

**Investigating the Capacity of Cities to manage urban flooding  
disasters: A case study of Sumbe, Angola**



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LMSNGO001

A Short dissertation submitted in partial fulfilment of the requirements for the award of the degree of Master of Philosophy Degree in Environment, Society and Sustainability.

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FACULTY OF SCIENCE

UNIVERSITY OF CAPE TOWN

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Cape Town – Western Cape

2024

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# Declaration

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The submission of this mini-dissertation has been approved by my supervisor, Dr Phindile Sabele-Rikthoso.

Ngoia Cidália Lopes de Lemos

July 31, 2024

## Acknowledgment

I would like to thank God for giving me the gift of life and for helping me overcome all the obstacles during my master's journey. God gave me strength when I was weak, love when I most needed it, wisdom to make pivotal decisions, and memory when all I remembered was my name. Through your grace, I was able to complete this journey.

I would like to express my profound gratitude to my supervisor, Dr. Phindile-Sabela Rikhotso. Your guidance, knowledge, wisdom, kindness, patience, support, and feedback were crucial for this challenging journey. Thank you for making this research possible and for always lending a helping hand.

To Dr. Philile Mbata, I cannot express how grateful I am for your support and compassion during my first year. Thank you.

To my beloved grandmother, Domingas Anacleto Lopes, you are my fountain and my inspiration. Thank you for being by my side day and night.

My beloved and wonderful parents, Maria Henriqueta Matias Lopes and Antônio Jose Evaristo Lemos, thank you for all the unwavering support, love, and education.

To my little brothers Virgílio da ressurreição Lopes de Lemos (Principe), Jose Evaristo Lopes de Lemos (Kelly), and Luís Matias Lopes de Lemos (Luizinho), thank you for cheering me.

To my beloved boyfriend, Germano, you are one in a million. Thank you.

To my beautiful Ayela, you have changed my life in ways I never imagined, thank you.

I extend my gratitude to all the people who accepted to be interviewed in my city and the local administration.

Thank you, University of Cape Town, for all the lessons that I had the opportunity to attend.

## **Dedication**

To the beautiful city of Sumbe, I hope I can see you shine again.

To João Luis Anacleto Lopes and Albertina Maria, your untimely departure this year  
has left my heart in pieces.

Ebenezer, até aqui o Senhor nos sustentou

A luta continua, fé e coragem.

## **Abstract**

Disasters involving urban floods are a major concern worldwide, particularly in developing nations with limited capacity to manage disasters. Located on the coast of Angola and the capital of the Cuanza-Sul province in the central region of the country, Sumbe has been suffering from the negative impact of urban flooding, which has become more severe over the past five years. The purpose of this study was to investigate the capacity of the Sumbe municipality to manage urban flooding disasters, focusing on two distinct communities: Assaca and Centralidade da Kibaúla. With the intent to assess the City's unique challenges, this case study used qualitative methods, involving 16 key stakeholders, 2 local officials and 7 community members from Assaca and Kibaúla. Findings revealed shortcomings in infrastructure, legal frameworks, early warning systems, preparedness, response, and recovery efforts in Sumbe. While both communities, Assaca and Centralidade da Kibaúla, face comparable challenges, there were some differences in socio-economic status influencing their capacity to respond effectively. This research provides insights in order to enhance disaster preparedness as well as mitigation endeavours in similar urban contexts.

**Keywords:** capacity, urban flooding, disasters, Sumbe, Angola, disaster management.

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## List of Acronyms

- CIMA – International Centre for Environmental Monitoring (Centro Internazionale in Monitoraggio Ambientale)
- CNN – Cable News Network
- CRED – Centre for Research on the Epidemiology of Disasters
- DRM – Disaster Risk Management
- DRR – Disaster Risk Reduction
- FAO – Food and Agriculture Organization of the United Nations
- G1 – Brazilian News Outlet
- GHA – Greater Horn of Africa
- GRDC- Global Runoff Data Centre
- INAMET: Instituto Nacional de Meteorologia e Geofísica de Angola (National Institute of Meteorology and Geophysics of Angola)
- IPCC – Intergovernmental Panel on Climate Change
- JMPLA – Juventude do Movimento Popular de Libertação de Angola (People’s Movement for the Liberation of Angola)
- NWS – National Weather Service
- SADC – Southern African Development Community
- SPCB – Civil Protection and Fire Service
- Texas A&M – Texas A&M University
- UMD – University of Maryland
- UNDRR – United Nations Office for Disaster Risk Reduction
- WFP – World Food Programme
- WHO – World Health Organization
- WMO – World Meteorological Organization

# Chapter 1: Introduction

This chapter starts with background information on urban flooding disasters not only at the global level but also in the Sumbe context. It covers parts of the main components of the research, such as the problem statement, aim and objectives, rationale, significance, and research questions. Finally, this chapter introduces Sumbe as the case study area and the ethical considerations undertaken in order to complete the research.

## 1.1 Background

Urban flooding is commonly understood as overflowing property or land in an urban environment. This event is typically caused by intense rainfall that surpasses the standard drainage system capacity (University of Maryland (UMD) & Texas A&M University (Texas A&M), 2018; World Meteorological Organization (WMO), 2008). This phenomenon is regarded as a significant threat not only to development but also to human well-being, negatively affecting residents, particularly in the constantly expanding urban environments in developing countries (Jha et al., 2012). However, this event does not only impact developing countries; it is also known as the world's most frequent naturally induced disaster, which affects approximately 82.7 million people around the world and caused a massive financial loss of \$34.1 billion from 2001 to 2020 (CRED, 2021).

The challenges posed by this natural phenomenon are complex, pluralistic, and pronounced due to meteorological, hydrological, and anthropogenic factors (Ghosh et al., 2024). Where meteorological factors include precipitation, snowstorms, temperature, and snowmelt (Ghosh et al., 2024), hydrological factors are a key elements in the cause of flooding, as watersheds are regarded crucial to determine the flow that the water will take (Ghosh et al., 2024), and Anthropogenic factors, as human activities, tend to cause impact in the air, sea, and land (Intergovernmental Panel on Climate Change, IPCC, 2021).

In a general context, climate change is seen as the consequence of anthropogenic activities, causing multiple changes in the climate, which could significantly impact the hydrological factors (Ghosh et al., 2024). Other human factors that might be responsible for the exacerbation of flooding in urban environments are associated with the growth

Population and subsequent urbanisation practices, which are considered necessary, challenging to avoid, yet beneficial (Jha et al., 2012). On the other hand, essential factors, including poor urban management, inadequate attention to drainage systems, governance, and the community's inability to cope effectively, are perceived as risk drivers which tend to result in flood disasters (Zheng et al., 2022).

It is commonly believed that the intensity as well as duration of urban flooding have become significant since the beginning of the twenty-first century (Najibi & Devineni, 2018). This trend is predicted to rise in the near future, subsequently affecting more people since population growth is projected to increase from 7.3 to 9.7 billion by 2050 (UN, 2015), where approximately 66% of the global population will be residing in urban places in the same time frame (UN, 2014). Rentschler et al. (2022) argue that 23% of the existing global population lives in flooding risk zones, with a 1% likelihood of a 100-year flood happening or even exceeding its limit in any given year and place, with 89% of the population residing in developing nations (Slater et al., 2021).

As flooding is a widespread phenomenon, this impactful event has had a crucial effect on many urban areas across the globe. A devastating flood hit Rio Grande do Sul state in Brazil, affecting approximately 471 cities; as a consequence, around 170 people lost their lives, and 600,000 individuals were found displaced (G1, 2024). Dubai in the United Arab Emirates faced what was considered the most intense rainfall in 75 years, with 250 mm of precipitation (CNN, 2024). A catastrophic flash flood also impacted the city of Mumbai, India, which caused 34 deaths and a massive disruption in the transport system in 2019, making this event the most impactful one-day rainfall in a decade (Pour et al., 2020). In the same year, a similar flooding disaster took place in the city of Kandahar, Afghanistan, where 30 hours of intense rainfall caused 20 deaths and the destruction of countless residences (Pour et al., 2020).

East African countries are also susceptible to extreme weather conditions (Kilavi et al., 2018). Kenya, for example, has experienced severe flooding roughly every two years, affecting approximately 70,000 individuals per event. The most impactful episodes occurred in 1961, 1997–1998, 2006, 2012, 2018, and most recently in 2024 (Parry et al., 2012). In May 2024, Nairobi faced a severe flooding event that resulted in 210 fatalities,

125 injuries, 90 missing people, 3,100 displacement, and damaged 1,967 schools (Shamim, 2024). Similarly, in April 2022, KwaZulu-Natal province in South Africa, including parts of Durban and the south coast, experienced more than 300 mm of rainfall in 24 hours, and resulted in food accompanied by landslides as well as mudflows (Grab & Nash, 2023). This disaster caused approximately 459 deaths, the destruction of 4,000 homes, displacement of 40,000 people, and temporary job loss for 45,000 others. Damages of the disaster exceeded USD 2 billion (Grab & Nash, 2023).

Angola has been witnessing multiple flooding events; from 2023 to 2024, a total number of 567 deaths were caused by flooding, and 228,825 individuals were considered at risk in the capital city of the country, Luanda (Ver Angola, 2024). Flooding has been impacting other regions of the country, such as the northwestern province of Uíge and Cabinda Province (Floodlist, 2020). 200 people were relocated in the province of Uíge, and 38 houses flooded, including one fatality and six people injured (Floodlist, 2020). On the other hand, in Cabinda, 150 homes were wrecked by flash flooding with road blockage and bridge damage, resulting in 2 deaths due to building collapse in January 2020. In 2019, approximately 2,500 families were affected by rainfall, with 378 houses obliterated and 975 houses harmed, impacting mainly the provinces of Cuanza Sul, Cuanza Norte, Huambo, Benguela, Bie, Zaire, Lunda Sul and Norte, Namibe, Luanda, Uíge, and Malange (Floodlist, 2020). In 2021, a flood impacted 11,000 individuals and destroyed 2,300 houses (The World Bank Group, 2022).

Sumbe, located in Cuanza Sul, was not immune to urban flooding impacts; several flooding events were reported in this region. 200 houses were completely destroyed by flooding in 2020 (Floodlist, 2020). In 2023, 36,190 people were homeless, with 7,238 residences flooded, entailing seven schools, five churches, and four houses that were destroyed and two injured individuals. The intensive rainfall resulted in the overflow of the Cambongo River, and consequently, the paediatric hospital of the city flooded, obliging the evacuation of 154 patients to another hospital (Jornal de Angola, 2023).

## 1.2 Problem statement

Urban flooding is considered one of the most impactful disasters on a global level, not only due to its complexity to predict accurately but also in excess of risk management and resilience-related challenges (Jha et al., 2012; Tingsanchali, 2012) and its ability to heighten the exposure as well as susceptibility of the people living in urban spaces (UNDRR, 2019). This hazard is more tremendous in African cities as fewer resources are available to manage urban flooding disasters. According to Phiri et al. (2020), a combination of two disastrous tropical cyclones, Idai and Kenneth, were experienced in the Southern African Development Community (SADC) in 2019, impacting nations such as Mozambique, Madagascar, Malawi, and Zimbabwe (Nhamo & Dube, 2021) negatively. The impact of these disasters cost approximately US \$1 billion in Southern African Development (Nhamo & Dube, 2021). It is predicted that in the future, pluvial flooding events will continue to rise in most southern African regions (IPCC, 2021).

Sumbe is a city that is constantly impacted by urban flooding. The city faces numerous issues from shallow groundwater—often less than 80 cm deep across most areas—particularly during the rainy season (Rampinelli et al., 2021). Although the specific date of flooding events in the city's local newspaper remains unknown, the consulted and reported resources suggest a start in 2013, continuing until the current year (Jornal de Angola, 2013). In 2013, the city witnessed unusual rainfall during the winter season, as it is not expected to rain in winter (Jornal de Angola, 2013). Since then, many have been reported with more frequency in the local journal. For instance, in February 2023, 600 people became homeless due to flooding that disrupted the regular routine of the residents (Angop, 2023).

Despite the fact that flood events are reported in the city, there is still a limitation in understanding the city's capacity to deal with urban flooding disasters effectively. The aim of this research was to investigate Sumbe's capacity to manage urban flooding disasters, with a focus on the neighbourhoods of Assaca and Centralidade da Kibaúla. This paper scrutinised the following themes: infrastructure resilience, the existing legal frameworks, early warning systems, and disaster preparedness, response, and recovery mechanisms to access the city management capacities. A profound review of current literature on disasters, urbanisation, capacity, vulnerability, hazards, and urban flooding

in the context of African cities was examined with the objective of identifying better gaps in the field that need further exploration.

### **1.3 Research aim and objectives**

Urban flooding remains a serious concern in the city of Sumbe, and there are limited studies on the capacity of the city to handle urban flooding disasters. The objective of this research is then to investigate the capacity of Sumbe, Angola, to manage urban flooding disasters, with a specific focus on two distinct neighbourhoods, Assaca and Centralidade da Kibaúla, as case studies. To achieve this, the following objectives will be explored:

1. To identify key indicators and factors influencing Sumbe's capacity to manage urban flood disasters.
2. To assess the local legal frameworks, policies, or regulations, as well as flood management strategies, in order to reduce the impact of floods in the city of Sumbe and within the two communities.
3. To propose a practical recommendation to improve the city capacity to handle flood-related disasters.

It is envisaged that this research may help to effectively respond to urban flooding challenges faced in the city. Stakeholders that may benefit from this study include local governments, private companies, residents, researchers, and educational institutions, as the current research findings address the capacities of the neighbourhood of Assaca and Kibaúla, considering pivotal themes such as infrastructure, preparedness, response, and recovery. These themes could potentially facilitate the implementation of suitable urban flood risk management, which may help to prevent future flooding hazards, as the implementation of this approach mixes structure and non-structural measures, which are regarded as challenging in municipalities with scarce technical capacity, financial resources, or any additional resources (Jha et al., 2012).

## 1.4 Research Question

To achieve the research goals, the questions below need to be addressed (See Table 1)

Table 1- Research objectives and research questions

	<b>Research objectives</b>	<b>Research questions</b>
<b>1</b>	Identify primary indicators and influencing factors of urban flood capacity in Sumbe.	<ul style="list-style-type: none"> <li>● What are the primary indicators (hydrological, infrastructural, institutional, and environmental) of urban flood capacity in Sumbe?</li> <li>● Which factors such as socio-economic, institutional, technological, infrastructural most significantly influence Sumbe's flood management capacity?</li> </ul>
<b>2</b>	Assess the local legal frameworks, policies or regulations, as well as flood management strategies to reduce urban flooding disaster.	<ul style="list-style-type: none"> <li>● How effective are Sumbe's current legal frameworks and flood management strategies in reducing flood risks?</li> </ul>
<b>3</b>	If needed, propose a practical recommendation to ameliorate the capacity of Sumbe to handle flood-related disasters.	<ul style="list-style-type: none"> <li>● What practical recommendations can be proposed to improve Sumbe's capacity to handle flood-related disasters? <ul style="list-style-type: none"> <li>○ What are the significant weaknesses and areas that require strengthening in Sumbe's ability to control</li> </ul> </li> </ul>

floods based on examining indicators, influencing variables, and current policies?

- What specific infrastructural modifications, including upgraded drainage systems and flood barriers, are necessary in order to control urban flooding more effectively?

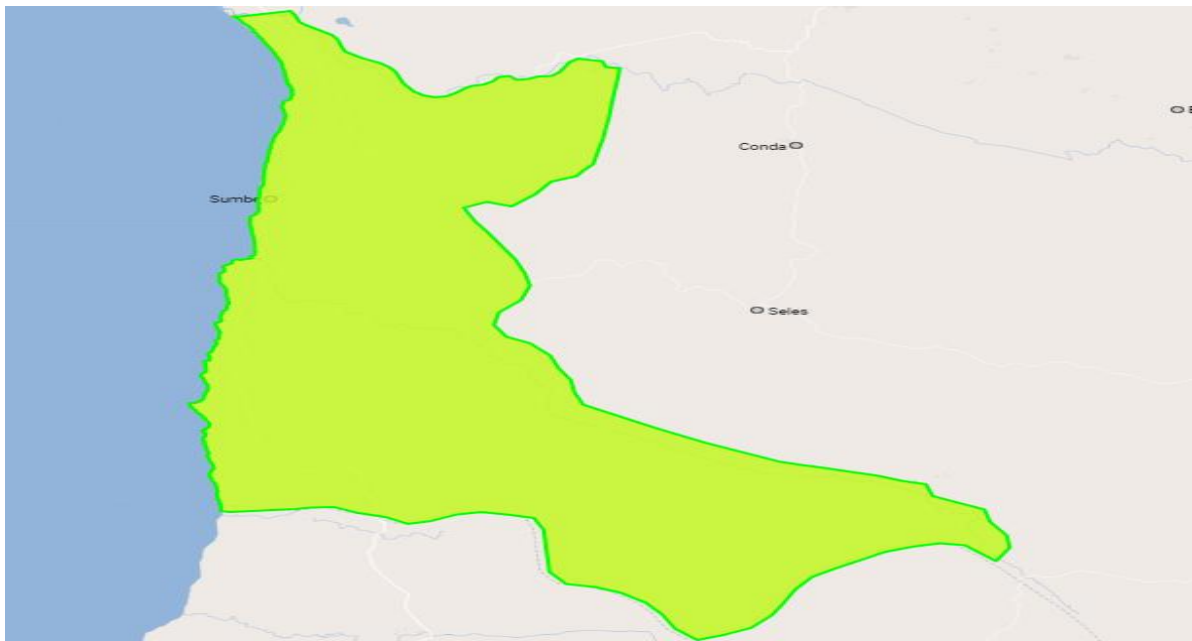
### 1.5 Case study Area

Sumbe is the capital city of Cuanza-Sul province and is situated in a coastal city in the west-central part of Angola. The city has a population of 352,700 individuals and encompasses an area of 4,050 km<sup>2</sup>; it is estimated that 73.5% of the region is urbanized (City Population, 2024), with a strong predominance of soil clay (Rampinelli et al., 2021). Several water resources supply the city, including the Queve River in the north, the Balombo River in the south, and the Atlantic Ocean to the west (Rampinelli et al., 2021). The city's annual temperature fluctuates between 22°C and 24°C. The rainy season typically takes place from November to April; levels of precipitation during this period vary between 300 mm and 400 mm (City Population, 2024). March is considered the month with the highest precipitation, while December and January are the lowest (City Population, 2024). In Sumbe, the rainy season normally aligns with one of the hottest temperatures of the year (26–27 °C) in March or April. Conversely, the Cacimbo season, which is the coldest, displays an average of 20–21 °C in daily temperature (City Population, 2024).

