 2022.
[29] Interview with Ntombi, Eerste Fabriek informal settlement, Mamelodi, 08 September 2022.
[30] Interview with Bonang, Eerste Fabriek informal settlement, Mamelodi, 08 September 2022.
[31] Interview with Molebogeng, Eerste Fabriek informal settlement, Mamelodi, 06 September 2022.

escape their flooded home in 2019 they have since moved back home to Kwa Mhlanga in Mpumalanga.

> I had to move my family to a safer place. My children lived here. They managed to escape but it was difficult for them. To this day, they do not come to this place. They live at home in Mhlanga. I remained with my wife in 77 [Bufferlake]. (Interview. Stanley, 08 September 2022.)[32]

Opting to flee from the floodplain post-disaster, depicts the complex effects extreme weather events have on young people's mental health. However, some continued living with their children despite the floods. Cleo (not her real name), lives with her two children. One is still a baby and the other a toddler.

4.4.2 Economic impact

Whenever flooding is predicted many residents must look for alternative shelter which costs money. Due to lack of funds, most of the participants remained on the flood plain and witnessed the flood which had severe impacts on the households. The dwellers already live on low incomes and the funds they could have used for the household are spent on dealing with the impact of the flood (Modiba, 2021). Floods contribute to increased poverty in affected communities.

Flooding poses a significant threat to the livelihoods of residents. Those who were employed had to take up to two weeks off work to deal with the impact. Meanwhile, residents on the unaffected side of the settlement were trapped and unable to run errands such as collecting child grants. During this time, residents focused on rebuilding and searching for their belongings once the water levels receded. The majority spent 3-4 months rebuilding and replacing the goods and some never recovered. Ntate France, a security guard could not go to work.

> I could not go to work because I lost everything. I lost my TV, bed, and clothes. I lost my identity (ID) book. I had to renew it and my bed was swept away. The damage to my shack was bad. I still cannot replace some of the goods. (Interview. Ntate France, 08 September 2022)[33]

[32] Interview with Stanley, Eerste Fabriek informal settlement, Mamelodi, 08 September 2022.
[33] Interview with Ntate France, Eerste Fabriek informal settlement, Mamelodi, 20 August 2022.

Stanley showed the me some of the goods that were damaged during the flood. He explained that he tried to replace some of the goods, but it was tough.

> The cupboards do not have a back board/cover. I cannot move the cupboard. If I do, it is going to fall into pieces. I had to put crates inside my couches to replace the seats. (Interview. Stanley, 12 September 2022)[34]

Households' income is affected because they incur expenses when rebuilding and replacing goods. Some do not replace the goods due to lack of finances. The weak housing structures harm their livelihood whenever there is flooding (Modiba, 2021).

Modiba (2021) asserts that the community is already battling and survives on low income now they need to reallocate it to cope with the effects of the flood. The dwellers lost important documents such as identity cards and certificates. A resident who works as a security guard had to pay around R5000,00 to retrieve his certificates. Applying for a new ID card is also another expense.

On the other hand, Ntate Jacob, who was not severely affected, used the flood as an opportunity to hustle and create a livelihood for himself. He collects the corrugated iron (from damaged shacks) scattered around the community and exchanges it as scrap metal to gain an income. He also engages in subsistence farming; therefore, does not view the floods in the informal settlement as negative because he harvests good vegetables. This proves that not all climate change related events are negative.

> It does not affect me as much. When it rains, my garden produces rich spinach. I also make money from damaged shacks and leftover zinc/corrugated iron which I sell to scrap metal buyers. (Interview. Jacob, 06 September 2022)[35]

4.4.3 Physical impact

Besides governance factors, housing structures in the informal settlement were used to determine physical vulnerability. They live in temporary and makeshift structures (Moloisane, 2017). These structures consist mainly of one-room shacks made of salvaged corrugated iron and other metal sheets. The shacks are built close together, with very little yard space (Mitchley & Schatz, 2020). Residents expressed the dire impact of the flood on

[34] Interview with Stanley, Eerste Fabriek informal settlement, Mamelodi, 12 September 2022.
[35] Interview with Jacob, Eerste Fabriek informal settlement, Mamelodi, 06 September 2022.

their housing structures. Ntate Ntuli, an unemployed father of four said the flood took everything away from him.

Figure 10:Floors of the shacks that were washed away *Figure 11: Floors of the shacks that were washed away*

Residents lost everything and had to acquire new goods and rebuild, as most of their shacks were swept away. They took goods and corrugated iron/metal sheets from other informal dwellers because, at that point, ownership was irrelevant . Some households have not been able to recover from the effects of the flood, and their shacks remain in poor condition. Tracy, who wishes to build a house in the future, went on to describe life on the floodplain as "stagnant" and demoralising because one cannot build a stable structure or accumulate assets while living on the floodplain.

> This place makes life feel stagnant but when you do not have a choice [sighs]. What can you do about it? You just tidy up the yard. You can't build a proper house; you can't do anything. It is a serious problem, and I am getting older. (Interview. Jacob, 06 September 2022)[36]

[36] Interview with Tracy, Eerste Fabriek informal settlement, Mamelodi, 12 September 2022.

4.5 Response strategies in Eerste Fabriek informal settlement

Adaptation can be achieved by reducing consequences and avoiding risks (Nenweli, 2015). Managing the risks of unprecedented extreme weather events is vital to prevent and limit the damage to the economic, social, and physical spheres of a state. Moreso, adaptation can reduce poverty. Section 5 (2)(4) presented the vulnerabilities within the informal settlement community. It showed that the community is impoverished. This leaves informal dwellers exposed to the devastating impacts of climate change.

This section addresses the following research questions:

1. How have households responded to adverse weather events? What mechanisms do they have in place to adapt to adverse weather events?
2. How have the government and non-governmental institutions responded to the informal settlement community's situation in a context of increased climate change vulnerability?

This section presents the adaptation strategies within the informal settlement community using Smit and Wandel's definition of adaptation in Chapter 2(1) which is inclusive of adaptation at all levels. This Chapter also explores and examines the state and non-state actors' actions and role in assisting the residents to adapt and cope with the 2019 flood.

Despite 2019 being the second time the community experienced a flood, they still lacked any adaptation strategies. The only action that the residents of 77 Bufferlake took was to blow a whistle. A whistle is usually blown to alert the community that they need to gather in one place when an emergency arises. The whistle was blown to alert the residents of the rising water level in the settlement. This was merely the equivalent of an alarm. One community member explained that they blow a whistle or use a cell phones to alert each other.

The lack of preparedness increased the vulnerability of residents and exposed them to danger.Residents who were not at work and were with their children sought safety on the bridge or in areas of the settlement that did not experience flooding. Some residents had left their children at home and gone to work, as the school holidays had begun. Those who remained at home had to help the children escape by carrying them on their backs. Molebogeng, a female household head who lived in the settlement prior to the 2019 flood remembered the events:

> We had to carry the children on our backs. The neighbours had to help me carry them as my brother's children had come to spend their December holidays with us. They arrived on a Saturday. On Monday, that is when the flood took place. They lost their Christmas clothes and we had to buy the items again. (Interview. Molebogeng, 06 September 2022)[37]

Those who were at work returned home to a disaster and could not salvage their belongings or important documents. Residents living in less affected areas felt trapped in the settlement, believing there was no way to escape the floods.