Cuanza-Sul is a province in Angola recognized for its varied physical characteristics, with almost 60% of its territory located at an altitude of 100 meters (Marques, 1966). The climate is directly affected by the frigid current that comes from the Benguela province, which results in significant variations in its climate (Marques, 1966). Sumbe

municipality, shows a diverse types of landforms, including coastal plains, regions with sedimentary and metamorphic rocks, mountains, peaks, and plateaus (Marques, 1966).

The economically active population of Sumbe, predominantly within the age range of 17 to 60 years, is involved in small-scale livestock and agriculture (Guia, 2016). Maize, potatoes, and a variety of horticulture are important agricultural commodities in the region (Guia, 2016). Despite its geographical importance, the city of Sumbe still lacks modern infrastructure and mostly relies on structures established by Europeans, making the municipality even more susceptible to floods. Recent efforts have been undertaken in order to restore and enhance infrastructure, specifically focusing on upgrading drainage systems for both rainwater and wastewater (Guia, 2016). However, there are limited resources, preventing the repair of sewage and drainage infrastructure from being completed (Guia, 2016). The persistence of the population's susceptibility to floods is evident, particularly in high-risk locations such as the Inconcon and Bumba districts (Guia, 2016).



*Figure 1: Sumbe map.*

Credit: City population, 2022

## 1.6 Summary

This chapter introduced the main concept of urban flooding disaster, the research problem, objectives and introduced the case study area of Sumbe.

### Mini dissertation Structure

This dissertation is structured into six chapters, which are presented as follows:

**Chapter One:** provides the background of the research, including the research problem statement, objectives, questions, and ethical considerations.

**Chapter two:** introduces the literature review of the study, entailing flood definitions, different types of flooding, flood hazards, exposure, vulnerability, capacity, and, lastly, investment in flood mitigation in the city of Sumbe.

**Chapter three:** presents the methodological process used to achieve the research goals.

**Chapter Four:** Demonstrates the result of the qualitative research approach

**Chapter Five:** Discuss the findings of the Centralidade da Kibaúla case study and Assaca neighbourhoods.

**Chapter Six** the research by summarizing the key findings and providing recommendations.

## Chapter 2: Literature Review

This chapter introduces the different conceptualisations of floods reflecting on how floods emerged over the time. Subsequently, it examines the various types of flooding, including riverine, urban, compound, flash, and slow-on-set flooding. Next, crucial definitions of the flood risk components encompass hazards, vulnerability, capacity, and exposure in an urban disaster context. Finally, chapter two delves into the impacts of floods in Sumbe and the city's investment in disaster risk reduction.

### 2.1 Defining flood

The definition of flood emerged in the literature between 1936 and 1952. According to Jarvis (1936) and Leopold and Maddock (1954), a flood is regarded as the transient overflowing of a dry region or a situation in which a waterway's speed exceeds its natural course capacity. On the other hand, other authors also define floods in the 2000s; Ojo (2007) and Rosenzweig (2009) argue that a flood is the result of excessive rainfall or flooding caused by a river or any other aquatic source, with significant potential to cause damage or complete devastation. A more recent concept of flood in 2014 is stated by Birkholz et al. (2014), wherein the public spectrum, flood occurrences cause substantial loss of lives, disruptions, and harm to property.

### 2.2 Flood causes

Many factors influence floods, including topographic and geomorphologic features, drainage systems, structural elements, and climatic conditions, encompassing rainfall frequency, severity, and duration (Do et al., 2017; Irannezhad et al., 2018). Two major factors, Global warming and the way the land is used, are considered responsible for the change in the natural cycle of water, which not only affects but also increases the prevalence, durability, and severity of floods (Fowler et al., 2021; Hosseinzadehtalaei et al., 2020; Konapala et al., 2020; Pielke et al., 2011; Singh et al., 2020; Wu et al., 2013). Inversely, human-caused global warming and land use can alter the duration as well as variability of rainfall (Konapala et al., 2020; Mishra et al., 2011). A scientific study showed that these two factors have a massive effect on the hydrological events causes of floods on both regional and international level (Do et al., 2017; Mallakpour & Villarini,

2015; Slater et al., 2015; Tremblay et al., 2020). Climate change may intensify river flooding in various areas of the globe (Arnell & Gosling, 2016; Konapala et al., 2020; Merz et al., 2021).

According to Arnell and Gosling (2016) and Hirabayashi et al. (2013), there is a foreseen growing flood risk in many different nations, especially in South America, Asia, and Africa. Different factors, including global warming, population growth, and urbanisation, are responsible for the rise of flood risk and susceptibility (Hirabayashi et al., 2013). Blöschl et al. (2019) state that there is a notable extended trend in the scale and occurrence of flood patterns in the previous five to ten years in different areas of the globe (Blöschl et al., 2019; Gudmundsson, Leonard, (Do et al., 2019; Mallakpour & Villarini, 2015; Petrow & Merz, 2009). Yet, the trend in flood occurrence patterns is not necessarily relevant (Petrow & Merz, 2009) and may not be associated with rainfall fluctuations (Sharma et al., 2018). Two important components that influence flood occurrence are the soil moisture level and the drainage area's wetness (Berghuis et al., 2019; Ivancic & Shaw, 2015; Sharma et al., 2018; Slater & Villarini, 2016). For instance, alterations in the seasonal timing alone do not provide a sufficient explanation for the shift in flood timing, as in Europe, the main driver of floods is the timing of melting snow or peak soil humidity (Whitfield, 2012).

Anthropogenic activities entailing the development of unplanned settlement, irregular development of buildings and massive modifications in the way the land is used have an enormous effect on the spatial and temporal trends of the hazard. This change is often associated with informal urban developments as they are typically not regulated by land use policies or regulation, master plans, buildings or drainage codes (Dalu et al., 2018). Furthermore, informal settlements barely have adequate infrastructure for flood mitigation, which is related to the unplanned and uncontrolled ways they are established. Another reason is the municipal government's resistance to investing in infrastructure in these settlements, which is essential to accommodate the growing population in these areas. These activities are commonly increased by environmental factors, particularly global warming in both urban centres and the countryside (Dalu et al., 2018).

## 2.3 Types of Flooding

The literature lists five types of flooding. Floods can be classified as inland flooding, which entails three main classes: riverine floods, flash floods, and urban floods. Other existing floods include coastal and compound flooding (Mishra et al., 2022).

- Riverine flooding is the result of plentiful amounts of rainfall, mostly from the sea storm systems, which include tropical cyclones or atmospheric rivers reaching the land and causing extended severe thunderstorms in a particular area (Aryal et al., 2018; Barth et al., 2017; Mukherjee & Mishra, 2021; Roderick et al., 2019; Smith et al., 2001), as well as rain combined with melting snow (Bell et al., 2016). Slow onset is also classified as riverine flooding in arid areas with inefficient drainage systems (Zickgraf, 2021). This type of flooding results from surface water overflow and is considered prevalent in delta and floodplain areas, mainly in countries like Bangladesh, which is affected annually by this type of flooding (Zickgraf, 2021). Although slow-onset floods are linked to fatalities attributed to illness, nutritional deprivation, bites from snakes, and disturbance in the daily routines of those impacted, people affected by this type of flooding have sufficient time to relocate to higher echelons, making slow-onset flooding less lethal (Mishra et al., 2022).
- Flash flooding is defined as an unexpected increase in water level in urban zones, creeks, and rivers as a consequence of massive rainfall in a short time period (Acosta-Coll et al., 2018; Vila et al., 2016; Ozturk et al., 2018; Yin et al., 2018; Khajehei et al., 2020; Ahmadalipour & Moradkhani, 2019). Flash floods are often related to catastrophic events such as severe thunderstorms and hurricanes. Additionally, flash flooding can happen from levee, dam failure, or glacial lake outburst floods (GLOFs) (Mishra et al., 2022).
- Urban flooding is regarded as a threat in both wealthy and poor countries due to the multiple disruptions caused in buildings, household assets, disruptions on the transport systems, loss of income in trade industries, as well as loss of jobs for temporary workers (Jha et al., 2012). Urban flooding is the outcome of severe rainfall in urban areas surpassing the standard capacity of the drainage systems. As a result of

urbanisation, the natural vegetation is removed and covered by impervious surfaces, which prevent the water from infiltrating the ground, resulting in heightened surface runoff right after rains (Mishra et al., 2022). This type of flooding is regarded as a threat in both wealthy and poor countries due to the multiple disruptions caused in buildings and household assets, disruptions in the transport systems, loss of income in trade industries, as well as loss of jobs for temporary workers (Jha et al., 2012). As the population, urbanisation, and occurrence of severe rains increase, urban flooding will remain a concern, mainly due to urbanisation as economic development is predicted to be around the cities, causing more harm to vulnerable people (Sayers et al., 2013; Henonin et al., 2013).

- Coastal flooding comes about through the intersection of solid events, including tidal waves, extreme rains, and severe onshore winds. This event is frequent in the northwestern region of Europe (Ganguli et al., 2020; Ganguli & Merz, 2019), South Asia (Douglas, 2009; Mirza, 2011), as well as the American Southeast (Benke et al., 2000; Ezer & Atkinson, 2014; Gornitz et al., 1994; Marsooli et al., 2019).
- Compound flooding is the combination of various physical factors such as coastal topography, hydrological conditions, and weather patterns (Couasnon et al., 2020; Leonard et al., 2014). The increase in this event is linked to climate change, sea level rise, and the expansion of urbanisation in coastal megacities in the past century. Due to the lack of climate mitigation measures to deal with this event, the probability of an increase is elevated (Wahl et al., 2015; Ezer & Atkinson, 2014; Moftakhari et al., 2017). See Figure 2 for a visual representation of compound flooding.

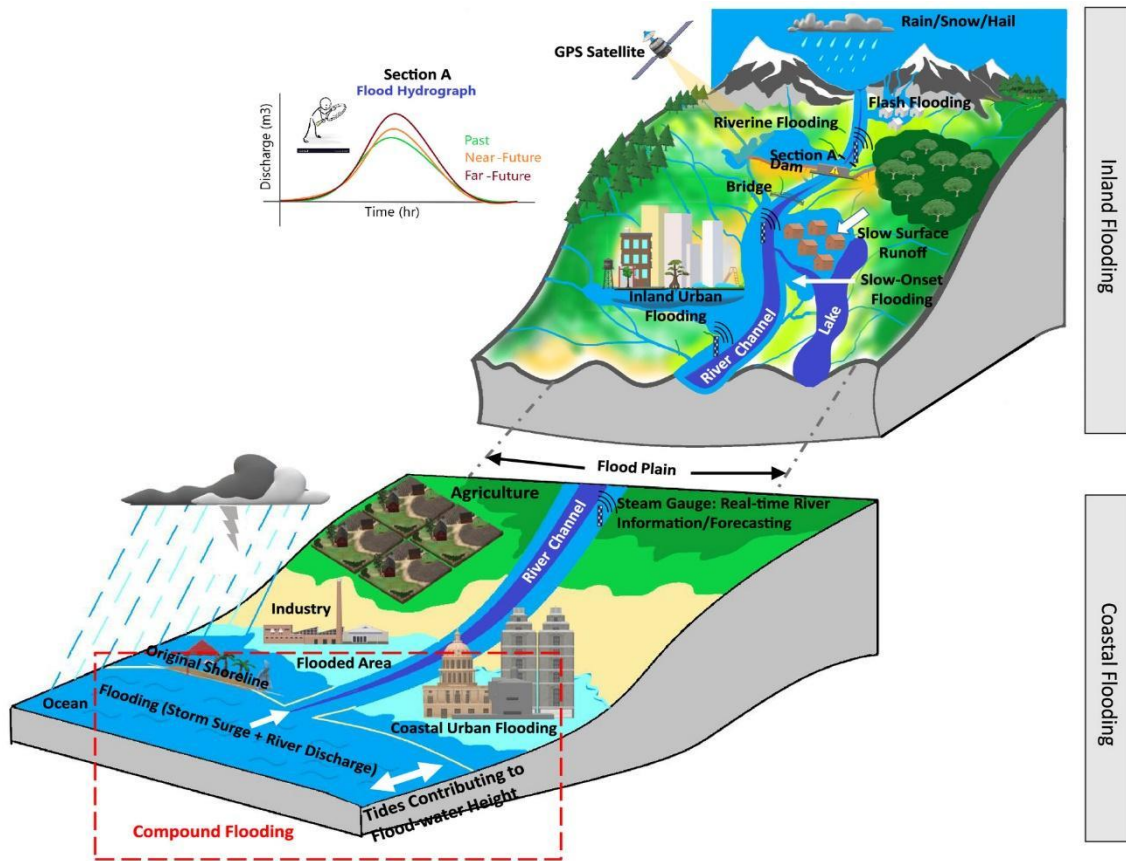


Figure 2: Types of floods

Image source: Mishra et al., 2022.

## 2.4 Contextualisation of Flood Disaster in Africa

Consisting of forty-four countries with a broad spectrum of climate conditions from equatorial to desert regions (Lumbroso, 2020), Africa has become well known as the continent most susceptible to floods, as suggested by many researchers who documented the rise in fatality rates and exposure in the past decades (Di Baldassarre, G. et al., 2010; Tanoue et al., 2016; Trambly et al., 2020; Tellman et al., 2021; Belloni et al., 2021). When it comes to disasters, developing and developed nations are equally exposed (Coppola, 2015; Etkin & Burton, 2015). Nonetheless, the African continent has limited resources and understanding compared to developed countries, with most of the vulnerable population residing in sub-Saharan Africa, accounting for 55% of the population living in extreme poverty and flood-prone areas (Rrokaj et al., 2021). The

approach to disaster management might differ among nations based on their specific hazards profiles, legislation, vulnerabilities, and objectives for reducing risks (Coppola, 2015; Etkin & Burton, 2015).

As mentioned above, the rise in flood rates is not only on the African continent. Based on observed data and future climate predictions, many studies worldwide have demonstrated a significant increase in flooding variabilities (Alfieri et al., 2017; Do et al., 2017; 2020; Hodgkins et al., 2017). However, there is also a significant change in flood variability at the regional level, which is often seen to contradict the findings (Najibi & Devineni, 2018; Yin et al., 2018). Despite the existence of continental-scale analysis to report long-term flood patterns and their important driving mechanisms (Villarini et al., 2009; Ivancic and Shaw, 2015; Blöschl et al., 2015; Blöschl et al., 2019; Winsemius et al., 2016; Wasko and Sharma, 2017; Wasko and Nathan, 2020), Limitation in the number of sub-regional stations in the African continent is mainly linked to absence of knowledge in most studies (Di Baldassarre et al., 2010; Nka et al., 2015; Wilcox et al., 2018). For example, Di Baldassarre et al. (2010) examined approximately 79 data series, specifically from central and northern Africa, between 1900 and 2000. The findings have shown no substantial monotonic trend in annual maximum discharge at 65 stations; only four stations showed an increase in flood trends. Despite the absence of an apparent rise in flood trends, flood fatalities were reported in several African countries.

In 2017, Do et al. (2017) also conducted a similar investigation by examining a global analysis of the trends in flooding through the Global Runoff Data Centre (GRDC) database, encompassing around 58 stations across the African continent, from 1955 to 2014. It was discovered that there is a global decline in the magnitude of flooding, particularly in the Western part of Africa, and a significant rise in South African stations. Nka et al. (2015) and Wilcox et al. (2018) investigated extended in 11 catchment regions of West Africa. It was noted that there was a rise in flood scale after the 1980s in some locations, although this magnitude is still considered lower when compared to those observed in the beginning of the 1950s. Despite numerous studies in different parts of the globe and across Africa, the evidence from this study suggested that there are gaps in understanding flood trends in North Africa, as few studies have focused on flood patterns in this region (Abida & Ellouze, 2008; Khomsie et al., 2016), and there are no significant trends to have been detected statistically. The African continent often has a limited

representation in global analysis due to this lack of numbers of stations that can provide observed discharge data in databases like the GRDC (Wasko & Sharma, 2017; Yin et al., 2018).

As flooding is mainly caused by weather events which are challenging to predict due to their chaotic nature, despite many advancements in weather forecasting it is still difficult to determine with certainty when it will rain and where storms will form. In other words, it is difficult to predict future flooding events occurrence or how high the water level or discharge of the next flood will be (Jha et al., 2012).

Floods prediction refers to the estimation of the likelihood of occurrence of future flood which requires analysis of rainfall trends, characteristic of the catchment and river hydrographs as pivotal variables (Yeboah et al., 2023). The aim of flood projection is to forecast water levels and discharge rates that exceeds the capacity and may put in jeopardy the safety of the properties in many sites in flood prone areas (Yeboah et al., 2023). These predictions have been considered crucial in adaptation strategy in order to prevent damages made by floods (Yeboah et al., 2023). The reliability as well as preciseness of flood predictions is fundamental to develop adequate strategies to deal with flood risk, reduction measures of flood hazards, and evacuate affected individual from flood plain zones and stewardship of environmental and water resources (Brocca et al., 2011).

Countries like Mali, Burkina Faso, Ghana, and the Ivory Coast (BVRB) are impacted by flooding annually during August and September impacting residents' daily routines and property (Judith, 2015). South Africa is also regarded as a country prone to flood hazards mainly in four central provinces, including Limpopo, North-West, Eastern Cape and Kwa-Zulu Natal, which are mostly non-urban areas (Le Roux & Van Huyssteen, 2010). The likelihood of flooding occurrence in South Africa is 83% of chances of occurrence every year (Zuma, Luyt, Chirenda, & Tandlich, 2012). The level of vulnerability of the country is considered high due to several socio-economic disparities as well as geographical factors (Zuma, Luyt, Chirenda, & Tandlich, 2012). Additionally, it was discovered that rural and informal settlements in South Africa, which are situated in valleys and wetlands, are considered more susceptible to flood hazards as well as disasters (Sinthumule & Mudau, 2019). Factors such as population growth impact, development

of settlements, and expansion of the rural-urban zones have contributed to rise in scale and occurrence of flooding (Chakwizira, 2019).

Many African cities are considered to be flood-prone areas (Baker, 2012). Factors including the migration of people to the cities to live in high-risk zones due to unplanned urban growth resulted in an increased number of deaths linked to floods in African cities (Di Baldassarre et al., 2010). Urbanization alone cannot be addressed at a local level as it is connected to many factors including Societal, financial, political and environmental dynamics (Di Baldassarre et al., 2010). The methods used in most African cities to manage urban water are still outdated and provide limited opportunities for the continuous professional growth of practitioners (Lumbroso, 2020). With the rise of urbanization in African city centres, it is pivotal to manage flood risk to enhance resilience and sustainability effectively (Lumbroso, 2020). Governments must create comprehensive, robust, proactive strategic plans for successful flood risk management. These plans must be based on research, data collection, public consultation, evaluation, and continuous learning (Egbinola et al., 2017).

## **2.5 Flood hazard**

According to UNDRR Terminology (2017), a hazard can be defined as any process, including human activities or natural events that could potentially result in death, injury, health problems, property destruction, socio-economic disruption, or environmental harm. Additionally, hazards can be considered as natural, human-induced, or socionatural (UNDRR Terminology, 2017). Natural hazards are related to natural processes or phenomena (flood and drought). Anthropogenic hazards result from human activities or choices. Socionatural involves both natural and human factors entailing changes in climate and environmental destruction (UNDRR Terminology, 2017).

In the context of flood, a hazard is commonly defined by location, intensity or magnitude, frequency, and likelihood of its occurrence (UNDRR Terminology, 2017). Flood hazards are shaped by a fusion of natural and human factors. For example, the severity of a fluvial flood will always rely on physical factors, including the severity, volume, and timing of precipitation (Jha et al., 2012). Flood hazards are considered crucial to dealing with flood risk, which is conceptualized in four stages, including the source of the flood water, the

course taken by the water, and the flooding receptor (human settlements, infrastructure, environment or field) (Jha et al., 2012). Moreover, a Flood hazard is a factor of a risk, risk to both human and animal lives and property like buildings, civil engineering structures, economic activities, public facilities, and infrastructure (Pham et al., 2022). In order to understand a hazard, it is crucial to have a wide comprehension of the causes, types of flooding, probability of happening, duration, depth, and velocity (Jha et al., 2012). Hazard predictions are typically expressed as probabilities, computed based on historical data for the interest area (Jha et al., 2012).

When it comes to disaster management it is crucial to fully understand flood hazards before the occurrence of the event, and during flood emergencies in order to develop mitigation, preparedness, as well as reduction of the damage activities (Jha et al., 2012). Additionally, to comprehend flood hazard, knowledge of the diverse types of flooding is required, the likelihood of its occurrence, how it is possible to model and map them, the compulsory data for map production and data source (Jha et al., 2012). A detailed comprehension of flood hazard is also essential in order to implement adequate flood risk mitigation measures including developing planning, forecasting as well as early warning systems (Jha et al., 2012).

The way the community perceives geo-environmental hazards has a major contribution on how society may react and manage this event (Bempah & Øyhus, 2017). In this way, the community response as well as understanding of flood hazard is influenced by multiple factors such as historical background, the community's comprehension of the hazards, and the accessibility of hazard information. These factors influence the implementation of effective mitigation strategies (Bempah & Øyhus, 2017). Misperception of hazards may lead to elevated vulnerability as well as increased risk of damage. For instance, communities may opt to live in floodplain areas due to perceived benefits, thereby exposing themselves to ineffective flood risk management practices (Messner & Meyer, 2006). In regions where floods are not frequent, the lack of capacity to perceive hazards can result in poor preparedness and greater susceptibility to disasters.

Conversely, communities with a strong awareness of flood risks, informed by past experiences and changing severity, are generally better prepared (Baan & Klijn, 2014). Thus, developing effective mitigation and adaptation strategies requires scientific

knowledge and a deep understanding of community perceptions, hazard awareness, and behavioural responses (Adelekan & Asiyanbi, 2016). Consequently, understanding how individuals perceive hazards can provide insights into their level of susceptibility.

The Civil Protection and Fire Service (SPCB) is responsible for coordinating disaster prevention and response operations, including floods, fires, road, rail, and air accidents in Angola (Diário da República, 2017). The Directorate for Disaster Risk Reduction conducts natural risk studies, evaluates risk reduction strategies across different levels, educates the population on mitigation measures, and monitors serious incidents such as catastrophes or calamities. During non-disaster periods, the SPCB maps vulnerable areas, maintains and oversees operational techniques, coordinates with other institutions, and manages emergency logistical reserves (Diário da República, 2017).

### **2.5.1 Understanding Flood Exposure and Vulnerability**

Exposure and vulnerability are considered two critical components in managing flood risk (Nasiri et al., 2016). According to UNDRR terminology (2023), exposure can be defined as the circumstances in which individuals, buildings, residences, production capacity, and other physical human assets are situated in a flood-risk area. On the other hand, vulnerability is a situation caused by “physical, social, economic and environmental elements or processes that can raise the susceptibility of an individual, a community, assets or systems to the impacts of hazards” UNDRR (2024). There are four distinct forms of vulnerability: social, physical, economic, and environmental vulnerability (UNISDR, 2018).

The rates of exposure and vulnerability are growing simultaneously, and managing these two components is still challenging (Velasquez, 2012). Factors including urban expansion, population growth, and elevated economic activities lead individuals to flood-prone areas and increase flood hazard. Additionally, countries with less diverse economic structures, which have elevated fiscal deficits, present high vulnerabilities even when dealing with disasters of small magnitude (Velasquez, 2012). For instance, it is estimated that flood damage accounted for \$10 billion in Pakistan in 2010, representing approximately 5.8 per cent of the country's GDP from 2009 to 2010 (Velasquez, 2012).

The existing link between exposure and vulnerability is evident in many regions. For instance, in 2012, a combination of catastrophic events in the Asia-Pacific region, including the Great East Japan Earthquake, devastating tsunamis, nuclear disasters, and, additionally, extreme flooding in Southeast Asia, specifically in Thailand, led to staggering economic losses amounting to \$294 billion, which accounts for 80 per cent of the total global disaster losses in 2011, which were approximately \$366.1 billion, not to mention the loss of life of some individuals (Velasquez, 2012). Additionally, the Asia-Pacific region is regarded as the most susceptible region worldwide and is often impacted by disasters. Approximately 2 million people lost their lives from 1970 to 2011, accounting for 75 per cent of all disaster deaths worldwide.

The most common hazard is associated with hydrometeorology, impacting most individuals in this region (Velasquez, 2012). This information demonstrates the massive impact of these disasters on the region, highlighting the necessary attention to disaster preparedness and risk management (Velasquez, 2012). These events serve as reminders of the unmitigated increase in disaster risks, which mainly affect the social and economic conditions of poor countries and threaten the economic resources of developed nations (Velasquez, 2012). According to Velasquez (2012), not only leaders around the world but also segments of the public find it daunting to understand how risk components such as hazards, vulnerability, and exposure interact with each other in order to heighten the total risk of a region and yet continue to cause significant losses. (Velasquez, 2012). The author also makes it clear that accelerated economic growth alone is not the only reason for vulnerability decreases; however, it often increases public exposure to a broader range of disaster risks (Velasquez, 2012).

When it comes to social vulnerabilities, not only women but also children, elderly individuals, and people with disabilities are susceptible to hazards and have different needs in order to minimise those vulnerabilities. It is considered that children's vulnerability tends to increase during disasters significantly (Velasquez, 2012).

Due to the recognition of the tremendous effect of the disaster on social and economic development, many flood exposure assessments were conducted around the world. The benefit of this assessment is the inclusion of recent high-resolution maps with meticulous details of a flood, assets, and population distribution, which cannot perform precise risk

examination risk (Chakraborty et al., 2014; Fielding, 2012). However, the majority of the conducted studies focus on developed countries such as the European Union, the United States of America, and Japan, primarily due to the availability of data and the substantial economic values of the countries at risk (Chakraborty et al., 2014; Fielding, 2012). On the other hand, some studies focus on developing nations. However, they tend to be in mega economic centres, including Jakarta, Dhaka, Dar es Salaam, Accra, and Ho Chi Minh City, with limited studies in the most vulnerable developing countries and subregions where floods cause a devastating impact on their way of living (Budiyono et al., 2015; Bangalore et al., 2019).

According to Jongman et al. (2012), the global number of people exposed to flood risk might increase to 1.3 billion in 2050. In contrast, Smith et al. (2019) argue that a minimum of 39% percent of this total (500 million people) had already been exposed to significant flooding by 2019. This highlights how critical high-resolution data is to capture and localise the nature of flood hazards. It also demonstrates how individuals frequently avoid moving to areas considered to be the riskiest. Moreover, other international studies conducted by Jevrejeva et al. (2018), Neumann et al. (2015), and Arnell & Gosling (2016) mainly concentrated on a particular type of flooding instead of assessing all the possible risks from floods, including fluvial floods, pluvial floods, and coastal floods. For example, more recent global research on the risk of the sea level increase on the population living in coastal areas (Kulp et al., 2019) expected that over 190 million individuals could be inundated by the sea level rise by 2100. However, this research does not include all sorts of floods; the inland flood risks were excluded entirely. In contrast, other vital studies restricted their assessment, making it specific to certain countries, which are typically limited to international evaluation (Tiggeloven et al., 2020). The existing connection between poverty and exposure to hazards was never scrutinized. The significance of studying the connection between these two factors lies in determining the vulnerability of individuals' resilience and their capacity to deal with and bounce back from flooding. (Hallegatte et al., 2017).

### **2.5.2 Flood Exposure and Vulnerability in Angola**

Angola is one of the nations impacted by extreme weather conditions in the Southern African Development Community (SADC). Flooding is one of the country's

most frequent events, mainly impacting the coastal areas and the Southern regions, with some concentration in the Eastern region of the country (CIMA & UNDRR, 2019, p. 28). It is estimated that approximately 25,000 individuals are affected yearly by flooding, accounting for 0.10 per cent of the total Angolan population (CIMA & UNDRR, 2019, p. 28). It is predicted that the number of individuals impacted by floods may rise four times to 115,000 individuals yearly if socioeconomic development and the country's population are considered (CIMA & UNDRR, 2019, p. 28). 115,000 individuals correspond to 0.15% of the total population, resulting from the expected future risk pattern and the population growth associated with urbanisation (CIMA & UNDRR, 2019, p. 28).

As Angola is a country with predominantly young people, most of the affected population is less than 24 years old. In this way, children and elderly people are in the category of the most vulnerable and are subjected to the consequences of flooding, and women are the most affected (CIMA and UNDRR, 2019). Women from rural areas, for example, rely on agriculture and are more susceptible to encountering unexpected flood events (CIMA & UNDRR, 2019).

## **2.6 Flood impact**

Natural disasters including floods, droughts, and storms impact well-being, food systems, sustainability, infrastructure, safety, and way of life (Gornall et al., 2010). Flooding is associated with a short- and long-term impact on child growth through alterations in food intake and infectious disease burden (WHO, 2018).

Disasters are linked to the loss of many human traditions, including languages, cultural practices, beliefs, and traditional food systems (Atalan, 2018). The disaster's impact on culture mostly depends on the community's characteristics and its own resilience. However, disasters are associated with long-lasting damage to tangible and intangible cultural heritage (Brabec et al., 2019), resulting in the loss of customs, knowledge, and indigenous traditions. For instance, indigenous knowledge, which includes plants and animals that may be used in medicines, is considered an essential part of intangible cultural heritage. However, violent weather events result in the loss of medicinal plants, especially those living in rural areas, and some medicinal practitioners have similarly lost their lives, increasing the vulnerability of those utterly dependent on traditional medicines

as well as restricting financial access (Maroyi, 2013). Violent weather events such as flooding and hurricanes threaten numerous irreplaceable traditional monuments, figurines, historical sites, and infrastructure (Brookings, 2016). Not to mention the loss of customs and stories (Brookings, 2016). This happens because of the relocation of climate-induced disaster victims to safer areas and property damage. Significant cultural assets such as cemeteries, sacred places, and places of worship crucial and unique to the community are often left behind during this process, along with the required practices.

The flood impact can be classified into short-, medium-, and long-term impacts (Hammond et al., 2015). Short-term impacts are related to property destruction, threats to both human and animal life, and transport malfunctions that occur right after flooding; medium-term effects refer to contamination from flood water, disease outbreaks, and environmental pollution that is also noticed after a flood event. Long-term impact is linked to financial repercussions within and outside the areas negatively impacted by flood which tend to rise after an extended period of flood incidence (Hammond et al., 2015). The financial effect of flooding events is usually quantified in monetary values, which are both tangible and intangible; the intangible values are considered more complex to measure when compared to tangible values which are simple and less challenging to compute (Hammond et al., 2015; Pyatkova et al., 2019).

- **Direct and tangible:** Refers to all the physical destruction on the infrastructure with direct contact with water. These damages are normally measured in monetary values and include destruction to infrastructure, roads and property (Abdulla and Birgisson, 2021).
- **Direct and intangible:** Are associated with physical damage or disruption of activity resulting from direct exposure to flood waters and are challenging to estimate in monetary terms, entailing the decline of network reliability (Abdulla and Birgisson, 2021).

Floods impact approximately 1.65 billion people worldwide (Alfieri, 2024). It is estimated that on average more than 82 million individuals are impacted annually by floods (Alfieri, 2024). Although the economic effect of flooding in developing nations is generally more severe, the number of fatalities and displacements is considered high in these nations due to their increased susceptibility to risk as well as the limited capacity to deal with calamities (Christian Aid, 2022).

Although flood and drought have been considered the two main natural hazards affecting human well-being on the African continent (Lumbroso, Brown, & Ranger, 2016), flood overtook drought in the last ten years in terms of individuals impacted by this event (Masters, 2019). Multiple countries around the world are impacted by floods in all the different continents. For instance, the Greater Horn of Africa (GHA), the indirect impact of disasters including flood or drought are often neglected, this indirect impact is associated with greater disruption, when compared to direct impact of flooding or drought. The indirect effect often entails water-borne disease, failed crop season, malnutrition, livelihood impoverishment, which can lead to rise of early childhood death rates, insufficient food supply, mass migration, which contributes to ultimately increase of factors such as social inequality, political conflict, and civil unrest (Maystadt et al., 2015; FAO and WFP, 2021). It estimated that approximately 2 million individuals are impacted annually in the GHA region. Due to climate and socioeconomic changes, it is possible to predict that in the future, the number of individuals impacted by flood in 2050 will increase to 2.7 million and may force around 1.3 million individuals to relocate every year (ICPAC, 2023).