Of particular interest is the unwillingness of the residents to come up with strategies that would assist them to adapt to similar disaster. For instance, the residents also thought of digging a trench from the centre of the informal settlement, to channel the water trapped in the floodplain into the river. However, the community leader, Vusi explained that the idea was not implemented as they do not want to give the impression that they can survive and continue living on the floodplain:

> If we come up with coping strategies, then we won't get what we want. When officials see that we are coping and surviving, they secretly come to take pictures and then hand them over to the media. They will claim that they told us to move but we refused and are making means to stay there by channelling the water to the river. They will probably televise it when an actual flood takes place.

[37] Interview with Vusi, Eerste Fabriek informal settlement, Mamelodi, 05 September 2022.

Figure 11: Rubble placed between the bridge & informal settlement

In other words, the community could not take own initiative, which further endangers their lives. This could prove that people intentionally settle in areas that are prone to disasters to get attention and preference from local governments (Nenweli, 2015) Thus, the community provided responses that were established after 2019 and partake in autonomous versus planned adaptation. The following coping strategies were mentioned:

- Some residents have organised temporary accommodation and move away before the flood takes place (temporary migration). However, the majority remain in the settlement.
- If a resident does not hear the whistle for some reason and the water level poses danger, community members bang on doors and windows or they try to contact them on their cell phones.
- Contributions made by the men in the community were used to purchase ropes. One of the ropes is tied onto a tree situated in the unaffected part of the area. The male dwellers tie these ropes around their waists and rescue those that are trapped in their houses. Residents need to hold on tightly to this rope until they reach safety.
- The community put a truckload of rubble from Ford (SAMCA) in front of the bridge. The community deemed that the rubble would prevent the water flowing from the dam. The mitigation effort was ineffective.
- Belongings of those that are affected by the flood are temporarily placed for safekeeping in homes of those that are not affected. Ntate Jack who is unaffected, accommodates those who have lost their houses.
- It is important to walk with a spade or gardening fork when the water level is high. This ensures that one's feet remain on ground level to avoid being swept away by the water.
- The community leaders contact the councillor, who then reaches out to the Disaster Management Centre. Tshwane Emergency Services rescue team arrives. However, when the water level is high and dangerous, the rescue team informs the community that they will not be able to rescue the trapped individuals.

The residents only have one adaptation strategy which is temporary migration. However, the rest of these strategies cannot be characterised as adaptation, as they do not minimise impact. Notwithstanding that every household and individual survived the 2019 flood, it can be said that the community lacks adaptation, known as maladaptation (Magnan et al., 2016).

Due to the failure to fulfil the housing project, the government is seen as responsible for relocation. Thus, the community feels that the government failed to assist in 2019 and state assistance was inadequate. 16 out of 20 participants said the solution to the flooding is relocation to safer land. Tshwarelo stated:

> We are not saying government should build houses for us. We are saying they should give us land/stands and then we'll see ourselves through the building process. (Interview. Tshwarelo, 18 August 2022)[38]

The following year (2020) the community tried to fight for relocation to permanent stands. Mamelodi Flood Victims, a forum inclusive of all informal settlements in Mamelodi that experienced floods was created. They marched to Tshwane House in February 2020 to hand in a memorandum requesting for relocation to safer land.

Among the politicians who visited the community is the current MMC of Human Settlements, Abel Tau. Tau had just joined ActionSA (political party establised in 2020) after his departure from the Democratic Alliance (second largest political party in South Africa) . He came with the founder of ActionSA, Herman Mashaba. They explained that they were willing to help the community with relocation and offered legal assistance. The community went to court; however, the legal process did not yield any results.

The municipality explained that there was vacant land which could only accommodate around 15 200 households. Eventually, the government began with the relocation process, which was to take place in three phases, Phases 1A, 1B and 2. Phase 1 was focused on people who remained at the church and community centres. Phase 2 will be focused on all informal settlements in Mamelodi affected by the floods.

In July 2020, only the 24 people who remained at the church were relocated and 100 were from the informal settlement. The community members went on to assist those who were being relocated. The number was inconsistent. The community expressed their dissatisfaction and believed that the municipality had capitalized on the number of people who remained

[38] Interview with Tshwarelo, Eerste Fabriek informal settlement, Mamelodi, 18 August 2022.

behind at the church because some community members had moved back to rebuild their houses. The informal dwellers said that this first phase was a trap they had fallen into.

Problems arose during the implementation of Phase 1B. There was conflict between the Mamelodi Concerned Citizens and gangs. Other informal settlements in Mamelodi questioned why the Eerste Fabriek was getting first preference while they had been living in informal settlements years before. The gangs wanted to take over tenders for trucks needed for the relocation. The relocation was put on hold. Consequently, only 24 households, including those from different informal settlements around Mamelodi such as Marikana were relocated to Mooiplaas.

In September 2021, the CoT Spokesperson said the city had obtained land in Mooiplaas where some families would be moved to, while other land was needed to accommodate the other families. The delay in the relocation for July 2021 was caused by the price of land (Rafapa, 2022).

Meanwhile Mr Tau, confirmed that the municipality had plans to relocate people residing on floodplains by end of October 2022 (Mahlokwane, 2022). Tau explained that the relocation process was met by challenges such as overpriced land, cost of supplying basic needs like pit toilets and budget to pay for the relocation costs of the families. The CoT is considering land in other parts of the city and is in talks with the provincial and various government spheres.

After the community leaders attended multiple meetings at the Municipal Chambers, the provincial government intervened. 200 hectares of land was purchased for purposes of relocation. The deadline for relocation was the end of October 2022, just before the rainy season started. The community leaders believed that the absence of corruption within the CoT could speed up relocation because the budget had been made available.

Regardless of the unity in the community, one of the founders disagreed with relocation as a solution. Relocating would be a big mistake as the area had the potential to be a renowned residential area like the Savanna Country Estate, a prominent estate in Silverlakes, Pretoria built on a wetland. The founder also indicated that it could potentially eradicate poverty as businesses could be built on that land to create employment. According to the founder, leaving 8 hectares of land to move to 20m of land was disadvantageous to the dwellers. They will be moving to a place with no formal housing, infrastructure or water and sanitation. In essence, the dwellers will have to start from scratch.

The vision of the founder is more focused on developing the land they have invaded; however, it is difficult to buy into such a vision when you are mired by poverty and have no escape. Furthermore, the founder does not mention any climate change adaptation or mitigation strategy to avoid the negative impact of the floods.

Other community members like Ntate Stevens felt it would be better if government worked with the people on the ground.

> They (government) must come here and find out what we want as we are all affected differently. (Interview. Ntate Stevens, 14 September 2022)[39]

Josephine thinks that the municipality should focus on developing the informal settlement.

> I think they should find ways to control the water, so it flows into the river because the people that live close to the deep side of the river do not experience floods. The river water is not the cause of the floods. (Interview. Josephine, 13 September 2022)[40]

The negative impact of the flood has divided the community between living on the floodplain and relocation. They now have different interests, agendas, and discussions. It seems the residents re-assessed the risk and realised that it has become dangerous to reside on the floodplain, especially during the rainy season. We see micropolitics come to play as "the political activities of individuals and small groups to influence others to attain desired goals" (Drivdal, 2016: 24).

By requesting relocation, the residents have missed out on an opportunity to influence local climate change adaptation policies. They also missed out on a chance to learn about the scientific aspects of climate change. Perhaps, the community does not have confidence in the government due to its failure to deliver basic services as outlined in the RDP policy in 1997 (Moloisane, 2017). These residents seek secure tenure, stability, and comfort in their lives.