From 2018 to 2019, a cyclone season in the south-west Indian Ocean was responsible for unpredicted flood damage in Africa (Masters, 2019). The primary cause was cyclone Idai which affected two countries, Mozambique and Zimbabwe which took place in March 2019 as a tropical depression over Malawi, resulting in a widespread flooding, which affected approximately 1 million people. Around 602 individuals have lost their lives in Mozambique due to cyclone Idai, and 299 in Zimbabwe (Centre for Research on the Epidemiology of Disasters, 2019), causing \$1 billion damages to important infrastructures (Hillard, 2019).

## **2.6.1 Damage to critical infrastructure**

### *a. Impact on transport*

The transport system is crucial in order to facilitate the human daily routines and the societal quality of life (Pant et al., 2018). In this way, disasters, including flood events and snowfalls, may result in harmful effects on the normal performance of infrastructure and economic disruption within the societal system (Bíl et al., 2015; Dong et al., 2020; Wiśniewski et al., 2020). There is a high reliance on all forms of transport, entailing

roads, transit, and aviation, on infrastructure networking and are susceptible to intense weather events such as floods (He et al., 2020). During flood events, the safety of the infrastructure may be in jeopardy, leading to significant consequences (Esposito et al., 2018). Floods impact negatively the transport system as well as its connectivity by limiting, postponing, or halting passenger travel, services, and movement of goods as roads may be inundated, closed, or unsafe (Douglas et al., 2017; Diakakis et al., 2020; He et al., 2020). Floods have a direct and indirect impact on transport infrastructure (Pant et al., 2018; Serre and Heinzlef, 2018; Wang et al., 2020). The direct impact is associated with the physical destruction of infrastructure. On the other hand, indirect impacts refer to a chain of reactions resulted from negative impacts that can severely affect essential infrastructure, such as energy network, which typically leads to the disruption of a city's infrastructure as well as its economy (Pant et al., 2018; Serre and Heinzlef, 2018; Wang et al., 2020).

Transport networks and power grids, which are essential urban infrastructures, are often interlinked. In this way, failure in one system may result in the malfunctioning of related components (Saidi et al., 2018; Wang et al., 2019). Global warming is predicted to intensify violent flooding in the future, together with continuous growing populations, and urbanization (Pregolato et al., 2017a). For instance, numerous studies suggest that damages to African roads linked to changes in climate will be higher in comparison to other regions in the world when considering factors such as population and GDP (African Development Bank (AfDB), 2011). Most of the road damage and infrastructure associated with weather is caused by floods (Lumbroso, 2020). A recent research report on the roads network in Mozambique indicates that the most devastating impact of flooding events are on bridge components of road transport networks (Lumbroso, 2020). When cyclone Idai occurred, it was estimated that 29% of Mozambique's national road network were obliterated as well as 20 bridges (World Bank, 2019a). There is an undeniable vulnerability in the transport system due to floods. With the rise of urban expansion as well as flooding events, there will be a need to develop more disaster resistant and resilient existing and new infrastructure for future calamities. Resilience in the flood event context refers to the capacity of a network to endure the effect of flooding through physical measures such as reinforcement, reduction of the destruction in severe events, recovery of network functionality, and minimising future network uncertainties

(Hammond et al., 2015; Wang & Reed, 2017; Serre & Heinzlef, 2018; Zhang & Alipour, 2019).

***b. Impact on Healthcare Infrastructure***

Flood disaster is also linked to damage to healthcare infrastructure, resulting in the evacuation of entire tertiary care hospitals (Kaliamoorthy et al., 2016), printed document loss, including medical records, and challenges in accessing electronic medical records and laboratory information. Water supply problems might also impact other hospital services, involving the sterilisation process for surgical equipment (Shelton et al., 2017). Other departments, such as the emergency, may also experience a significant rise in visits after Hurricane Sandy in New York, with an increase in homelessness or inadequate shelter, particularly affecting vulnerable people such as the elderly (Doran et al., 2016).

***c. Health impact***

Floods can lead to a detrimental effect on human health. Drowning may be an important factor when it comes to flood fatalities, as it is regarded as the most common and immediate cause of fatality shortly after the occurrence of onset flooding (Du et al., 2010). In this way, the risk of fatalities rely on the speed of the flood, for example, flash flood is more lethal than other types of flooding, which typically start less quickly (NWS, 2016). In wealthy countries, men are disproportionately represented among those affected by flooding, which may potentially indicate a risk-taking behaviour. For instance, in 2016, flood-related deaths from passengers and vehicles accounted for 46% in the United States.

Other severe events caused by flooding are associated with orthopaedic injuries, lacerations, burns, and electrocution resulted from flammable, low-density liquid on the water surface (Du et al., 2010). Additionally, after the flood event, poisoning of carbon monoxide from unventilated generators or kitchen equipment is unexpectedly prevalent (Du et al., 2010).

Flood hazards also have a huge effect on chronic health conditions. This impact entails medication and lack of compliance resulted from the access and unavailability of health care services and manual labour, which is linked to clean-up and reconstruction (Ryan et al., 2016). The effect of the halt may vary based on root factors, it was reported a rise in

diseases that appears to be linked to cardiovascular and diabetes after a disaster occurrence (Ryan et al., 2015). Additionally, intensified exacerbation of heart diseases and the worsening hypertension control and myocardial infarctions, related to the rise risk of death, were noted following hurricane events linked to flooding (Mckinney, 2011). There was a rise in patients with chronic respiratory diseases after the occurrence of a natural disaster; this interruption is associated with maintenance therapy, power shortages, mainly among patients that completely rely on oxygen and nebulizer, and overcrowding (Robinson et al., 2011). For example, the control of glycaemic control in insulin users tends to deteriorate in a year as a consequence of flooding in British diabetes patient's examinations (Ng et al., 2011). Treatment interruption, lack of good nutrition, and change in activity may result in increased risk of exacerbation ketoacidosis and fatalities (Mckinney, 2011).

A more comprehensive study demonstrated that flooding is also associated with psychological issues such as post- Trauma Stress Disorder (PTSD), anxiety, sadness, anxiety, sleeplessness, nightmares, and thoughts of suicide (Alderman et al., 2012a; Bland et al., 1996; Leon, 2004; Paranjothy et al., 2011). A similar study suggests that 19 percent of post-flood PTSD victims were still developing the symptoms more than 10 years after the event. One of the long-lasting factors of PTSD was associated with the loss of loved ones during the flood disaster, body injury, limited social support, and adverse coping mechanisms (Dai et al., 2016). Moreover, although there are limitations in this study, an analysis in the United Kingdom revealed a rise in antidepressant prescriptions in a year after the occurrence of a disaster (Milojevic et al., 2017). Symptoms such as stress have been experienced by pregnant women who were negatively impacted by flood disasters (Hilmer et al., 2016). These symptoms are related to the lower birth weights as well as impaired social functioning in their children (Simcock et al., 2011). On the other hand, flooding may seriously impact households' well-being, resulting in non-monetary or intangible losses (Camont et al., 2015). The losses transcend financial aspects and include multiple losses such as loss of life, damage, and biodiversity loss, as well as to the ecosystems (Prettenthaler et al., 2015). Emotional impacts although mostly overlooked are important in influencing how individuals react to floods; the strain and disruption caused by property loss or migration may greatly impact human well-being (Lamond et al., 2015)

Other health issues related to floods are linked to infections. There is a risk of infection following vulnerability to floodwaters, and it often captures the public's significant attention, as it is a common reason for seeking healthcare right after a flood event. Trauma is considered the frequent harm caused to patients when trying to escape from flood water or clean up after a flood. Infections such as cellulitis have been at peak from 3 to 4 days after flooding and continue above the baseline for more than 3 weeks (Lin et al., 2013). Mold infection is common to be seen after exposure to flood disasters (Benedict et al., 2014), and its diagnosis may prove complex. After flood exposure, fungi are frequently growing from wounds, although the presence of these microorganisms represents a colonization rather than an infection (Patterson et al., 2016).

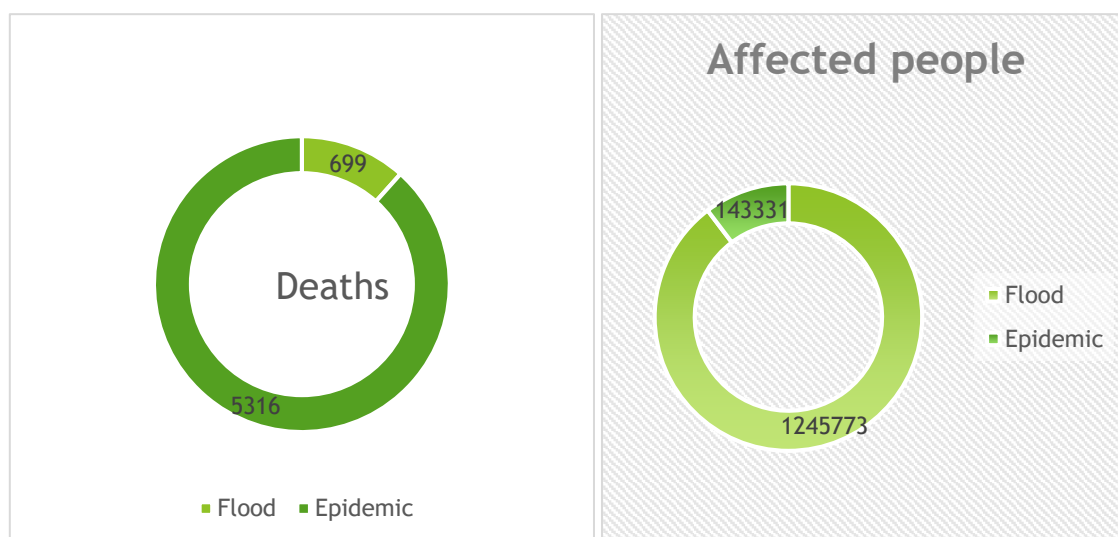
## 2.6.2 Flood Impacts in Angola

Angola is a country susceptible to disaster such as drought and flooding, which affects the country annually causing multiple damages (UNDRR 2020). The country is also impacted by fires, storms, storm surge and landslides, however, these events are considered less frequent (UNDRR 2020).

*Table 2- Summary of Disasters in Angola from 1985 to 2015 (UNDRR, 2020).*

Disasters	Year	Affected people	Total death
Flood	1989	100. 000	-
Epidemic	1989	-	766
Epidemic	1998	-	115
Epidemic	1999	-	147
Flood	2004	331 700	-
Epidemic	2004	-	329
Epidemic	2006	-	2354
Epidemic	2007	-	515
Flood	2008	81 400	

Epidemic	2008	-	229
Epidemic	2008	-	134
Flood	2009	220 000	
Flood	2010	110 886	
Flood	2011	-	113
Epidemic	2015	-	384



Graph1 – The Number of fatalities and population impacted by main disasters, from 1985 to 2017, (UNDRR 2020).

One of the Sendai objectives is to reduce the direct substantial economic loss until 2030 (Objective C). The estimated direct loss resulted from flood events in Angola corresponds to approximately 94 million dollars annually. This represents roughly 0,06% of the total economic value of the assets considered and 0.8% of the GDP in 2017 (CIMA and UNDRR, 2019). The agriculture and housing sectors are the most impacted by flooding, followed by transport and critical infrastructure. The annual average loss may vary per sector due to climate conditions. The number of health care centres and schools affected annually corresponds to 20 as well as 5 correspondingly (CIMA and UNDRR, 2019).

Additionally, 170 kilometres of roads are impacted on average every year. Most of the financial losses caused by floods in Angola are predicted to occur in the provinces of Uíge, Cuanza Norte, Benguela, and Cunene (CIMA and UNDRR, 2019).

When it comes to flood impact in the city of Sumbe, there has been a remarkable surge in the occurrence of rainfall since 2023, leading to significant repercussions for Sumbe and its residents (Angop, 2023). Prolonged and heavy precipitation has resulted in significant destruction to bean fields, impacting an estimated area of 55 thousand hectares and jeopardizing 70% of the crop. As a result, there has been a substantial increase in the cost of beans, worsening the problem of food insecurity (Angop, 2023). Moreover, several residential neighbourhoods have seen inundation, disrupting the daily activities of both public and private sector employees, as well as students (Angop, 2023).

The flood episodes in Sumbe have had significant consequences, resulting in the loss of vital infrastructure such as bridges and locally built dams, as well as aquaculture operations. Moreover, there have been reports of fatalities and property damage, as two people tragically lost their lives in 2023 as a result of persistent rains. Strong gusts, which occurred alongside heavy rain, have resulted in significant destruction to homes and businesses in nearby communities. Flooding has had a negative influence on both public and commercial organizations, highlighting the extensive consequences of these catastrophes (Angop, 2023).

Historical records document substantial flood incidents in Sumbe, with remarkable occurrences in recent years (Angop, 2021). In 2021, almost 100 people were obliged to abandon their houses due to the city's main river overflowing, flooding houses along the riverside as it flowed towards the sea (Angop, 2021). In 2023, heavy and continuous rainfalls caused fatalities and significant damage to structures, including residential buildings and infrastructure. This event emphasised the ongoing difficulties caused by floods in the area (Angop, 2021).



Figure 3: Impact of the rainfall on paediatric hospital in Sumbe

Source: Administração municipal do Sumbe



Figure 4: The effect of rain in an educational institute in Sumbe (Instituto politecnico do Sumbe).

Source: Administração municipal do Sumbe.

## 2.7 Capacity

It is widely acknowledged that a disaster takes place when a community or a system loses its capacity to respond effectively (Allahbakhshi et al., 2019; Öcal, 2020). In this way, to investigate the capacity of cities to manage urban flooding disasters, it is crucial to grasp the concept of capacity from multiple perspectives. The definition of capacity varies depending on the researchers, practitioners, and international agencies using it (Christoplos et al., 2014; Hagelsteen et al., 2014). Different authors provide multifaceted viewpoints on how capacity is perceived and applied, yet there is still confusion due to the lack of a universal definition for capacity and related terms which are used interchangeably on the literature such as ‘capacity building,’ and ‘capacity development’ (Christoplos et al., 2014; Hagelsteen et al., 2014).

To define capacity, there is a need to look at historical concepts in the literature. In order to understand capacity three distinct viewpoints such as political science, systematic and development practice perspectives (Garcia, 2011; Mann, 1993; Cohen, 1993). In political science scholarship, capacity is seen as a notorious attribute of the state, which reflects its ability to function adequately, exerting control not only over its population but also in its entire territory, making pivotal decisions such as collecting taxes and developing policies (Garcia, 2011; Mann, 1993; Cohen, 1993). This viewpoint associates capacity with administrative, professional, and technical capabilities (Cohen, 1993; Bebbington et al., 2006).

From a systematic viewpoint, capacity is perceived as an attribute of an entire system, which is able to be sustainable and create value over time (Alaerts & Kaspersma, 2009). This includes individual and collective abilities to utilize knowledge, find resources, and collaborate effectively (Zimmermann, 2004).

When it comes to development practices, capacity is defined as the ability to handle affairs in a strategic way (OECD, 2006). The International Strategy for Disaster Reduction (ISDR) presents a distinct concept of capacity. According to the ISDR, capacity involves all the existing available resources, capabilities, and strengths within an

organization, society, or community to manage and minimize disaster risk through the enhancement of resilience (UNDRR, 2024). This entails various institutions, infrastructures, knowledge, skills, together with the so-called collective attributes like social relationships, leadership and management. (UNDRR, 2024). The rise of the definition of capacities in the disaster risk reduction context was significantly influenced by the increased recognition that individuals from the most unprivileged places should be part of leading roles in development efforts due to their valuable knowledge as well as resources (Freire, 1970; Hall 1978; Chambers 1983). Gaillard et al. (2019) argue that the capacities of individuals in dealing with calamities and hazards were regarded as a key in order to encourage participation in disaster risk reduction (DRR). This idea recognises that individuals should be involved in DRR efforts (Gaillard et al., 2019).

Different authors' definitions of capacity share some similarities. They analyze capacity at three levels: macro, meso, and micro. The macro level refers to institutional capacity, the meso level relates to organizational capacity, and the micro level is related to individual capacity, which is included in the meso level (Isaza et al., 2015). The definition of capacity that will be used in this paper is from the UNDRR. This definition aligns with the objectives of the research, which will examine indicators such as institutions, infrastructure, skills, relationships, management and others. As capacity is associated with international development practice (Isaza et al., 2015). This link is fundamental and helps to understand different approaches and define measurable indicators (Isaza et al., 2015). Indicators are regarded as measurements that normally reflect characteristics of a system of interest (Tate, 2012). Indicators are important for several reasons, including enhancing stakeholder involvement, better informing decision-makers, establishing agreements, investigating underlying mechanisms, and engaging in advocacy (Parris and Kates, 2003). The literature describes a generalized manner of carrying out measurements, which will be applied to examine the indicators relevant to this research.