Other than relocation, Drivdal (2016) states that situ-upgrading is a better response to poverty and vulnerability, which is macro-policy at local government level. Situ upgrading involves

[39] Interview with Ntate Stevens, Eerste Fabriek informal settlement, Mamelodi, 14 September 2022.

[40] Interview with Josephine, Eerste Fabriek informal settlement, Mamelodi, 15 August 2022.

the identification of informal settlements that need improvement. Government developed a national policy on informal settlement upgrading. Municipalities apply to the provincial and federal governments for funding for this process. This application is accompanied by a business plan (Moloisane, 2018). CoT informal settlements like Phomolong, Mamelodi and Jeffsvile, Atteridgeville, are being formalized through governance instruments such as Upgrading of Informal Settlements Programme (UISP), to create sustainable human settlements and ease the impact of floods on the environment by providing basic services such as water, sanitation, and waste management (Ngwenya-Bendile, 2021). However, this option is unfeasible because this informal settlement is in a disaster-prone area (floodplain). It will be difficult to develop or upgrade the informal settlement.

4.5.1 Government and state actors response in Eerste Fabriek informal settlement

This section looks at how national government, City of Tshwane and non state actors responded to floods in Eerste Fabriek informal settlement.

4.5.2 National government and City of Tshwane response

One of the steps to ensure adaptation is establishing vulnerability to weather and future sensitivities. This can be achieved through early warning systems (Hallegatte & Rozenberg, 2010), resulting in early evacuation. The information and communication can be passed on to the population, timeously (Hallegatte et al., 2010). According to Hallegatte et al. (2010), this can reduce human consequences and building vulnerability .

Thirteen participants said the government never issued any warnings. According to the community leader in section 5 (2)(4), the councillor of that time, Mr Zitha warned the community to vacate the informal settlement the night before the flood happened. Nonetheless even if a warning was issued, it was not timeously. Either way, the residents did not have sufficient time to move their belongings from the shacks or vacate the informal settlement area.

Although the participants do not confirm the warning from the councillor, they refer to hearing the rumour about dams being opened. Most of the community members were adamant that no warnings were issued. Elias put it in this manner:

> I am not sure, but I have never heard of a warning. If there was a warning, then we would not have lost important belongings. With a warning, then you can move the important stuff. However, we just woke up to flooded shacks. (Interview. Jacob, 06 September 2022)[41]

According to Ntate Stevens they should have received a warning as there is an expectation that those on the ground (community leaders) and local government have communication channels. However, it is ineffective because these stakeholders are constantly at odds due to their vastly differing mandates

Amongst the participants, the temporary migration to the church is one of the noticeable strategies in which the local government played a role. The provincial and local government (CoT) requested temporary shelter for the displaced community members at the Mamelodi Baptist Church located in Mamelodi West. Not all residents moved to the church. Some remained in the settlement because their shacks were not damaged or swept away. Some stayed behind because they feared that their belongings and what remained of their housing structures would be stolen by 'nyaope boys'(these are drug addicts who steal goods like metal, zinc, and iron in exchange for money and drugs). Others eventually moved back to the informal settlement because the church was crowded and lacked privacy. The informal dwellers were still at the church when Covid-19 pandemic struck and felt that the crowding was a danger to their health because social distancing was impossible. Additionally, some could not stay at the church for an extended period as they needed to clean their shacks in order to return to work.

The timing of the flood prompted the military (Department of Defence) to donate a cheque for the children's school uniforms for January 2020. Tshwarelo witnessed the donations.

> I remember I sat at the church gate when donors and donations arrived. The last organisation to donate was the Military. That is one of the government departments I saw donating. It donated a cheque for school kids so that when schools started in the

[41] Interview with Elias, Eerste Fabriek informal settlement, Mamelodi, 12 September 2022.

> new year, they would have uniforms. I do not know how the money was distributed. (Interview. Jacob, 06 September 2022)[42]

Politicians and government officials such as the former Minister of Corporate Governance and Traditional Affairs, Dr Nkosazana Dlamini-Zuma and the ex-Premier of Gauteng, David Makhura also paid the community a visit. The Premier warned the community against rebuilding on the floodplain as more heavy rains were expected (Kgosana, 2019). Makhura asked the residents what solutions could help avoid the harmful impacts of floods . The community requested for relocation to safe and permanent stands. The former Premier promised relocation to a permanent site before the 25th of December of that same year. Yet, three years after the incident, the community remains in the settlement. The community expressed that they expected a lot from the government and felt that the visits were a publicity stunt. In conclusion, the majority believed that the government did not assist in any way during and after the 2019 floods.

One of the founders of the informal settelement, Gavin, highlighted the influence of political dynamics in the provision of government assistance.. He mentioned that the government attempted to assist the informal dwellers by providing them with a bowl of soup and a blanket. However, the coalition local government hindered further state assistance. During decision-making, the parties in the coalition held different views due to their different responsibilities

The researcher also noted an ambiguity among the respondents regarding state assistance. Some believe that all the donations received were initiated or influenced by government. One of the community members stated:

> They did assist. However, we see things differently. I believe that if government was not involved then the non-state actors would not have assisted. When the municipality communicates with organisations, they will not mention that they spoke to certain entities like Motsepe Foundation, and Shoprite to help. If you see the municipality officials present, then it means government is lending a hand. However, you won't see it directly. Had the municipality not participated then we would not have received help

[42] Interview with Tshwarelo, Eerste Fabriek informal settlement, Mamelodi, 18 August 2022.

> because we do not have access to the non-state actors. (Interview. Kea, 13 September 2022)[43]

Ten participants felt that government did not help at all. Humbulani said:

> Government has not helped us in any way. Well-known politicians have been here; however, they have not done anything. (Interview. Humbulani, 13 September 2022)[44]

Modiba (2021) states that besides issues of rapid population and economic growth, the CoT faces a predicament in meeting the needs of its citizens during climate change which is seen through severe flooding. In a similar study on the 77 Bufferlake community, Modiba (2021) noted that there weren't enough flood mitigation strategies from the municipality such as early warning systems, stormwater drainage systems, provision of sandbags and tree logs, building houses on raised foundations and constructing protective walls. Adaptation strategies such as social grants to implement adaptation or a flooding contingency plan are unavailable in this community (Modiba, 2021). Conversely, the state helped them 'cope' or reduce fatalities by calling the rescue team which is administered by the Tshwane Emergency Services.

Although the Gauteng Provincial government launched a Disaster Management Centre to issue out early warnings on extreme weather events that very year (Polity, 2019), the communication failed to reach the informal dwellers and prevent the dire impact of the floods on the Eerste Fabriek community. The residents emphasise that had they been warned timeously, they would have evacuated the settlement and ensured that their belongings were safe. These predictions should have pushed the government into educating communities in the province on climate change. Additionally, it should have devised and implemented adaptation strategies because this community experienced the floods more than once after the 2019 incident.