Capacity building and capabilities are frequently associated with capacity. These terms are interconnected and sometimes might be used interchangeably; however, they focus on distinct aspects of potential and performance (Christensen & Gazley, 2008, p. 266). While capability is associated with specific skills and competencies that enhance capacity (Christensen & Gazley, 2008; Alaerts & Kaspersma, 2009). Coping capacity building on the other hand, encompasses all efforts that heighten these competencies and skills

(Christensen & Gazley, 2008; Alaerts & Kaspersma, 2009), Coping capacity is characterized as the ability of individuals, companies, or systems to utilize all available resources and skills to address negative situations, hazards, risks and calamities. It requires continuous awareness, sufficient resources, and practical management skills. The capacity to cope often requires ongoing awareness, adequate resources and effective management, in absence of disaster and during disasters or other negative events. Additionally, it is considered that coping capacities directly contribute to mitigate disaster risks (UNDRR Terminology, 2024). Capacity involves both the backward- looking aspect of coping capacity which is based on past experiences and the forward-looking aspect of capacity building which typically entails the anticipation of future changes on the environment (Gaillard et al.2019). Additionally, the concept of capacity is often seen as pluralistic and has an independent definition from the individual capacities or the capability of an organisation, institution, nation or group of individuals to accomplish financial objectives (United Nations International Strategy for Disaster Reduction 2009; Few et al. 2015; Capacity for Disaster Reduction Initiative nd; Gaillard et al.2019).

To reduce disaster risk, capacity building is fundamental and is analyzed at three levels: individual, institutional, and systemic (Sinha, 2012). Social capacity in disaster management is considered essential due to its effectiveness in minimizing disaster risk, which is advantageous to human well-being. However, building social capacity alone is not proven sufficient to enhance the capacity of a central government in reducing disaster damages (Cvetković et al., 2021). To effectively respond to disasters, disaster management capacities need to be strengthened at all levels, including local government, provinces, districts, as well as towns. This practice ensures not only better national but also international coordination during disasters and efficient use of all the available resources (Cvetković et al., 2021).

On the other hand, individual capacity refers to a combination of cognitive, affective, health, psychological, as well as motivational aspects such as knowledge, competencies, ethics, attitudes, health effects, awareness, and motivations (Cvetković et al., 2021). It requires a space for active participation. On the other hand, terms such as capacity development, human resources, physical resources, and different networks, systems of punishment and reward, and performance describe organizational processes, including organizational culture and leadership (Cvetković et al., 2021).

Organizational capacity refers to an individual's contribution to an organization (Cvetković et al., 2021). In this context, the population is considered the core when handling disaster risk, and all the essential stages, including diagnostics to evaluation, are based on the community's interests and strengths (Cvetković et al., 2021). All activities conducted by all the stakeholders entailing the community and society need to be organized in order to raise awareness for disaster preparedness (Sinha, 2012)

Institutional capacity is regarded as the state's ability to implement decisions strategically, and this decision must be independent of who makes it (Elias, 2001, 1990; Tilly, 1985). In contrast, Garcia (2011) focuses on the state's ability to exert control of its territory and population. According to the UNDP (2010c), institutional capacity can be measured based on three main factors: adaptability, performance, and stability. These are further complemented by institutional arrangements, which can be increased by leadership, knowledge, and accountability. These factors typically develop specific items and allow the creation of Customized indicators. These indicators consider efficiency in performance, stability, and adaptability in the governance context (UNDP, 2010c).

### **2.7.1 The relationship between risk, vulnerability, and capacity.**

Worldwide, multiple efforts have been made in order to understand both vulnerability and capacity in order to prepare for climate variability and sustainable growth (IPCC 2014). The relationship between vulnerability and capacity is essential in order to develop strategies to mitigate disaster risk for hazard-prone societies (Cutter et al., 2008). Exposure and susceptibility are considered as vulnerability's adverse side, and capacity is regarded as the positive side (Birkmann, 2008). Vulnerability and capacity are interrelated, as capacity is considered one of the main elements in order to understand the vulnerability of a system when facing an external threat. It is regarded to have two dimensions, adaptive and coping capacities (Jamshed et al., 2019).

Previous work in the field has shown that capacities emerged from the vulnerability paradigm, which states that individuals are at risk of disaster due to the uneven distribution of factors such as power and resources in society and not primarily because of severe natural hazards; these aspects are responsible for people's vulnerability (O'Keefe et al. 1976; Hewitt 1983). When labelling some individuals as vulnerable, it may result in stigmatisation and being considered as helpless victims of an unequal

community as well as more powerful people. In the 1970s and 1980s, disaster risk reduction practitioners at the local level in places such as Latin America, South Asia, and Southeast Asia observed that people were regarded as proactive and creative when dealing with natural hazards (Gaillard et al., 2019). According to Anderson and Woodrow (1991, p. 47), regardless of how destitute some individuals might be, due to the amount of loss they incur during a disaster, they still possess some material capacities.

People's capacities tend to be completely distinct from their vulnerability, which is mainly influenced by external and structural factors that are considered beyond their reach, such as power dynamics as well as resource distribution in a community (Wisner et al., 2004). Several vulnerable individuals may have a vast array of knowledge, resources, and skills, while others equally vulnerable individuals may possess a limited capacity. Reciprocally, those individuals who are less vulnerable might have more or even fewer capacities (Gaillard et al., 2019). The distinction between both is considered pivotal in determining priorities for different disaster risk reduction (DRR) initiatives at different levels (Gaillard et al., 2019).

Capacity may encompass multiple forms of resources that, when combined, can provide individuals with unique strategies in order to manage hazards as well as disasters (Gaillard et al., 2019). These resources may include those naturally occurring in nature, such as wild fruits, animals, water springs, and hazard-resistant crops, which are considered essential for a food crisis or destruction of farmland. The vernacular architecture is combined with water irrigation, which protects against earthquakes and droughts. Additionally, factors such as formal education, indigenous medicine, and previous experiences with events that can be harmful may equip individuals with some sort of valuable knowledge about hazards, how they can potentially impact, and coping strategies (Gaillard et al., 2019).

Social networking, which is frequently associated with the social capital concept, is seen as the most extensively researched support system that is used by people when dealing with risks. Collecting, collaborating, offering, trading, lending and buying resources are facilitated by these resources (Gaillard et al., 2019). It may entail transnational connections like money transfers made by migrants to their families before, during, and after a disaster occurrence. Financial help may include microfinance initiatives such as

tontines, microcredit, and micro insurance (Gaillard et al., 2019). Lastly, conventional leadership and governance systems may offer the required versatility to mitigate the negative impact of disasters and promote decision-making in difficult physical and social environments (Gaillard et al., 2019).

Each form of resource requires particular knowledge and skills for people to access them in an effective way when facing hazards as well as disasters. For example, collecting wild fruit from forests needs extensive knowledge of the flora as well as physical strength and the ability to climb a coconut tree to harvest (Gaillard et al., 2018). Additionally, building houses made of earth or bamboo in order to withstand earthquakes and tropical cyclones demands engineering skills, which can be provided by formal education, including reading comprehension that is necessary to interact with Western scientific research (Gaillard et al., 2019).

Managing first aid necessitates appropriate knowledge and familiarity with local medicinal herbs (Gaillard et al., 2019). Moreover, donations are often sent or received by mobile transactions, which not all individuals might be familiar with. Additionally, different forms of knowledge, skills, and resources are often combined to address particular threats. For instance, unusual animal behaviour might set off an early warning system that combines both traditional methods, including gongs, and more contemporary tools like cell phones (Gaillard et al., 2019).

Individual capacity tends to vary depending on their scope, strength, and diversity. Many factors influence this variation, including age, gender, ethnicity, and physical ability (Gaillard et al., 2019). Although resources are often shared, knowledge and skills capacity are not evenly distributed in the same family community. For instance, local knowledge can be used as a power source, controlled by a small group of individuals, and withheld from others (Wisner et al., 2014). The power dynamic among individuals is responsible for shaping the ability to access and use collective capacities.

## 2.8 Urban flooding capacity indicators

Urban flood capacity can be assessed through six key essential indicators including infrastructure resilience, legal frameworks, early warning systems, disaster preparedness, disaster response, and recovery mechanisms.

Infrastructure resilience is regarded as the “*timely and efficient prevention, absorption, recovery, adaptation and transformation of national infrastructure’s essential structures and functions, which have been exposed to current and potential future hazards*” (UNDRR, 2022, p. 16). On the other hand, In the context of disaster management, “*legal framework usually includes statutes, executive acts or orders, and regulatory mechanisms that provide formal authority to programs and institutions responsible for addressing hazards, risks, and overall risk management*” (Mattingly, 2002, p. 20).

Early warning systems refer to a comprehensive framework that typically integrates hazard monitoring, forecasting, risk assessment, communication, and preparedness measures to enhance the capacity for informed decision-making and timely action in order to minimize disaster risks in advance of hazardous events (UNDRR, 2017). This systems are associated with four essential components: (1) an understanding of disaster risk, through data collection and risk assessment; (2) the detection, monitoring, analysis, and forecasting of hazards and their potential negative impacts; (3) the dissemination and communication of timely, accurate, and actionable alerts that is issued by authorized sources including information on the likelihood and potential impact of the hazard; and (4) preparedness at all levels in order to respond effectively to the warnings provided ( UNDRR, 2017).

The European Union Commission (2023) defines disaster preparedness as a coordinated anticipatory action taken by diverse stakeholders including governments, organisations, communities or individuals to enhance response capacity and recovery outcomes regardless of hazard origin, natural or anthropogenic. The objective of preparedness is to build the required capacities in order to manage in an efficient way across all hazard types, ensuring transitions in an orderly way from immediate response to sustained recovery (UNDRR, 2017). Additionally, Disaster preparedness is grounded in comprehensive risk analysis and robust integration with early warning systems, entailing contingency

planning, the stockpiling of equipment and supplies, the development of arrangements for coordination, evacuation and public information, and associated training and field exercises (UNDRR, 2017). These elements need to be supported by formal institutional, legal, and budgetary capacities (UNDRR, 2017).

Disaster response is defined as the measures taken immediately before, during, or directly after a disaster with the objective of preserving human life, mitigating health-related consequences as well as crucial survival needs of those affected (UNDRR, 2017). Disaster response targets immediate and short-term requirements and is usually referred to as disaster relief. The effectiveness of response normally depends on preparedness of efforts informed by disaster risk assessments, which involve building the response capacities of individuals, communities, institutions, national governments, and international actors. In contrast, Disaster recovery refers to a restoration and enhancement of the socioeconomic as well as environmental conditions of communities impacted by catastrophic events (UNDRR, 2017).

## **2.9 Financial resources at national level**

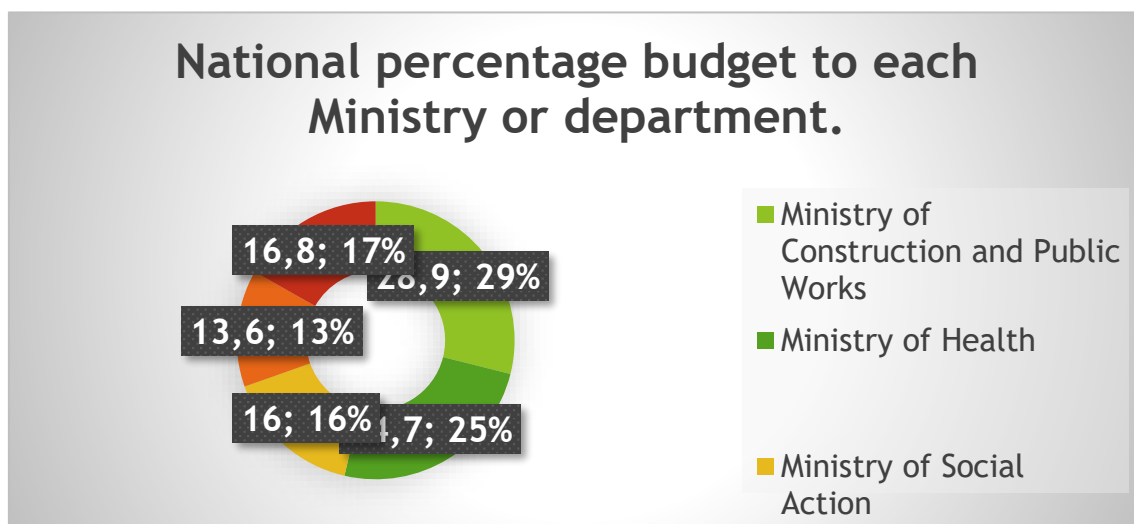
There has been a recognized lack of financial capacity on the part of the local administration to address flood disaster-related issues, due to the absence of a specific fund designated for their resolution. Currently, only mitigation of these issues is undertaken using financial resources sourced from alternative channels.

According to UNDRR (2020) disaster risk management (DRM), Angola faces several challenges due to the lack of clarity presented in documentation within national budget programs, which limits the effective integration of DRM and disaster risk reduction (DRR) into public expenditures. Despite this limitation, the country is committed to the field by investing in DRR activities across various government levels, including ministries, departments, agencies, and provincial governments (UNDRR, 2020).

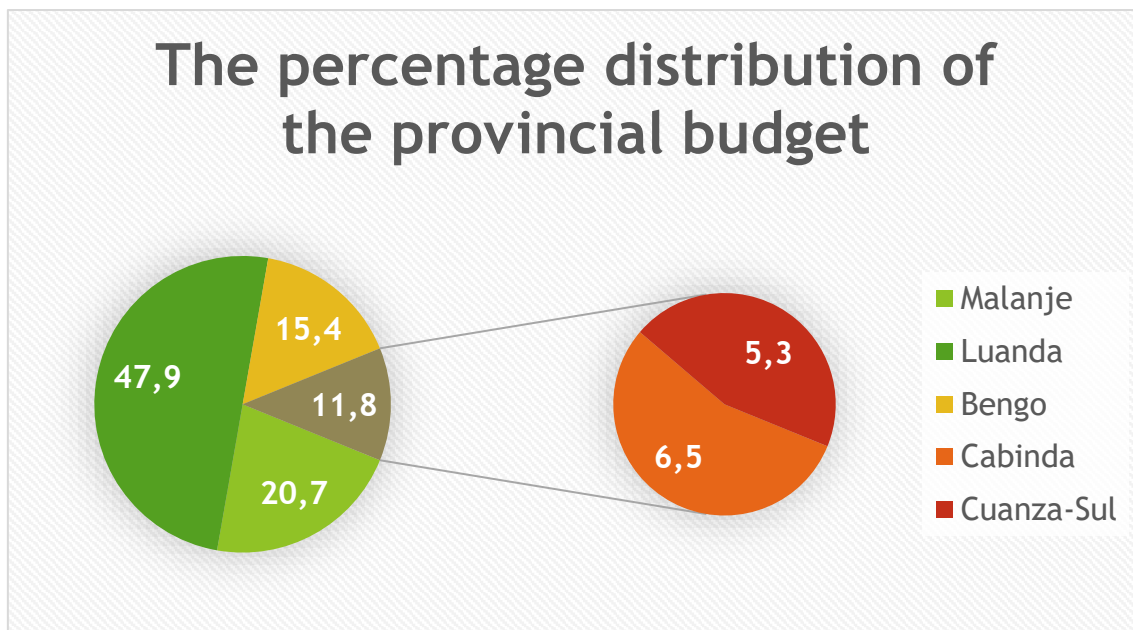
It has been reported by the UNDRR 2020 that approximately 2,421 DRR-related programs were identified and distributed among 22 government bodies and 18 provincial governments between 2017 and 2019. During this period, the total allocated for DRR

amounted to USD 3,397.6 million, averaging USD 1,133.5 million annually, equivalent to approximately 2.82% of the total national budget (UNDRR, 2020).

The budget distribution by sector and administrative level is considered equitable among various ministries and departments. At the national level, notable sectors include the Ministry of Construction and Public Works (28.9%), the Ministry of Health (24.7%), the Ministry of Social Action (16.0%), the Ministry of Agriculture and Forests (13.6%), and other ministries, departments, and agencies (16.8%). On the provincial level, budget distribution is more equitable among Provincial Governments (PGs), with Luanda, the capital city, receiving the largest share, approximately 47.9%, followed by Malanje, Bengo, and Cabinda (20.7%), other PGs (ranging from 15.4% to 6.5% each), and the remainder (50.3%) (UNDRR, 2020).



Graph 2- The pie chart illustrates the distribution of the national budget among various ministries or departments, highlighting the Ministry of Construction and Public Works as the primary recipient of investment in RRD, (UNDRR, 2022).



Graph 3— the image above illustrates the budget distribution at the provincial level, with Luanda receiving the highest allocation, approximately 47.5% (2017-2019), (UNDRR, 2020).

During the years 2017 to 2019, the province of Cuanza Sul had only one project designated as a flagship Disaster Risk Reduction (DRR) which started in 2019. In contrast, several projects considered significant were implemented over these years. In 2017, 22 significant projects were carried out, followed by 24 projects in 2018 and 12 projects in 2019. These numbers highlight a notable association with the 5.3% of the budget allocated to significant projects, especially considering the scarcity of flagship projects specifically for DRR (UNDRR, 2020).