The government publishes weather warnings from the South African Weather Services (SAWS) on the news section of the City of Tshwane website. Not all the residents in Mamelodi are exposed to smart phones and television. Only 19,6% of residents in Mamelodi have a television and 8,1% have a cellphone (StatsSA, 2011). The information provided on

[43] Interview with Kea, Eerste Fabriek informal settlement, Mamelodi, 13 September 2022.
[44] Interview with Tracy, Eerste Fabriek informal settlement, Mamelodi, 13 September 2022.

the CoT website about Disaster Management of various climate change-related weather events is not accessible to the residents. Those with a higher socioeconomic status can obtain information at a faster rate. Chapter 5(5)(2) stated that this community cannot access Rekord (a local community newspaper) as these households are not officially recognised by CoT, therefore, it is not delivered to their houses. The study suggests that those with low socioeconomic status might struggle with access to important information. The researcher refrained from asking the informal dwellers whether they did not receive information from media such as newspapers, television, and websites as it would seem like discrimination. Some cannot afford newspapers. Others do not have access to television as they have lost their assets before in the floods. They are not able to acquire knowledge from the media. It was established that the community relies on a directive from the local government, specifically the ward councillor, to evacuate the area if there is possible flooding.

According to Statistics South Africa, 61,7% of the population in Mamelodi does not have access to the internet (StatsSA, 2011). The community has a low socioeconomic status; hence such information is inaccessible as a smartphone or laptop and a data connection is needed. Moreover, education and technical skills are necessary to manoeuvre, comprehend and implement the strategies provided.

The Gauteng Provincial Government (GPG) opened a state-of-the-art “first of its kind” R44 million Provincial Disaster Management Centre in Midrand, Johannesburg (Polity, 2019). It was launched on the second of June 2019 by the MEC for the Department of Infrastructure Development (DID) Mr Jacob Mamabolo and counterpart MEC for Cooperative Governance and Traditional Affairs (COGTA) Mr Uhuru Moiloa (Polity, 2019). The facility will act as the coordination centre for the province’s disaster management. The facility hosts the South African Weather Services (SAWS) where “live access and monitoring of weather information including access to weather stations, rain maps, the weather forecast, and the seasonal forecast” takes place (Polity, 2019). According to Polity (2019), the centre’s intention is to facilitate the legislative mandate and support disaster management stakeholders as well as municipalities . The green technology building will also house a disaster operation centre with monitors that allow COGTA to have a full view of activities that take place during disasters (Polity, 2019).

Globally, local governments and cities are responsible for climate change resilience and disaster risk reduction (Ngwenya-Bendile, 2021) As part of its vision 2055, the CoT outlined

some of the environmental programmes adopted in line with the national and provincial policies. According to Ngwenya-Bendile (2021), the CoT does not have a comprehensive sustainability policy to address environmental challenges, instead it uses governance tools such as strategies, programmes, and bylaws . In its response to climate change, the city's outlook went global. It wanted to be recognised as one of the most modern and sustainable cities in the world with an environmental policy driven by global warming. It signed the Compact of Mayors' Declaration in 2014 (now known as the Covenant of Mayors for Climate and Energy) and became a member of the C40 Cities Climate Leadership Group (C40), (COGTA, 2020). As a signatory of the Compact of Mayors' Declaration and a member of C40, the city is afforded an opportunity to be recognized as a leader in local climate change." (COGTA, 2020).

4.5.3 Non-state actors

Residents in informal settlements are challenged by economic vulnerabilities which have necessitated assistance from government and non-governmental organisations (NGOs) (Drivdal, 2016). The Mamelodi Baptist Church was of great assistance because it provided shelter for ± 700/800 displaced individuals. A few donations came from the government. Business corporations such as Shoprite, Gift of the Givers, and NGOS like Motsepe Foundation, and others assisted the church with food and clothing. Pastor Jentile's (Mamelodi Baptist Church Pastor) quest for assistance via social media propelled others to donate. Collaborations between the state and nonstate actors is known as networked governance/ good governance (Drivdal, 2016) and has the ability to improve adaptive capacity if implemented correctly. The donations came from different provinces, as far as Limpopo and Cape Town to mention a few. Although the church was helpful, it was crowded and there wasn't any privacy:

> If you are referring to them (government) taking us to the church during Covid-19, where there wasn't any social distancing. They were trying to kill us. They placed us there and donations came but they weren't consistent. (Interview. Bontle, 18 September 2022)[45]

Three to four months later, the dwellers started moving back to the informal settlement to rebuild their shacks. They helped one another to rebuild. The community feels that the pastor and the church were pivotal in ensuring they coped after the floods. On the other hand, they

[45] Interview with Bontle, Eerste Fabriek informal settlement, Mamelodi, 18 September 2022.

feel that moving to the church was a mistake on their part. Relocating away from the floodplain has alleviated their burden on the municipality.. Tshwarelo, who was elected a community leader after the 2019 flood said he predicted this beforehand.

> I was against going to the community hall or church. I was trying to show them (community) that there was not much help they were going to receive. They (municipality) are just going to dump and leave us there. On the first day, the councillor failed to feed us. The community donated two- and three-rand coins to buy gas. Abel Tau never visited to check on the people and their situation there. (Interview. Tshwarelo, 18 August 2022)[46]

Subsequently, the government wrote a letter to the Mamelodi Baptist Church requesting them to release those who had remained at the church. One of the dwellers, Cleo, said she did not receive much but someone bought her a shack after the 2019 flooding incident.

The presentation and analysis of the role of the community, state, and non-state actors in this section, depicts that 77 Bufferlake cannot adapt to climate change and more planning and strategies need to be put in place to render this collaboration efficacious (Drivdal, 2016). It is a "multi-scale effort" where individuals, households, community, and all spheres of government, along with businesses and non-governmental organisations (NGOs) need to be involved (Drivdal, 2016:21) in climate change adaptation macro-policies.

4.6 Chapter summary

This Chapter presented a profile of the CoT and the informal settlement which consist of socioeconomic factors and established that this informal settlement community lives in poverty. It concluded that the community has a low socioeconomic status, based on factors such as the education level and employment status of the residents. It went to show how their socioeconomic status played a role in the establishment of the informal settlement on the flood plain. Rapid urbanisation, failure, and broken promises to provide housing and backlogs from the post-apartheid, plus affordability were some of the factors that drove the occupation of vulnerable land. Additionally, it stated flooding as an environmental challenge that the city faces. The chapter found that the informal settlement is a downstream area where dam water is released to. While it is stated in Chapter 2(3) of this paper that poverty does not

[46] Interview with Tshwarelo, Eerste Fabriek informal settlement, Mamelodi, 18 August 2022.

always equal vulnerability in this case, we discover that the low socioeconomic status of the households makes them vulnerable to climate change-related events. The Chapter showed that informal spaces are the most affected as it provided details of the flooding incident that took place on the 9th of December 2019 in Eerste Fabriek.

The knowledge and perception of climate change was explored. It found that the community did not have a scientific understanding of climate change. The participants gave different views of what type of flooding they deem as caused by natural factors. The majority feel it is manmade and caused by water coming from the Vaal Dam. Others linked the floods to spiritual beliefs such as African traditional beliefs and Christianity. Lastly, it presented the economic, social, and physical severe impacts of the flood on the households in the community. It concluded that extreme weather events exacerbate existing economic, social, and physical vulnerabilities because they need to take out money to rebuild and replace.

The vulnerability studied in the beginning of this Chapter was an effort to measure adaptive capacity and contribute towards building adaptation. This chapter presented the adaptation and coping strategies adopted by the informal settlement community during the 2019 flood. It concluded that the informal dwellers did not have any adaptation strategies before 2019. The community developed coping and not adaptation strategies using their social networks. They employed them after experiencing the dire impacts of the 2019 flood. The local government assisted by summoning the Tshwane Emergency Services to the informal settlement when necessary. The effectiveness of the rescue team has been questioned as they arrive hours after or do not enter the flooded community after analysing the risk.

The government also temporarily moved the affected flood victims to community facilities such as centres or churches for shelter. The residents feel that the only way to prevent the consequences of this extreme weather event is to be relocated to permanent stands with proper infrastructure. This solution does not resolve the issue of climate change adaptation and mitigation in SA, as locals could contribute to macro-climate policies. Non-state actors reacted with restricted resources and low adaptive capacity. Due to the community participating in coping, they repeatedly experience the negative of extreme weather events. Even though the community cannot adapt to the flood, they continue living on the floodplain because they have nowhere else to go.

CHAPTER 5: DISCUSSION, CONCLUSION & RECOMMENDATIONS

5.1 Introduction

Over the years, there has been an increase in flooding caused by intensified rainfall driven by climate change in South Africa. Indigent communities living near rivers have often faced the terrible consequences of flood, leaving them in distress. While these incidents have become continuous occurrences, there seems to be little that is learnt, as the same communities are continuously experiencing similar consequences, with no end in sight to their vulnerability. This study was motivated by the highly publicised flooding incident that took place in an informal settlement in Eerste Fabriek, Mamelodi in December 2019. It set out to understand the situation of this informal community, the people's understanding of why there has been continuous flooding in their area, and their coping and adaptive responses to adverse weather events. It sought to provide answers to one main question:

How vulnerable, adaptive, and knowledgeable are households in an informal settlement in the Mamelodi township Eerste Fabriek area regarding heightened adverse climatic events?

Specific research questions were:

- What are the factors that make households of the informal settlement community in Eerste Fabriek in Mamelodi Township vulnerable to adverse weather patterns associated with climate change?
- How do the households in this informal settlement understand climate change, and how do they explain adverse weather events and their resultant effects on their community?
- How have households responded to adverse weather events? What mechanisms do they have in place to adapt to adverse weather events?
- How have the government and non-governmental institutions responded to the informal settlement community's situation in the context of increased climate change vulnerability?

As such, the study set out to explore the lived realities of this informal community and understand whether they are visible in the eyes of the state and non-state actors. It explored four themes: The vulnerabilities the community faces, uncertainty in climate change, maladaptation and state and non-state actor's role in adaptation:

This conclusion aims to pull these themes together in a form of discussion, and to discuss the broader linkages to informal communities in South Africa and elsewhere in the developing world, and to discuss the policy implications and what needs to be done for informal communities.

5.2 Discussion

5.2.1 Vulnerabilities faced by the Eerste Fabriek community

South Africa's stages of development such as the migrant labour system under colonial rule and apartheid drove urbanisation. Since then, South Africans have been fighting for space in the city. Chapter 4 (3)(3) illustrated the growing demand for housing, challenges in supply and the strategies devised by the government to meet the demand till the advent of democracy. Besides urbanisation and poverty, as mentioned in Chapter 4(3)(4), corruption and maladministration aere also part of the limitations to housing provision. Additionally, this housing gap is exacerbated by development challenges such as poverty and high unemployment.

People cannot afford to buy or rent accommodation in the city. Thus, they participate in land grabs in cities and live on dangerous land because it is close to economic opportunities. Survival and sustaining livelihoods take higher precedence than climate change and extreme weather events. In an attempt to fill the housing gap, they create informal settlements like the Eerste Fabriek informal settlement community. The informal settlement under study is a poverty-stricken community. In other words, the inability to afford housing led to informal dwellers who were more concerned about having a roof over their heads, their next meal, and securing employment and income. Living on a floodplain leaves them vulnerable to adverse weather events such as flooding and has serious implications as they cannot cope nor adapt to adverse weather events. Much like the community of Seramang, Indonesia, an informal settlement in a downstream area, they perceive flooding as a risk but choose to stay due to economic constraints and better access to opportunities and facilities. Unlike the Eerste Fabriek informal settlement, they have come up with a sustainable adaptation strategy to avoid the harmful impacts of floods (Hermini, Nadia & Satwika, 2018).

The Eerste Fabriek informal settlement experienced the dire social, economic, and physical impacts of flooding in the community. The physical characteristics of this informal settlement

such as location on hazardous land, low-quality housing made of corrugated iron and lack of infrastructure, also make informal dwellers susceptible to adverse weather events. These impacts overlap with the physical impact acting as a catalyst. It drives the economic and social impacts that the community experiences. For instance, the physical impact of the flooding forces the informal dwellers to wait for the land to dry, assess the damage and then search for their belongings before they return to work or rebuild their shacks. Taking time off work threatens their livelihood. Fixing the shacks also requires money. Additionally, some informal dwellers remain trapped and cannot collect their social grants. All these occurrences, including eco-anxiety, demoralise the community and perpetuate poverty. Without funds, they have limited adaptive capacity to adapt to adverse weather events and need to rebuild and buy new assets frequently, hindering their progress and stability.

Human capital within the community determines the residents' adaptation strategies and knowledge and perception of climate change. The researcher excluded the phrase 'climate change' to avoid leading the participants on during interviews by explaining what it is. In this manner, an unbiased response was obtained. There's notable uncertainty regarding climate change amongst informal dwellers. Uncertainty about climate change is defined as "a lower subjective sense of conviction or validity as to whether climate change 'really' exists, is caused by human activity, and/or will have major impacts. (Poortinga et al., 2011). The study established that climate change can be both natural and man-made. Natural in the sense that prolonged rainfall, or intense rainfall causes flooding attributable to climate change. Man-made causes are linked to human activities such as settling on a floodplain, inadequate design and maintenance of stormwater pipes and drainages and dam management. The data suggests a need for climate change education in the community.

The correlation between low education and employment levels were depicted in the severe impacts of the floods. Chapter 2(5) states that adaptation depicts climate change education. Based on their knowledge, they explained what caused flooding in their community. Some of the participants admit that heavy rains cause flooding and that they live in a flood zone or dangerous area. Additionally, they describe different types of floods that they think could account for the flooding. The majority think the flash floods are man-made, particularly because flooding does not happen in the most common way, which is through overbank flooding. Even though they are aware of heavy rains and their consequences, they do not believe it can result in flooding. On the other hand, the informal dwellers experienced the impacts of the flooding differently. A few participants who lived close to the riverbank were

not directly affected by the flood. Their shack remained intact but were trapped as the exit and entry points in the informal settlement were flooded. The degree of exposure to the risk was not equal and proves that not all poor people are vulnerable to adverse weather events.

The Eerste Fabriek informal settlement community held the government liable for the lack of infrastructure as they compared their experience to that of formal areas in Mamelodi. This stuck out for the researcher as it shifted the focus to the link between inequality in urban areas and dam management in South Africa. Not everyone in Mamelodi experiences flooding yet this informal settlement is exposed due to its location on a floodplain. Overall, the emergency opening of floodgates due to heavy rainfall is not supposed to be destructive. The informal dwellers do not understand that the process of emergency releases of water from dams is one way to mitigate flooding. In the absence of climate change education, they will continuously suffer the terrible effects of the flood and remain in an ongoing cycle of poverty.

Undoubtebly, the sudden release of water has affected many communities around the world. A community in India had a similar experience. In 2005, thousands of pilgrims were bathing at a religious mela at Dharaji when water from the Indira Sagar dam was released. The people were met by a voluminous amount of water where people were swept away and left almost 50 people dead. The community felt that the dam was mismanaged as dam officials were aware of the religious gathering and felt proper warning systems could have been placed (Rasaily, 2005).