## 2.9 Summary

This chapter outlines a comprehensive review of flood-related literature, entailing key concepts of flood types such as (riverine, flash, urban, coastal, and compound flooding). Flood hazards, and exposure risks. It also scrutinizes the impacts of flooding on critical infrastructure including transport networks, healthcare systems as well as public health outcomes. In Angola, most flood-affected individuals are under 24 years old. The children, the elderly, and women face disproportionate vulnerability. Rural women are particularly at risk due to their reliance on agriculture, which is highly susceptible to sudden flood events. The concept of capacity is also explored by Gaillard et al. (2019)'s

framework, which identifies diverse resources for disaster resilience including natural resources (wild foods, drought-resistant crops, and water springs that mitigate food insecurity during floods); built environment (vernacular architecture and irrigation systems adapted to hazards), (e.g., earthquakes, droughts); Knowledge systems, Formal education, indigenous medicine, and lived experience with disasters that inform coping strategies.

## **Chapter 3: Methodology**

This research adopts interpretivism as its philosophical approach in order to better understand Sumbe capacity in dealing with urban flooding disasters, aiming to avoid generalisation in its findings. A qualitative method through a case study in the city of Sumbe was utilised in order to achieve the research goals, where data collection methods involved interviews guideline that addressed the research questions to both local communities and local government in the city of Sumbe.

### **3.1 Research philosophy**

This study adopted interpretivism as a research philosophy, which, according to Creswell (2007), aims to deeper understand a phenomenon considering its own context rather than use generalizations of the findings across populations. Additionally, Hammersley (2013) emphasizes that when it comes to interpretivism, it is crucial to understand that people experience and understand the world in a completely distinct way, which may be shaped by multiple contexts as well as cultures. Taking into consideration the uniqueness of the city of Sumbe, this approach is relevant in the urban flooding study of the city in order to comprehend the different interpretations and experiences of the city stakeholders including residents and local administration, as the responses might vary significantly based on different backgrounds and contexts.

One of the advantages of this approach is that, as interpretivism explores diverse perceptions of how people look at a phenomenon, this approach does not only describe objects, humans, or events but also considers the deep complexity in understanding their social context (Tuli, 2010). However, there is a limitation to this approach due to a lack of verification related to the utility of the findings in scientific procedures (Cohen, Manion, & Marison, 2011).

Despite this limitation, the depth of qualitative information collected taking this approach into account provides a powerful insight related to the distinct realities faced by the stakeholders in the city of Sumbe, allowing a more comprehensive understanding of Sumbe's ability to manage urban flooding disasters. Moreover, emphasis on context-

specific experiences raises the potential for developing specific strategies crucial to address the unique challenges of urban flooding in Sumbe.

### **3.2 Research method**

A qualitative method through a case study was used in order to achieve the research aims. Qualitative research serves to respond to the how, why, and what questions of a studied phenomenon (Green and Thorogood 2014). This method commonly uses language as its data, whether verbally or written; it may also include photos, videos, and other sorts of recordings (Tamarinde et al., 2019). The justification of the chosen method lies in the limitation found in the existing literature regarding Sumbe's capacity to deal with urban flood disasters. Resources that address urban flooding as well as capacity at both local and national levels are scarce, mainly related to early warning systems, precise weather forecasts, and types of local floods. As a consequence, a qualitative approach enables the study to explore these gaps and specific challenges faced in the city.

Qualitative research aims to uncover the subject's point of view linked to the research question (Tamarinde et al., 2019). The data gathering is often made via interview, focus groups or observation (Tamarinde, et al., 2019). Additionally, the current body of literature to enrich the research was collected from multiple sources, including online journal articles, the University of Cape Town virtual library (Primo), Google Scholar, and books.

### **3.3 Data Collection Methods**

This research relied heavily on qualitative data in order to understand the capacity of cities to manage urban flooding disasters. Data collection refers to an interconnected process with the main objective of collecting information to respond to research questions (Cypress, 2018, p. 303). According to Cypress (2018), data collection can be done through a variety of relevant sources, combining both human and non-human sources. Human sources rely on interview techniques that can be made through open-ended, closed-ended, focus groups, one-on-one or web-based interactions, and observation including participants and non-participants, and nonverbal cues (Creswell, 2017). Non-human sources entail unobtrusive measures, documents, and record analysis, both private

and public, and audio-visual materials ranging from photographs to artefacts that are made by participants (Creswell, 2017).

High-quality research requires strict data collection. The two most frequent methods of data collection are interviewing and observation. Interviewing is considered one of the most used methodological tools in qualitative research (Cypress, 2018, p. 303). It is referred to as a conversation with a specific goal. The objective of the qualitative research is to gather data that is considered significant to the research. In this way, the researcher must immerse themselves in the world of the participants in order to allow them to share personal experiences and narratives, including real-time insights regarding people, events, organizations, feelings, motivations, worries, and other relevant entities (Creswell, 2018). One of the advantages of the interview is that it allows participants to delve into time by recalling the past, examining the present, and predicting the future (Creswell, 2018). These interviews can be structured, which are formal, focused, and standardized, or unstructured, including informal, more profound, specialized, or exploratory (Creswell, 2018).

Although unstructured interviews are regarded as more flexible when compared to structured interviews, this type of interview cannot be considered pointless. The focus of the interview will still be on the phenomenon of interest, research questions, and the study's overall purpose, which will allow the conversation to flow naturally based on the data as well as responses provided by the participants (Patton, 2015). One-on-one interviews can be made through many sources, including phone, text message, or online chat. On the other hand, focus groups can occur online, in settings such as chat rooms or bulletin boards (Creswell, 2018). According to Creswell and Poth (2018, p. 164), it is indispensable to create a comfortable environment to conduct the interviews, particularly in group settings, where it is pivotal to encourage all participants to interact in the conversation while managing those who may be in charge of the discussion. However, unstructured interviewing has its shortcomings, which entail poor performance and financial burden. It cannot be assessed or formalized, making it difficult for replication as the only instrument of the study is the researcher (Cypress, 2018, p. 304).

Observation is considered one of the oldest methods of data collection, and is also widely used by scientists as well as social scientists (Powell 1997). According to Kumar and

Sharma (2023), observation encompasses a systematic recording of observable phenomena or behaviour in a natural setting. Additionally, it may entail the collection of multiple data such as field notes, video, audio recordings maps, photographs, and organizational charts (Heigham and Croker 2009). During the data collection in Assaca and Kibaula, observation was also used in order to gather contextual and non-verbal information that might not be captured through interviews. Photographs were taken to complement these observations (see figure 7 to 17).

The city of Sumbe has been experiencing several negative impacts from floods, as mentioned in the literature review. For data collection, an unstructured interview and observation was conducted in Assaca and Centralidade da kibaúla, including the local administration of Sumbe. The field observation aimed to document physical evidence of the flood impacts in the city, and the selected neighbourhoods, as well as assess urban infrastructure conditions, vulnerabilities, and community response strategies. Observations were conducted through unstructured walks in both neighbourhoods. Elements observed include drainage systems, road networks, building structures and public amenities. Additionally, environmental factors (topography), community responses including temporary flood mitigation; presence and condition of municipal flood control infrastructure. Observations were conducted over three weeks during the period of May in 2024

Sixteen people were interviewed, which includes two members of the city administration. The 2 administration representatives were selected from different departments such as infrastructure, and environmental and sanitary. The community participants were recruited in both Assaca and kibaúla neighbourhoods with 7 residents selected equally in both areas. Assaca occupations vary from cupapata (motorcycle taxi), public workers, pastors, teachers, and students, While Kibaúla, Geologist, students, and economist.

Participants in Assaca needed at least 5 years of residency to capture long-term flood experiences, while those in Kibaúla required a minimum of 3 years. In this way, participants represented diverse demographic characteristics entailing age groups from 25 to 88 years and occupational backgrounds. A door-to-door engagement was used in flood risk zones in the Assaca community, and a written consent was obtained from all volunteers explaining the research objectives. The inclusion of the two administration

participants was pivotal for institutional perspective for comparative analysis. The fourteen voluntary participants, 7 in each neighbourhood) were sufficient, as the preliminary analysis indicated redundancy after the fifth interview. Additionally, this sample size allowed scrutiny of distinct floods. Additionally, the interview with the local administration examined how the administration increased its capacity to deal with flooding disasters. This part was more conversational in order to collect pivotal information and any other insights or observations that may not be covered in the guideline, such as the level of income, water management, gender disparities, and social vulnerability. The administration interview guideline focused on legal frameworks and laws, the administration's role in minimizing urban flood disasters, and the local government's capacity to address urban flooding. The interviews were conducted in the local language, Portuguese, and were transcribed and translated (see table 3 and 4 in annexes). However, these tables do not include the complete conversation guideline.

### **3.4 Data recording transcription**

Data recording commonly involves two dimensions, such as fidelity and structure. Fidelity refers to the researcher's capacity to reproduce in an accurate way the data that is collected in the field (Cypress, 2018). The highest fidelity may be achieved through both audio and video recording (Cypress, 2018). Raw data are typically collected from diverse qualitative research designs in an unstructured format such as tape, digital recordings, or transcripts of conversations (Cypress, 2018).

This research interview was audio-based and recorded to determine the accuracy of the information. The benefit of using audiotaping or videotaping lies in the possibility of subsequent examination by independent observers. Additionally, it is seen as a reliable source that provides opportunities to review the recording more than two times, allowing observation of nonverbal cues such as voice tone, emotional outbursts, and important pauses (Cypress, 2018). On the other hand, the disadvantage might be related to mechanical limitations such as battery discharge (Cypress, 2018, p. 306).

As the recording was made taking into account ethical considerations. As a fluent in both Portuguese and English, the transcription was personally made by me to avoid errors or limitations in the transcription of the interview extracts of software programs.

Additionally, the transcription involves verbatim quotes in order to preserve the 14 participants' original phrasing to ensure accuracy and integrity in qualitative analysis.

### **3.5 Data Analysis**

Qualitative data analysis has multiple meanings and is often associated with a specific methodology, research tradition, theoretical point of view, or field (Lochmiller & Lester, 2017). This research used a thematic analysis for data analysis, which has the objective of identifying trends across qualitative data sets (Braun et al., 2019, p. 844). Additionally, due to its flexibility, this data analysis is used in multiple fields such as medicine (Cassol et al., 2018), psychology, health services (Norris et al., 2017), tourism (Costa et al., 2016), and education (Halverson et al., 2014). After data collection, the data were categorised and divided into 6 themes, which included infrastructure, legal framework, early warning, disaster preparedness, disaster response, and disaster recovery.

### **3.6 Case study**

A case study can be defined as a factual analysis that scrutinizes a modern phenomenon (the case) in detail and within everyday context (Yin, 2014, p. 16). For example, these may help to comprehend the association between pathways that might arise from new policy initiatives or service development (Yin, 2009). According to Yin (2014), a case study includes logic design, data collection skills, and specialized methods for data evaluation.

In this case, investigating the capacity of Sumbe to manage urban flooding disasters with a specific focus on two neighbourhoods, Assaca and Centralidade da Kibaúla, falls under the collective case study category. What I expected to see when I chose these two neighbourhoods was to gain a broader understanding of urban flooding management in Sumbe, which is the phenomenon being studied, which may include comprehension and insights into capacity and effective disaster strategies in the Sumbe context.

### **3.7 Ethical considerations**

Ethical principles are regarded as pivotal in any research study, as it guarantees the protection of human subjects (Arifin, 2018). Ethical approval was granted to gather important data for this research, including two main approvals, one from the science

faculty ethics committee of the University of Cape Town (SCI/00554/2024) and the other from the local administration of Sumbe.

### **3.8 Informed consent and debriefing**

Informed consent is considered a fundamental research practice involving human participants (Girvan et al., 2012). Informed consent is considered one of the most essential research practices involving human participants (Girvan et al., 2012). Research in which human participants are included must be spontaneous and informed (Arifin, 2018). Additionally, volunteers must be granted the right to withdraw participation without causing any type of harm (Eaton, 2020).

The 16 participants in this study provided explicit consent including forms of data collection including audio recording of interviews and photography. For audio recordings, participants agreed to have their voices recorded during research interactions, and understand that the recording would be used solely for research purposes, transcribed as needed. For photographs few participants consented to have their images captured during research taking into account that these visuals might be used in research outputs with appropriate anonymization measures when required. Both consents included the right to withdraw permission and the assurance that all materials would be handled confidentially and probably destroyed. As language is considered a challenge in obtaining the consent, barriers might arise, as volunteers may not fully comprehend the study risks, benefits, and procedures if it is not in their native language (Agre et al., 2003; Ghandour et al., 2013; Israel, 2016). The consent was translated into the local language, Portuguese, to ensure full understanding of the participants.

### **3.9 Privacy, anonymity, and confidentiality**

The confidentiality, pseudonymity and privacy of all respondents in this research were preserved, and the names as well as the identity were not disclosed in the data gathering, evaluation, and reporting of the research findings.

### **3.10 Summary**

This chapter outlined the methods used to conclude the research, starting with research philosophy. In this study, the most appropriate research philosophy was interpretivism. Second, the research method was described, including key definitions of qualitative research, what it entails, the data collection method, the data analysis method, data recording transcription, and a case study.

## Chapter 4: Findings

Based on two case studies conducted in the city of Sumbe, pivotal data was gathered in order to address the research objectives. This involved identifying crucial urban flood capacity indicators, the analysis of the factors influencing Sumbe's capacity to effectively handle urban flooding disasters, the effectiveness of the current legal frameworks, regulations, and flood management strategies in mitigating flood impacts, and contrasting these aspects between the Assaca as well as Kibaúla neighbourhoods (see figure 5 and 6). Practical recommendations to improve Sumbe's ability to control floods were also proposed.

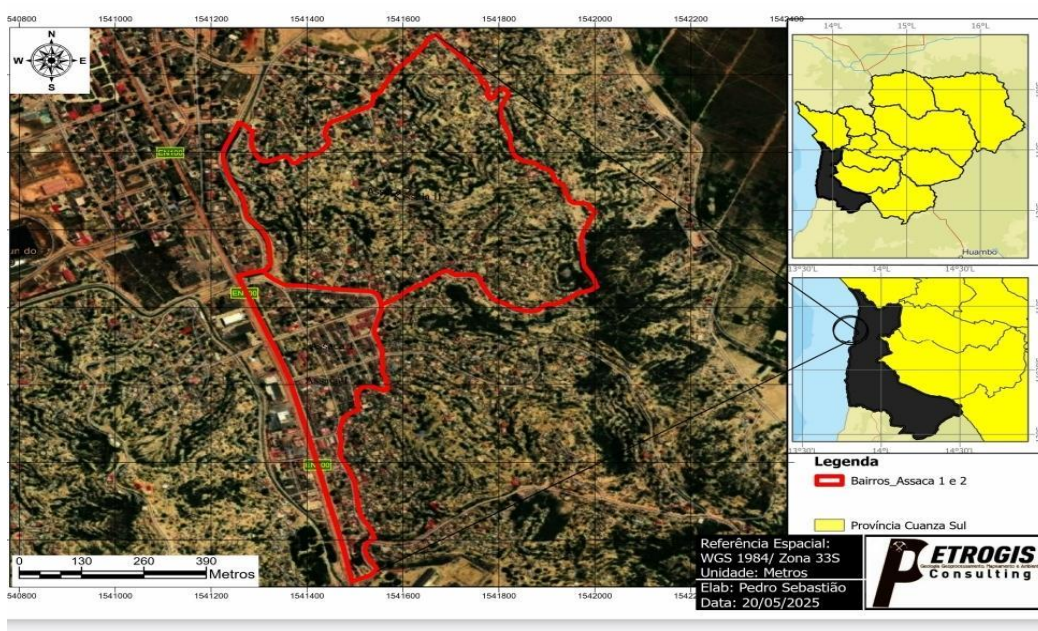


Figure 5: Assaca neighbourhood

Map credit: Pedro Sebastião, 2024.

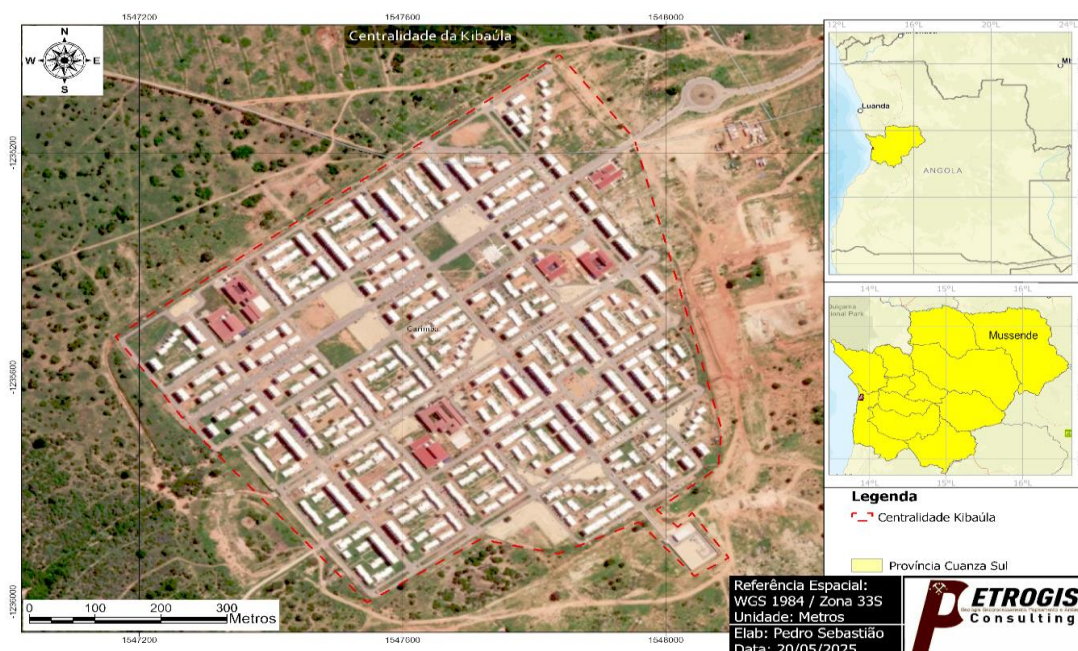


Figure 6: Kibaúla neighbourhood

Map credit: Pedro Sebastião, 2024.