5.2.2 Informal dwellers response to adverse weather events

The vulnerabilities shape adaptation to adverse weather events and the scope of impact. The informal dwellers lack the physical and financial capital necessary for adaptation to extreme weather events and hence participate in maladaptation. The flooding has caused trauma and fear within informal dwellers which drove the community into autonomous adaptation. This is highlighted in the family structures as many participants do not live with their children due to the danger of the floods. The small number of informal dwellers who can migrate to other accommodations participate take part in autonomous adaptation to avoid the harmful impacts of climate change. Even if they do move, they come back to a disaster where most of their shacks are dilapidated and might need rebuilding.

The men in the community are more expressive with their responses. The most significant coping strategy is the use of ropes to rescue those who are trapped in their houses. Traditionally, men are entrusted with the role of ensuring the safety of women and children in the community. Therefore, they might be more proactive in devising adaptation strategies. Worthy to bear in mind is the unwillingness of the community to come up with effective adaptation and mitigation strategies with the fear that the government will not move them to safer land. This supports Nenweli's assertion in Chapter 5(1)(1) which suggests that people deliberately live in dangerous informal settlements as they are aware that their situation will spark interest and pressurise the government to move them to safer land.

As mentioned by Modiba, communities tend to possess the will and unity to assist one another during an emergency without any expectations. This is usually driven by a common problem. Community members are forced to rely on each other because there is limited external assistance (Nenweli, 2015). Thus, they need to strengthen their social networks to cope and adapt to climate change. For this reason, "a calamity frequently results in increased levels of social exclusion" (Modiba,2021:44). The high sense of togetherness in this community has resulted in zero deaths in the community due to floods. The harmony within this community is expressed in Chapter 3(4)(1) and is portrayed through the above-mentioned coping strategies. All things considered, most participants mostly partake in maladaptation and have devised coping strategies to survive climate-induced weather events. Maladaptation has the effect of exacerbating the vulnerabilities the community is already facing. New vulnerabilities arise, and they must builT from scratch. Rather, this community participates in coping. Coping, as stated in Chapter 2(4), transpires using temporary migration and social networks.

5.2.3 State and non-state actors' role in adaptation

The analysis depicts the state as a participant in public and planned adaptation with the councillor issuing a warning. Most participants feel that the state failed to issue warnings timeously which would have granted the community sufficient time to move from the floodplain. Gauteng Provincial government also launched a Disaster Management Centre to issue early warnings on extreme weather events that very year (2019). The City of Tshwane also offers an online Disaster Management document. One could wonder that instead of relying on the state, the community could have received the weather warnings on the news or social media. However, the study discovered that the role of media is limited by

socioeconomic factors such as education level (illiteracy) and access to media itself. The media is key to the dissemination of early warnings and could assist in interpretations of climate change and mitigation. News reports can translate scientific explanations of climate change into graspable language in the form of texts, photographs, and videos. Furthermore, climate science has been accused of not only giving unreliable weather predictions due to increased rainfall variability in Africa but also the forecasts being too technical, making it difficult for local people with low levels of education to interpret and understand (Kasei, Kalanda-Joshua & Benefor, 2019).

The state helped them 'cope' or reduce fatalities and sent the rescue team which is administered by the Tshwane Emergency Services. The men in the community were also involved and assisted with rescuing community members. The state also requested temporary accommodation from the local church, giving the residents time to recover and rebuild their homes. The military (Department of Defence) also donated a cheque for children's uniforms as school was starting in January. Although most of the participants believe that the government did not provide much assistance, and most donations that were received from organisations such as Shoprite and Motsepe Foundation. As a matter of fact, there is ambiguity on the extent of government assistance within the community.

Government officials visited the informal settlement during the 2019 flood. The former Premier promised relocation to a permanent stand before the 25th of December that same year. Four years after the incident, as promised government has reloacted more residents to safer land. Yet, life continues for other community members as they wait to be part of the next phase of relocation. The study also suggests that some might continue living on the floodplain because it is close to economic opportunities and affordable accommodation. The municipality is planning on moving the community to Mooiplaas, which is located South-West of Pretoria. The proposed relocation of the informal settlement might be counteractive as people are relocated even further away from the city or further away from their original slums. The government tends to relocate these people to faraway places known as "sterile environments" (Bradlow, Bolnick & Shearing, 2011). This exacerbates social issues of crime and drug use amongst others than in their previous settlements and excludes the poor in city. For example, in SA, Sandton, dwellers have access to rapid railway transport systems such as the Gautrain, buses and meter taxis, amongst others. While in an township

directly opposite it, Alexandra, people live far from the city and cannot afford the transport to the city, even if it is just to go to work.

The study highlights that relocation can be a viable adaptation strategy. However, to be successful, it must be well-planned, implemented and financed. Relocating the dwellers away from the urban centre might displace them and result in a loss of their right to the city. Therefore, relocation must not disrupt people's livelihoods. So far, the municipal government is pursuing relocation to combat natural disasters by finding/buying suitable land to accommodate most of the informal settlements in the city. This process could take years while informal settlements in the CoT repeatedly suffer the terrible consequences of climate-related disasters.

The study emphasises that people would rather participate in self-help housing, where the state provides land and basic infrastructure than wait for the government to build houses for them. There is a high demand and a low supply of housing, so self-help housing is the solution to this dilemma, which shifts the responsibility for the provision of housing from the state to informal dwellers. The people continue living on the floodplain as they hope the government will move them to permanent stands where they can build houses for themselves. This is known as self-help housing. The state offers basic assistance in the form of a plot, legal land title, and main infrastructure such as roads, electricity, water pipes and a sewage system. More so, the state can offer good building materials and microfinancing solutions (Bredenoord & van Lindert, 2010). Bredenoord et al. (2010:278) postulate that this be included in national and local housing policies to ensure that relocation is long term. UN Habitat describes it as cheap because it is a standard house; people involved in this acquire valuable skills to meet their shelter needs. It can meet people's affordability rates and is flexible because people gain independence and are able to expand their dwellings, over time (Bredenoord et al., 2010).

Chapter 5(2)(2) illustrates that there is an issue with the implementation of climate change laws and regulations in all spheres of government. However, it is more concerning for the local government level as they are primarily responsible for disaster risk reduction and resilience. It is evident that the CoT faces a predicament in meeting the needs of its citizens during climate change which is seen through severe flooding. The issue with the CoT's efforts towards sustainability is that it is biased towards the environment and neglects the social ills that stem from environmental issues. This environmental policy benefits those who

live in formal spaces and not informal settlements. These concerns are supposed to work interdependently to create sustainable urban areas. Social ills such as poverty and housing come forth in this study, showcasing the disconnect with the people who are most affected, being those in informal settlements.

The national government's macro-policies on climate change adaptation need to be examined as flooding proves to be recurrent in certain provinces. This renders city life risky for the poor (Filho et al., 2019), who cannot afford policy solutions that do not address their needs. Conversely, the implementation of mitigation and adaptation strategies in informal settlements may be hindered by the occupation of hazardous land, which inhibits government support and, hence, the lack of basic services in informal settlements.

5.3 Conclusion

The study followed a qualitative research design, which allowed a deep, lived account of the participants. Through open-ended, guided interviews the findings provided a profile of the Mamelodi township and the Eerste Fabriek Informal settlement. It concluded that the informal settlement has a low socioeconomic status. The lack of affordable housing in the city drives informal settlements. The community resides on a floodplain and is susceptible to flooding. They have experienced flooding numerous times; however, life continues as normal as they seek assistance from the government.

The findings began with a background of South Africa's development. It provided a discussion of each stage of development SA underwent; from colonialisation, rapid urbanisation, and pre- and post-apartheid. This background corresponds to the findings in the study that urbanisation can not only be caused by climate change-related phenomena in the rural areas, but rather the lack of agricultural activities in rural areas pushed people to working in the city, which exacerbated poverty. In this instance, the urban 'push' took place both during apartheid and in present times where people move to cities to acquire economic opportunities. These developments highlighted poverty in rural South Africa and the urgent need for housing and jobs in the city triggered by rural-urban migration. The government introduced Bantustans ,and, in democracy, RDPs, yet still failed to accommodate the urban population leading to people building informal settlements on hazardous locations.

Informal settlement communities suffer the terrible consequences of climate change-related phenomena because of their location. Extreme weather events such as heatwaves, drought,

and most commonly, flooding in informal settlements have been reported. Vulnerability (one of the core concepts) is the outcome of extreme weather events in informal settlement communities. It locks people in a vicious cycle of poverty where they already cannot afford suitable accommodation and lose their belongings and assets repeatedly and struggle to replace them. Climate change further widens the gap between the rich and poor in SA. The current weather conditions in SA also depict that we cannot rule out climate change-related phenomena as one of the causes of rural-urban migration.

The residents do not entirely comprehend the scientific cause of climate-related flooding because of a lack of education. They allow the flood to heavy rains, religious and African traditional beliefs and that it is man-made due to poor infrastructure in the municipality. The 2019 flood was severe, pushing many out of their homes and suffering terrible social, physical and economic impacts. The community suffered trauma and anxiety. They do not have the financial muscle to replace their belongings.

Furthermore, the community only possess one adaptation strategy which is temporary migration. However, the rest of their strategies do not minimise impact. Therefore, the community participates in coping which is short-term. The government did lend a hand and partnered with other organisations, such as the church and businesses, to accommodate the community after the flood and donate goods the residents needed. The Premier of that time had previously warned the community to move away from the floodplain. Additionally, the councillor sent out a warning on the day of the flood even though the community felt it was late.

The preferred resolution to flooding in this community seems to be relocation to safer land. The informal settlement community needs to be on safe place that presents them with economic security because in-situ upgrading is not plausible. Future research should investigate relocation as a climate change adaptation strategy in the future. To ensure its efficacy, livelihoods and social networks must be maintained.

6.3 Limitations

The researcher noted a methodological gap in previous studies on the Eerste Fabriek informal settlement where qualitative methods could have been utilised to gain a deeper understanding of the problems pertaining flooding and informal settlements. The study shows need to combine both quantitative and qualitative methodologies to address limitations.

5.4 Policy implications & Recommendations

The results suggest that:

1. A need to raise awareness about climate change

There is a link between poverty and climate change knowledge and adaptation. The knowledge and perception of floods are linked to the community's human capital. Embedding climate change knowledge in communities by teaching them about the natural hazards and how to identify and mitigate risks (Tadgell, Mortsch & Doberstein, 2017) and dam management could foster an understanding of climate change and urban planning and help them build adaptive capacity, no matter where one resides in the city. Strategies such as "building shacks on high-lying areas, parameter walls and sand beds" (Modiba, 2021:83) can be implemented on safer land. Furthermore, internet security is pivotal to creating awareness. The DFFE states that 'internet security' in the form of access, availability and affordability is key to early warnings, disaster response and general information sharing and awareness regarding climate change." (2023:162).

2. Temporary migration

Government could ensure that whenever there's heavy rains, community halls or centres are readily available to allow migration from flood-prone areas.

3. Economic development

Poverty reduction through employment and job creation to reduce vulnerability and increase responses to climate-related events. Sustainable Development Goals are related, and we cannot adapt to or mitigate climate change (SDG13) without addressing poverty.

4. Early warning systems

Migration from flood-prone areas goes hand in hand with early warning systems, where the municipality warns the residents timeously of the possibility of extreme weather events. People in informal settlements are unable to respond and prepare themselves for extreme weather events. Kasei et al. (2019: 202) propose investment in a credible warning system entrenched in "a flood risk reduction system from national to local levels and coupled with systematic vulnerability reduction efforts" to save lives and protect livelihood assets. Thereafter, people can ensure that their belongings are safe and move to the shelters or community centres.

5. Social grants

By providing social grants, the municipality can reduce the vulnerability of the dwellers, allowing them to implement the strategies and increasing their adaptive capacity as a result. However, this must be done on safer, permanent land.

6. Collaboration between stakeholders

All stakeholders (informal dwellers, business corporations, NGOs, and government) must participate in anticipatory adaptation and reactive adaptation under transformative adaptation. Focus is placed on networks, interactions, partnerships and collaborations between actors from different sectors beyond government (Drivdal, 2016:24). However, the problems that could arise in this cross-level (Musungu et al., 2016:87) interaction must be investigated and taken into consideration.

7. Inclusive environmental policies and formalization of informal settlements through relocation

Environmental policy issues should be concerned with social inclusion and justice. Policies favour those who live in formal spaces and those who live in informal spaces do not benefit. Local government needs to incorporate the environmental challenges of informal settlements, which can be resolved through the formalisation of these spaces to build sustainable cities. Additionally, relocation is an adaptation to climate change, so the land allocated must be close to economic opportunities and urban resources. The informal settlement should be moved to land that is close to the urban centre and meets environmental safety standards. Otherwise, they will not fully relocate and will continue living on the floodplain. Alternatively, if they are moved away from the urban centre, transport to the urban centre must be provided which has the implications of increasing costs for low-income households.

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ANNEX I: ETHICAL CLEARANCE FROM UNIVERSITY OF PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Fakulteit Geesteswetenskappe
Lefapha la Bomotho

Humanities 100
Since 1919

2 August 2022

Dear Miss DA Mogotsi

Project Title:	Informal urban settlements, adverse weather events and adaptation: responses to incidents of flash flooding by residents in Eerste Fabriek, Mamelodi
Researcher:	Miss DA Mogotsi
Supervisor(s):	Prof V Thebe
Department:	Anthropology, Archaeology and Development Studies
Reference number:	16051603 (HUM009/0322)
Degree:	Masters

I have pleasure in informing you that the above application was **approved** by the Research Ethics Committee on 28 July 2022. Please note that before research can commence all other approvals must have been received.