## 4.1 Findings

The findings of the two case studies were organised in six thematic areas, including infrastructure resilience, legal framework, early warnings, disaster preparedness, disaster response, and recovery. The categorisation of the findings was based on interviews involving responses from local administration and community stakeholders. Case study 1 focused on the Assaca (figure 5) neighbourhood, while case study 2 examined the Kibaúla neighbourhood (figure 6) in the city of Sumbe.

## 4.2 Case Study 1: Assaca

### *Theme 1: Infrastructure Resilience*

It was observed that inadequate sanitation, poor solid waste management, inadequate use of soil, improper construction practices, and a lack of afforestation were part of the infrastructural complexities of the neighbourhood, directly contributing to urban flooding in Assaca. These challenges do not affect Assaca neighbourhood but also the entire city of Sumbe. These infrastructure deficiencies include unpaved streets (figure 7), electrical wire exposure (see figure 11), poorly maintained piped water, and poor construction

standards (figure 8 & 9) in high-risk areas without architect oversight. *“The entire city is undergoing a process of urban redevelopment. However there is a lack of well-constructed houses here and make us more susceptible to flooding” (participant 3).*



Figure 7: The drainage ditch in the Assaca neighbourhood floods during heavy rainfall. On the right is a representation of the many unpaved streets in the Assaca neighbourhood.

Photo credit: Ngoia de Lemos, 2024.



Figure 7: Drainage system in Assaca

Photo credit: Ngoia de Lemos, 2024.



Figure 9: Types of residences in Assaca and unpaved pavements/roads

Photo credit: Mario Bastos, 2024.

**a. *Subminimal building Material***

The housing materials in Assaca vary, from Barro (adobe or mud brick) to chapas (metal sheets) to cement bricks (figure 9). Chapas, resin, and plaster are commonly used as roofing materials (figure 7) by residents. However, these materials are considered unsafe during flood events due to their vulnerability to water and strong wind. For example, houses made of mud tend to absorb water and become moist and typically do not withstand the magnitude and duration of an extreme flood event. On the other hand, Chapa's houses can be blown by strong winds, which may put the lives of residents at risk. *"My house is made of cement blocks, and the roof is made of metal sheets. When there is severe rainfall, I usually lose some of my belongings and have to go to a safer place, which is normally an area with high elevation such as E-15(see figure 8), to stay safe. This house is not safe, and my income isn't enough to cover the damages or daily living expenses."*(Participant 4).



Figure 10: This image portrays Assaca neighbourhood and surrounding areas which are surrounded by natural elevations, from which water naturally flows downwards towards lower-lying regions and the variety of building materials used in the settlement.

Photo credit: Ngoia de Lemos, 2024.

***b. Electric wire exposure***

During the rainy season, it was discovered that electrical wires presented a substantial danger by immediately exposing residents to the risks connected with the improper connections of electrical cables located near homes (see figure 9). These irregular electrical connections pose a significant danger of electrocution, particularly during flooding or intense rainfall. It was possible to observe electrical cables cross through trees and connect to the homes. All the participants in Assaca reported that in the event of a flooded neighbourhood, a power outage occurs as a government precaution to prevent deaths caused by electric shock. *“I have lived in this neighbourhood for more than 40 years, and there are various cases of electrocution due to floods”* (Participant 1).



Figure 11: Unsafe electrical cables linked to a public utility pole, with stagnant water from the rainfall in front of a residence, posing a potential hazard to the residents.  
Photo credit: Ngoia de Lemos, 2024.

### *c. Inadequate waste management*

The Assaca community faces challenges with inadequate sanitation, which involves poor waste management practices. This problem goes beyond Assaca, as the city lacks a sanitary landfill which meets the engineering standards; as a consequence, the city has numerous open-air garbage dumps dispersed throughout its urban area. *“There are three controlled garbage dumps and three solid waste transfer points. Solid waste used to be deposited in containers, but these have been decommissioned due to a shortage of specialised or appropriated trucks”* (Local Administration 1).

Most interview participants are of the view that in the Assaca community, garbage collection services exist but are not consistently carried out (Participants 1-5, and 7). Additionally, there is poor infrastructure for proper waste disposal, leading to improper dumping, with garbage being left freely on the ground without appropriate containers for collection. This improper way of waste disposal increases the negative effect of flooding, resulting in blockage, contamination as well as health issues, making it difficult for the community to manage flooding events. The majority of the participants reported that garbage and kitchen wastewater are thrown onto the unpaved street (figure 7), just as garbage is often placed haphazardly on the ground, often without using plastic bags for containment and transport to the disposal point. Additionally, there are few environmental education programs conducted by the local administration to educate the population on proper waste disposal (Participants 2- 6).

Solid waste separation only occurs at transfer stations, managed by waste pickers who mainly rely on waste for their livelihood. Moreover, the lack of waste containers results in improper waste disposal by the population. *‘‘Later this year, a new waste disposal program will be launched, which includes specific schedules for deposit and collection’’* (Local Administration 1).



Figure 12 - The image depicts solid waste frequently disposed improperly on the ground, without appropriate containers for disposal

Photo credit: Ngoia de Lemos, 2024.

It was also observed during the site visits that there was an accumulation of waste garbage in an open-air deposit (figure 10), which was exacerbated by flood events. It was noticed a variety of materials, including sharp objects, organic and inorganic waste, and dead and live animals such as dogs and cats. When a flood occurs, these waste materials tend to be carried by water to the lower part of the neighbourhood close to many residences and spread through the neighbourhood, which creates a breeding group for disease-transmitting vectors like mosquitoes and rats. As a result, during and after the rainy seasons, diseases such as malaria, paludismo, and dengue are reported to increase due to poor sanitation conditions that are heightened by flooding, putting the health and well-being of the vulnerable populations in Assaca at risk, especially elderly people and children (Participant 1,2,3,4 and 5).

The table presents the constituents of solid waste observed in the Assaca neighbourhood. (Please note that the table was developed from observations conducted on 02-05-2024.) Some of the material can be seen in Image 10.

Table 5: Constitution of solid waste in Assaca

Constitution of Solid waste in Assaca				
	Potential Biological Hazards	Potential Physical Hazards		
	Vector-borne diseases	Sharp Objects	Bad odors	Inorganic material
<b>Liquid fraction</b>				
<b>Domestic Wastewater</b>	✓	✓		
<b>Rainwater</b>	✓	✓		
<b>Urine (human or animal)</b>			✓	
<b>Solid fraction</b>				
<b>Domestic organic waste</b>	✓	✓	✓	✓
<b>Domestic inorganic waste</b>	✓	✓		✓
<b>Garden waste</b>		✓		
<b>Manure/ leachate</b>	✓			
<b>Construction and demolition waste</b>		✓		✓

It was found that there was only one drainage ditch in Assaca, which was covered by vegetation and solid waste. During floods, this ditch cannot adequately drain surface water, resulting in flooding that endangers the lives of nearby residents. Additionally, this situation hinders the passage of vehicles, including access to other provinces like Benguela.

***d. Absence of open defecation***

In terms of open defecation, the community of Assaca and other surrounding neighbourhoods have overcome this issue. This challenge has been addressed by the National Strategy for Total Sanitation led by Communities and Schools in Angola from 2019 to 2030, with the aim to ensure the quality of life for citizens. Open defecation shows vulnerability and a lack of sanitation infrastructure, which leads to seeking higher ground or garbage dumps to defecate. These human waste products are swept away by rainwater, potentially contaminating the water and putting the lives of residents at risk of multiple diseases transmitted by ingesting contaminated water, such as cholera. Community latrines were noted in the neighbourhood surroundings to mitigate issues of open defecation.



Figure 13: Certificate of absence of open defecation

Photo credit :Ngoia de Lemos, 2024.

***e) Socio Economic Vulnerability***

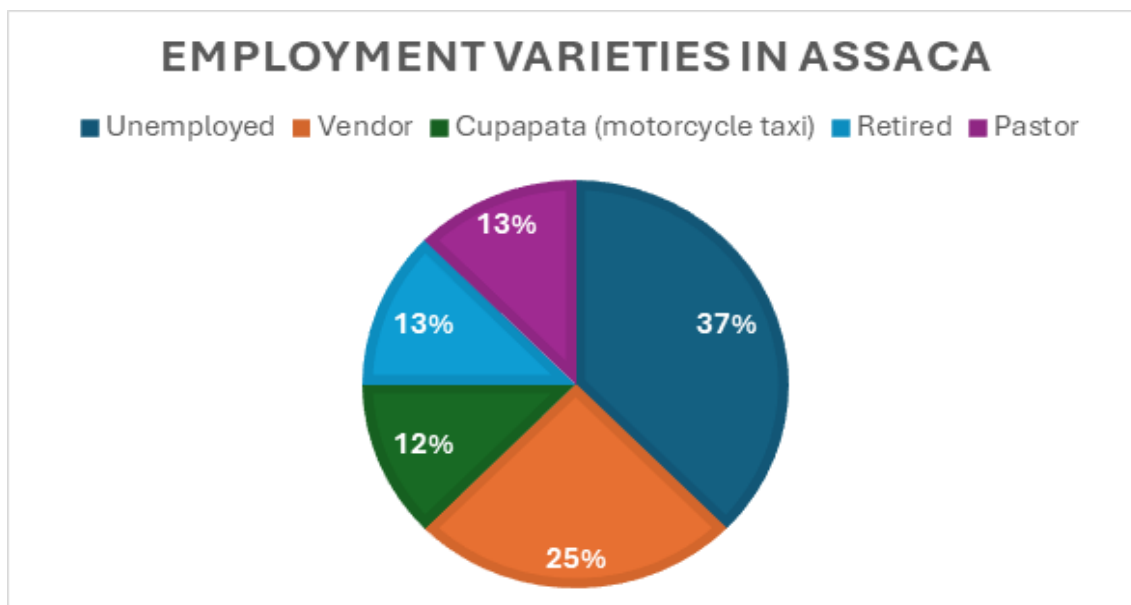
The Assaca community primarily rely on informal employment opportunities, which are insufficient to ensure secure financial stability, mainly due to the rising cost of living in the entire country. The majority of the participants reported that the average income of the residents ranges from 10 to 50 thousand Kwanzas (208 to 1043 rands) (Respondents 1-7). The respondents reported a high unemployment rate among young people.

Additionally, the community's demographics primarily consist of youth, young adults, and children, with a limited presence of elderly individuals. Among the prevalent occupations are vendors (figure 12), cupapata (Motorcycle taxi), public workers, pastors, teachers, and students. This leads to poverty, and the community may have limited resources to invest in disaster preparedness, response, and recovery. (See image 13 and graph 4).



Figure 14: Informal businesses conducted by residents of the neighbourhood, which is the sale of organic products as a means of subsistence

Photo credit: Ngoia de Lemos, 2024.



**Graph 4:** The above graph illustrates the occupational diversity among the interviewed people in Assaca.

## ***Theme 2: Legal Framework***

### *Community perspective*

Participants are unaware of any laws or policies related to urban flooding management. No educational programs have been implemented or even communicated to the residents of Assaca. As the local community is not involved in decision-making or has no sense of community, the community has become more individualist (Participants 2 and 3).

### *Government perspective*

The administration, along with groups such as the Juventude do Movimento Popular de Libertação de Angola (JMPLA) and some environmentalists, carried out campaigns to raise awareness among the population about the improper disposal of solid waste. However, no programs are related to flood disasters (Local Administration 1). Before the rainy season, the local administration prepares the city by, for example, cleaning all the drainage ditches and collecting solid waste (Local Administration 1).

There is no legislation or policies associated with urban flooding management. However, there will be documents and projects to manage urban flooding. This document will

address the municipality's real problems and propose measures to prevent and mitigate urban flooding (Local Administration 2). Although no local legislation or policies related to urban flooding exist, Angola has laws and policies directly and indirectly associated with flood management. Some fundamental laws and policies associated with flood management include:

- The National Plan for Preparedness, Contingency, Response, and Recovery in the Case of Calamities and Disasters, number 29/16. This presidential decree outlines the roles, key actions, responsibilities, and leading programmes to minimise the effects of disasters and calamities, including floods and droughts (Diário da República, 2016).
- National Water Law (Lei das Águas) - Lei nº 31/11 - This law is related to the water management in the entire country (Diário da República, 2011).
- Environmental law Lei n. ° 5/98) states that everyone has the right to a healthy environment and the benefit of rational use of the country's natural resources, implying the obligation to participate in their defence and sustainable use. This law has specific principles that entail training and environmental education, participation, promoting quality of life and sustainability (Diário da República, 2020).
- Presidential decree on solid waste management regulations (Decree No. 190/12). The proper disposal of solid waste refers to disposal in sealed and hygienic conditions. This disposal should be done in containers specifically designated for waste, which must be clean and always covered with a lid. If possible, waste should be placed in plastic or paper bags to prevent its dispersion in public spaces (Angolex. 2022).

Article 14 suggests that the local authority should adopt the collection and transportation system that is technically appropriate for each situation and for each type of material to be collected, provided that hygiene conditions are maintained, and public health and the environment are not put at risk (Article 14 of Presidential Decree No. 190/12; Angolex, 2022).

### ***Theme 3: Early Warnings***

#### *Community Perspective*

*I usually use the traditional method to predict heavy rainfall: I look out the window and check whether the clouds are very dark. Sometimes, it feels more reliable than the weather forecasts provided by communication channels like the radio or television (Participant 1).* Communication channels like radio and television are not always accurate, but they are somewhat reliable in transmitting information regarding floods (Participants 2-7).

#### *Government perspectives*

INAMET manages the early warning system. INAMET monitors climatic conditions and is responsible for disseminating information through television and radio channels locally and nationally.

### ***Theme 4: Disaster Preparedness***

#### *Community perspective*

In order to prepare for urban flooding, the community uses some measures to prevent water entry. This preparation includes covering those parts of the roof that have holes, placing sandbags at the door to prevent water from entering the residence, and placing stones to create a pathway. All the critical appliances are typically moved to the highest parts of the house to avoid damage during floods. Most of the interviewees mentioned that water commonly enters the entire house, causing the destruction of numerous appliances and other valuable items and posing a life-threatening risk (participants 1-7). “A neighbour lost her newborn due to the collapse of a wall that fell on her” (Participant 3). The electrical panel is turned off to prevent electrocution. Various incense sticks are lightened to prevent mosquito bites resulting from accumulated water, as well as cleaning the house and surroundings to avoid accumulation of solid waste that could later cause diseases (Participants 1).

During the rainy season, regular water shortages worsen the challenges faced by residents who do not have direct access to piped water in their houses. Alternatively, they

frequently depend on wells (chafariz) to obtain water, which they transfer using buckets, plastic basins or plastic jerry cans to the household for storage. Furthermore, families connected to the piped water network also experience interruptions during these time frames, which can endure for 3 to 4 days (Participants 1,2,3,4,5 and 7). As a result, inhabitants are compelled to store water in sizable containers such as tanks, buckets, or canisters, as shown in Figure 14, in order to alleviate the consequences of irregular supply. Additionally, financial constraints often prevent them from moving to safer locations (participants 5 and 6)



Figure 15: Water storage area due to water distribution failures, residents are compelled to store water in case of water cuts.

Photo Credit: Ngoia de Lemos, 2024.

### *Government perspective*

During the rainy season, some measures are made by the local government to mitigate urban flooding disasters, such as the cleaning of the entire drainage ditch in the Assaca neighbourhood, as well as the collection of solid waste left at the community waste drop-off point, in order to prevent blockages and ensure proper waste management. *“Turning off the neighbourhood’s electricity to prevent fatalities from electrocution during flooding”* (Local Administration 1)

### ***Theme 5: Disaster Response***

#### *Community Perspective*

*‘It is daunting to effectively respond to urban flooding, mainly due to lack of capacities such as financial, and human strength’* (Participant 5). The community alone cannot respond to flooding; the help of the local administration is needed to save some of the residents who live in more risky areas. *‘I live next to the drainage ditch and have no strength to fight against the water; last flooding, I needed the help of my grandchildren to put me in the highest part of my house; if I were alone, I would not survive as I can no longer walk’* (Participant 1). Nearly half of the interviewees (3 of 7) reported using mechanisms such as bailing water out of the residence with the help of buckets or basins and using rocks to make plank bridges in order to move around the neighbourhood as a response method (Participants 2,3 and 7). The fire department is responsible for responding to flood emergencies, but it often takes a long time to reach affected areas, typically around two hours or more. *‘By the time they arrived, we already resolved the emergencies independently’* (Participant 7). On the other hand, the lack of access roads makes it difficult for firefighter vehicles to reach and rescue the affected population (Participants 2 and 3). Additionally, the majority of the respondents reported that there are few vehicles, limited preparation and capacity, and a shortage of firefighters to meet the demands of the population (participants 1-7).