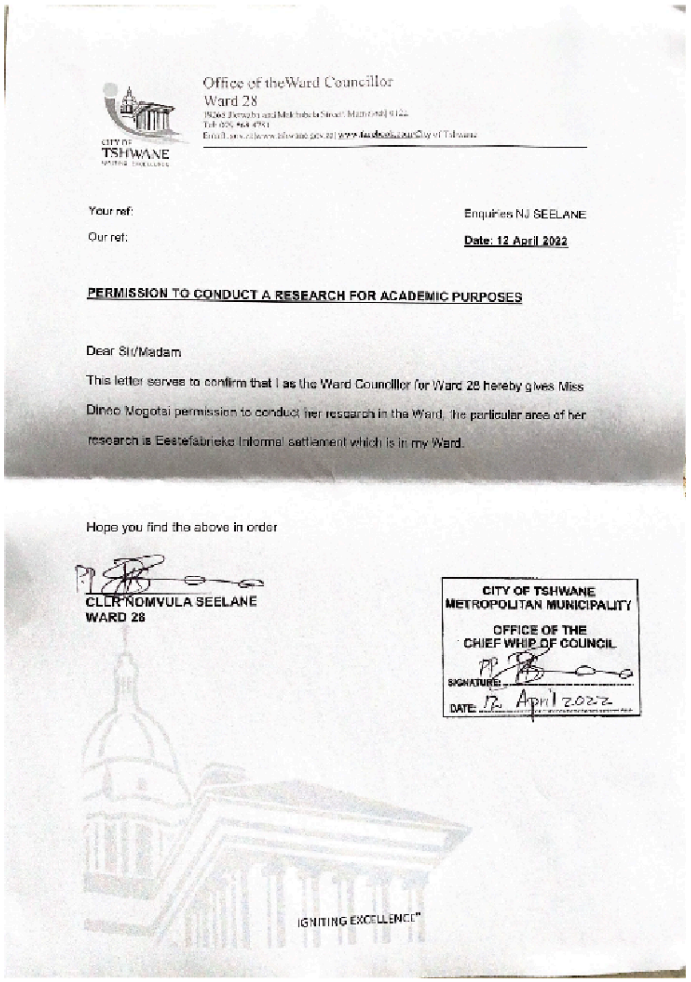
Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. Should the actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

We wish you success with the project.

Sincerely,

Prof Karen Harris
Chair: Research Ethics Committee
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail: tracey.andrew@up.ac.za

ANNEX II: PERMISSION LETTER FROM TSHWANE LOCAL MUNICIPALITY



Office of theWard Councillor
Ward 28

CITY OF TSHWANE

Your ref:
Our ref:

Enquiries NJ SEELANE
Date: 12 April 2022

PERMISSION TO CONDUCT A RESEARCH FOR ACADEMIC PURPOSES

Dear Sir/Madam

This letter serves to confirm that I as the Ward Councillor for Ward 28 hereby gives Miss Dineo Mogotsi permission to conduct her research in the Ward. The particular area of her research is Eesterfabrieke Informal settlement which is in my Ward.

Hope you find the above in order

CLLR NOMVULA SEELANE
WARD 28

CITY OF TSHWANE
METROPOLITAN MUNICIPALITY
OFFICE OF THE
CHIEF WHIP OF COUNCIL
SIGNATURE
DATE 12 April 2022

IGNITING EXCELLENCE"

ANNEX III: INFORMAL SETTLEMENT COMMUNITY LEADERS' INFORMED CONSENT FORM

Faculty of Humanities
Fakulteit Geesteswetenskappe
Lefapha la Bomotho

Department of Anthropology and Archaeology

Informed Consent Letter (Community Leaders)

You are hereby invited for to participate in a research study led by Ms Dineo Alice Mogotsi of the University of Pretoria. This study investigates how households in the Eerste Fabriek informal settlement adapt to adverse weather events, particularly the flood that happened in December 2019. It covers issues such knowledge and perception of climate change, vulnerability and state and non-state actors' role in assisting the people. Please take time to read through this letter as it provides information on the study and your rights as a participant.

Title of the study

Informal Urban Settlements, Adverse Weather Events and Adaptation: Responses to Incidents of Flash Flooding by Residents in Eerste Fabriek, Mamelodi.

What will happen in the study?

The study will involve interviews with you on issues around your expertise, knowledge, role and involvement in aspects covered by the study. The researcher (Ms Mogotsi) will ask for your permission to record the interview. The interview will be conducted in English.

Risks and discomforts

There will be no danger/harm to you. You are free to ask any questions you might have about the study before signing consent. It may be difficult for you to share some information, however, you are free not to answer any questions that may make you feel uncomfortable. If you experience some level of discomfort during the interview, and you would like to stop participation, please feel free to say so. I will allow you to stop participation without any prejudice and the data already collected will be discarded.

Furthermore, measures will be taken to minimise the spread of Covid-19. The following Covid-19 protocals will be followed; the researcher and her companions will be wearing face masks.

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Hatfield 0028, South Africa
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Email u16051603@tuks.co.za

ANNEX IV: INFORMAL SETTLEMENT HOUSHOLDS' INFORMED CONSENT FORM

Faculty of Humanities
Fakulteit Geesteswetenskappe
Lefapha la Bomotho

Department of Anthropology and Archaeology

Informed Consent Letter (Households)

I am Dineo Alice Mogotsi from the University of Pretoria. I am asking you to participate in my research study. Please take time to read through the information below. It provides the title of the study, the objectives of the study; what will happen in the study, your rights as a participant, risks involved and what I, as the researcher will do to protect you (confidentiality).

Title of the study

Informal Urban Settlements, Adverse Weather Events and Adaptation: Responses to Incidents of Flash Flooding by Residents in Eerste Fabriek, Mamelodi.

What will happen in the study?

My study investigates how households in the Eerste Fabriek infomal settlement adapt to adverse weather events, particularly the flood that took place in December 2019. It covers issues such knowledge and perception of climate change, vulnerability and state and non-state actors' role in assisting you.

Risks and discomforts

There will be no danger/harm to you. You are free to ask any questions you might have about the study before signing consent. It may be difficult for you to share some information, however, you are free not to answer any questions that may make you feel uncomfortable. If you experience some level of discomfort during the interview, and you would like to stop participation, please feel free to say so. I will allow you to stop participation without any prejudice and the data already collected will be discarded.

Furthermore, measures will be taken to minimise the spread of Covid-19. The following Covid-19 protocals will be followed; the researcher and her companions will be wearing face masks. They will be carrying a sanitizer and will spray it on their hands regularly. You will also be

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ANNEX V: INTERVIEW QUESTIONNAIRE FOR HOUSEHOLDS

Faculty of Humanities
Fakulteit Geesteswetenskappe
Lefapha la Bomotho
Department of Anthropology and Archaeology

ANNEX A- INTERVIEW GUIDE FOR HOUSEHOLDS

HOUSEHOLDS

1.1 Personal Information

Basic information about the research participant – social demographics which will be used to measure socioeconomic status of the households.

- Name/ pseudynm.
- How old are you?
- Sex?
- What is your highest level of education?
- Are you single or married?
- Are you employed?
- What forms of income do you have?
- Do you have any dependents?
- Were you born in Eerste Fabriek?
- If not, why did you decide to move to Mamelodi?
- When did you start living in Eerste Fabriek?
- How long has it been?

1.2 Climate change

In this section, the household's perception of floods and knowledge on climate change will be investigated.

- How does living on a floodplain affect you?
- Do you experience flooding in your community?
- What do you think causes the floods?

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ANNEX VI: INTERVIEW GUIDE FOR COMMUNITY LEADERS

Faculty of Humanities
Fakulteit Geesteswetenskappe
Lefapha la Bomotho
Department of Anthropology and Archaeology

ANNEX A- INTERVIEW GUIDE FOR COMMUNITY LEADERS

COMMUNITY LEADERS

This section will be used to assess how government has responded to the community's situation.

- Do you reside in this informal settlement community?
- How would you describe this community?
- What strategies are in place to assist the community during and after the flood?
- Which non-state actors assisted the displaced people?
- How did the municipality and the provincial government assist the church?
- Why do you think the people continue living on the floodplain even though they have been warned?
- What do you think needs to be done to assist the people in this community?

QUESTION AND ANSWERING SESSION

At the end of the interviews, participants will be given the opportunity to ask the researcher questions that they might have regarding the study and the interview itself. Once completed, participants will then be thanked for their time and for sharing.

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