Displaced people are usually sent to tents for a temporary stay. However, not all displaced are sent to tents. Nearly half of the interviewees reported that they prefer to stay in families or neighbouring houses due to the poor conditions provided in these temporary shelters offered by the local administration (Participants 3, 7, and 2). Most of the respondents are not satisfied with the local administration as job opportunities increase vulnerability to flood risk, and little has been done to raise the resilience of the community due to inadequate flood management strategies (Participants 2,3,4,6 and 5).

#### *Government perspective*

Before and after flooding, cleaning of the ditch drainage and collection of waste is done in order to prevent more issues related to the impact of urban flooding. The fire department is typically responsible for handling emergencies. Yet, it faces significant challenges in accessing certain areas due to unplanned construction, which often places homes along riverbanks or on slopes. Additionally, the city is in a low-lying area, effectively making it a retention basin for floodwaters (Local Administration 1).

Unaffordable housing forces many residents to live in these high-risk areas (Local Administration 2).

There is an evacuation program in place for residents affected by floods, where they are temporarily sheltered in tents until better conditions can be provided. In other cases, for residents who are not in immediate danger of evacuation, the local administration offers measures to help mitigate the risks they face in these flood-prone areas (Local Administration 2). There are restricted resources such as human force work and vehicles to attend to the city's demand; normally, when flooding takes place, the Firefighters' Neighborhood is also facing the same problem, as well as the local administration infrastructure making it difficult to fulfil the obligations (Local Administration 2).

### ***Theme 6: Disaster Recovery***

#### *Community perspective*

It takes time to recover from urban flooding, typically one week or more (Participants 1-7). After flooding, the local administration usually comes and assesses all the damages caused by flooding, but nothing else is done to resolve this situation (Participants 4, 7 and 8). Normally, the local administration provides resources such as sheets (chapas) and stones (pedras) and a few donations, which serve as immediate responses yet are not sufficient to attend to the demands of displaced residents. These materials are not sufficient for the reconstruction or stabilisation of homes. Additionally, there is no monetary assistance to the community (Participants 2, 3, 5, and 6).

#### *Government perspective*

Risk areas are not officially registered in the city of Sumbe. Recovery from urban flooding is completely dependent on the neighbourhood's specific needs. The Flooding neighbourhoods in the city have been identified, and there are plans in place to respond to emergencies to safeguard human lives. There are designated areas for temporary settlement as well as for permanent settlement. The city of Sumbe is now going through the requalification of infrastructures, where people living in risk areas will be relocated to new projects. There are also plots for self-built housing in safer zones (Local Administration 2). *“One of the projects is the "Sabemos Andar", with 2083 plots and*

*another settlement in the antenna area, a higher zone with approximately 600 plots. The Atuku neighbourhood has 1,000 plots, and Pomba Nova is a new development plan still under construction. These new projects aim to accommodate the population in high-risk areas (Local administration 2)''.* There are limited economic capacities; no fund is reserved specifically to attend to flood-related issues, and the resources come from other sectors (Local Administration 2).

### **4.3 Case Study 2: Centralidade da kibaúla**

The Kibaúla Housing Development (Centralidade da Kibaúla) is a planned urban expansion project that is situated in Sumbe municipality in Angola. The neighbourhood contains approximately 2,010 housing units with three distinct typologies: apartment blocks (1,404 units), duplex dwellings (393 units), and single-family villas (213 units). Additionally, Kibaúla also has 156 commercial units designed to stimulate local economic activity.

Kibaúla's social infrastructure includes diverse amenities such as two primary schools, one secondary school, and two early childhood education centres. Healthcare services are provided through a dedicated medical centre. The neighbourhood has the capacity to accommodate 10,000 residents. Other facilities include a water treatment station that has a capacity of 350 cubic meters per hour, ensuring a stable water supply to the community. Kibaúla is also equipped with an electrical substation and an integrated drainage network for both storm water and wastewater which contributes to the environmental sustainability and operational efficiency of urban space (Jornal do Imobiliário, 2019).

#### ***Theme 1: Infrastructure resilience***

##### *Community perspective*

Unlike most neighbourhoods, the Centralidade da kibaúla does not face flooding issues (figure 14), as it is in a high-lying area and has sandy soil adhering to strict urban planning (Participants 1-7). Kibaúla possesses various infrastructures, as mentioned above, including schools, a system for treating and distributing potable water ( figure 20), a medical centre (figure 18 ), an electrical substation (figure 20) , drainage systems (see

figures 16, 17 and 19). Additionally, Kibaúla is a middle-income neighbourhood, with incomes ranging from 50,000 to 500,000 Kwanzas (1,043 to 10,438 rands).



Figure 16: Kibaúla neighbourhood

Photo credit: Mitrelli 2019.



Figure 17: Paved roads and buildings in Kibaúla

Photo credit: Mitrelli, 2019



Figure 18: Medical centre in Kibaúla

Photo credit: Mario Bastos, 2024



Figure 19: Types of houses and drainage system in Kibaúla

Photo Credit: Ngoia de Lemos, 2024



Figure 20: Power station

Photo credit: Mitrelli, 2019.



Figure 21: Water treatment plant

Photo credit: Mitrelli, 2019.

## ***Theme 2: Legal Framework***

### *Community perspective*

When it comes to the legal framework in Kibaúla, despite of high levels of education and diverse professional backgrounds of the residents including lecturers, nurses, police officers, local government staff, provincial government officials, economists, geologists, students, and psychologists, there is limited information available regarding laws, regulations, or policies issued by the local government. *“I am aware of other laws such as sanitation but not any related to urban flooding disasters”* (participant 1). Similarly, the other six participants from Kibaúla (Participants 2 -7) also reported a lack of awareness about any existing laws, policies, or regulations related to urban flooding disasters. *“There is no law or regulation regarding urban flooding disasters at the national or municipal level, if there is one, I am not aware of it”*(participant 2).

## ***Theme 3: Early Warnings***

### *Community perspective*

The community receives communication regarding weather forecasts mainly through television and radio. However, forecast predictions are not always reliable; sometimes, they give accurate weather forecasts. Some participants know about heavy rainfall through Facebook, television, and radio (Participants 1-6). On the other hand, others are informed verbally by neighbours (participant 2), and through phone weather forecasts (participant 7).

## ***Theme 4: Disaster Preparedness***

### *Community perspective*

Unlike other neighbourhoods in Sumbe, Centralidade da Kibaúla stands out for its adequate preparation to handle flood disasters. While the neighbourhood does not experience flooding. The majority of participants reported that health problems usually arise due to severe rainfall, such as paludismo and malaria caused by mosquitoes during

rainy seasons. According to Participant 7, Preparedness measures primarily include ensuring that all doors and windows are closed adequately to prevent mosquito entry into the residence (Participant 7). Fatalities or property damage are non-existent as the surface water drains perfectly through the drainage ditches, which has no problem and can support medium to heavy rainfall. Although the community of Kibaúla do not face urban flooding-related issues, the respondents are not completely satisfied with the local administration support (1-6). *There are few environmental campaigns such as waste collection and disposal within the community, however, nothing more than this* (participant 1).

### ***Theme 5: Disaster Response***

#### *Community perspective*

Despite not experiencing floods, most interviewees express being entirely unprepared to address issues linked to floods due to the absence of mitigation plans or programs in the community (Participants 1-5). *“This neighbourhood is completely different from all the others in the city, in terms of infrastructure as well as in how people deal with flooding issues.”*(Participant 4). The impact of floods has been expressed to cause secondary and cascading issues, incidents in particular. This is highlighted by participant 3 as follows : *“During extreme flood event challenges occur on our way to the city centre, as there are potholes on the roads that can even cause accidents, especially in the area around Morro do Chingo, the patholes normally are covered with sand to avoid accidents”* ( Participant 3).

Regardless of these challenges, participants (1 and 2) expressed that life must go on hence they must be immediately ready to perform their daily activities after a flood event. However, according to Participant 7, the maximum it can take for the land to be dried entirely is 2 days. Others claim it takes 3 days to a week (Participants 3-7). *“I live and work here, and when it rains heavily, I don’t experience major difficulties because the school where I teach is nearby and it never floods. So, I can say that recovery from these events is quite quick here unlike in other neighbourhoods, where the situation is different due to the lack of an efficient drainage system.”*(Participant 1).

## 4.4 Summary

Chapter Four highlights one of the most crucial aspects of the research: the results. In this chapter, it was possible to understand the differences between Kibaúla and Assaca. Assaca faces more severe flooding issues than Kibaúla, with the problem exacerbated by inadequate infrastructure, which is crucial for disaster preparedness, response, and recovery. Both neighbourhoods are subject to the same legal framework, as only one local municipality is responsible for all urban flooding management and related issues. However, residents in both neighbourhoods are unfamiliar with any laws or policies concerning urban flooding management.

In terms of early warning systems, the communication channels used to receive weather forecasts are similar in both areas, with only a few differences. Preparedness, response, and recovery efforts in the two neighbourhoods vary significantly due to differences in infrastructure, social vulnerability, professional expertise, education levels, financial resources, and overall capacity to manage flood disasters.

## Chapter 5: Discussion

This chapter explores the factors influencing Sumbe's capacity to effectively manage urban flooding disasters, drawing comparisons between the Assaca neighbourhood and Centralidade da Kibaúla. It also covers the role of existing legal frameworks and regulations and proposes practical recommendations to enhance Sumbe's resilience to flood-related disasters.

Indicators usually play a crucial role in evaluating the danger of floods and the ability to control them. They encompass socio-economic aspects, physical environmental characteristics, and regulatory frameworks. The contrast between Kibaúla and the Assaca neighbourhood highlights significant disparities in their vulnerability to urban flood disasters. This contrast can be attributed to multiple factors such as geographical location, soil composition, infrastructure type, drainage systems, urban planning, waste management practices, and community education levels.

When it comes to vulnerability, the residents of the Assaca neighbourhood face multiple socio-vulnerability challenges related to the reliability of the informal sector, which does not provide a satisfactory and stable income, ranging from 10,000 to 50,000 Kwanzas (208 to 1043 rands). The combination of low income and unemployment, mainly among the youth, limits the capacity of the people residing in Assaca to effectively cope with urban flooding disasters, as these financial limitations impede the residents from investing in more resilient houses and other infrastructures to prepare for disasters. These findings align with Douglas et al. (2008) and Abam et al. (2000) study on "Unjust Waters: Climate, flooding, and urban poor in Africa." This article highlights how low-income communities are prone to living in floodplain zones in urban environments due to affordable residences or essential services, which make them vulnerable to extreme weather. Assaca is in a low-lying zone of Sumbe, with clay, which makes the natural drainage of rainwater difficult, making the residents exposed and more vulnerable to flooding hazard. Additionally, Assaca's infrastructure is poorly developed, with unpaved roads, irregular electrical wiring, and insufficient waste management systems. During the rainy season, the waste is often carried by water blocking the drainage channels, which usually increases flooding. Economic capacities are the financial resources available to cope with the hazard (Działek et al., 2013).

On the other hand, Kibaúla is a middle-income neighbourhood, with incomes ranging from 50,000 to 500,000 Kwanzas (1,043 to 10,438 rands). The residences are well-built, allowing the community to better prepare for disasters. Due to its geographical location, the region benefits from sandy soil that naturally drains rainwater, reducing flood risks.

The local administration has implemented strategies to address the city's infrastructural problems, including requalification of urban areas and relocation programs to safer zones. These projects include the "Sabemos Andar" housing scheme and other relocation plans, with the objective of moving people residing in risk areas of the city to a better place and increasing the quality of life.

Both the local administration as well as the communities of Assaca and Kibaúla lack a comprehensive flood management law at the local level (see table 6). The absence of laws and suitable policies or regulations on urban flooding management from both communities can be considered a critical challenge in addressing urban flooding. Although there is an existence of national laws such as the National Plan for Preparedness, Contingency, Response, and Recovery in the Case of Calamities and Disasters, as mentioned above in the findings chapter theme 2. These policies are not properly implemented in the city by the local government, and the flooding risk can be seen as acute. Moreover, despite the existence of other laws, including environmental law (5/98) and solid waste management regulations (Decree No. 190/12), (Article 14 of Presidential Decree No. 190/12), and National Water Law (Law No. 6/02), there is little evidence of the enforcement of these laws in the Assaca community. The local administration is developing a local document and plans to address urban flooding at the local level, but these efforts are still in early stages.

Despite different levels of education, income, and professional expertise, both communities are not familiar with the laws directly or indirectly associated with urban flooding management or waste management, as the communities reported to be excluded from the decision-making process that directly affects the way of living.

According to the Local Administration, the INAMET is responsible for weather forecasts at the national level, and the information provided about the weather forecasts is reliable. In contrast, residents do not always rely on INAMET; they use other methods such as traditional methods by observing dark clouds and wind, which are more precise than TV

and radio. Other residents find TV, radio, Facebook, and neighbours' information more accurate.

The capacity to prepare for urban flooding disasters may be fundamental, but it does not prevent flooding, as the neighbourhood of Assaca is constantly inundated during the rainy season. Disaster preparedness in Assaca mainly consists of the use of informal mechanisms, with reliance on personal measures such as sandbags, moving valuable items to higher ground, and preparation of buckets and basins for bailing water. On the other hand, Kibaúla does not flood, and the preparedness includes ensuring that all windows and doors are properly closed to prevent diseases such as malaria, paludismo, and dengue, as health issues related to floods have been reported.

Government measures are limited to the cleaning of drainage ditches of the entire city and waste collection, which is considered insufficient to mitigate the flood risk in the long term. The community of Assaca, as the only one facing flooding in comparison to Kibaúla, usually resolves flooding problems on their own through the usage of personal methods, including bailing water with the help of a basin or buckets, moving essential appliances and other belongings to the highest part of the residence to avoid damages, sticking to secure the roof, and creating a rock pathway. Despite the existence of firefighters and other emergency services, the response often takes two or more hours, obliging the community to sort flooding independently, as there are also limited firefighters and vehicles to supply the community demand.

The primary response of the government focused on damage assessment in order to provide assistance for those in emergencies and provide some resources, such as donations and building materials, including rocks and sheets. This effort provided by the local administration does not meet the community's needs for rebuilding homes. Additionally, the government recognises the lack of funds for flood response and recovery as the resources usually come from other sectors, which delays the assistance to the communities. This response contradicts the findings in the financial resources at the national level on page 53, which states that 5.3% of the national disaster risk management reduction (DRR) budget is allocated for disaster risk reduction at the provincial level.

There is a gap in how the government and community perceive and respond to flooding risks. While the government's relocation plans and infrastructural requalification programs are a long-term process, the community of Assaca feels abandoned and not

satisfied with these measures, as they are not enough or are delaying addressing the immediate risks that they face.

Waste management contributes massively to urban flooding in Assaca. The lack of containers to properly dispose of the waste led the residents to improper ways of waste disposal. Garbage is disposed of incorrectly on the unpaved floor, which is transported by the rain to the drainage ditch during the rainy season, blocking it and increasing the flooding risk. Additionally, waste materials, including hazardous items, dead animals, and organic matter, are carried by floodwaters, increasing health risks and creating breeding grounds for disease-transmitting vectors such as mosquitoes and rats. This poor waste management infrastructure is compounded by the limited coverage of solid waste collection services, which are often inconsistent and insufficient to meet the community's needs.

The waste management challenge in Assaca resonates with the study of Krystosik et al. (2020). According to this article, households in informal settlements in low-income neighbourhoods frequently engage in incorrect waste disposal practices, hence subjecting communities to potential health hazards (Krystosik et al., 2020). Additionally, Rasmeni et al. (2019) and Pulling (2004) study on waste disposal practices in low-income settlements of South Africa shows that waste collection services in economically disadvantaged neighbourhoods such as Assaca have different frequencies, even though government regulations require weekly pickups. The discrepancy is worsened by the limited resources of municipalities, difficulties in operational capability, and challenges faced by suppliers (Statistics et al., 2021). In the Assaca neighbourhood, it was observed that waste is not collected or even disposed of in adequate manners; as mentioned above, it is disposed of in an improper manner on the floor that puts the health of residents at risk (see Figure 11).

There is acknowledgement from the local government regarding the shortage of specialised trucks as well as containers for proper waste disposal. This shortage forces the community to deposit the waste in improper manners. The community reported limited knowledge of waste management regulations or laws but observed that there is the existence of waste management and waste collection national law, which is mentioned above.

The research finding also resonates with the study of Gaillard (2019) about capacities; according to the author, individuals in both affluent and poor regions of the world have different capacities to cope with hazards and calamities; this statement was observed in the city of Sumbe as kibaúla and Assaca have a distinct way of dealing with urban flooding. Additionally, Wisner (2016) states that people facing disasters typically struggle to use their capacities due to diverse structural obstacles and temporary challenges. This obstacle includes government ideologies, political decision-making, physical limitations, technological failures, and environmental constraints (Anderson & Woodrow, 1989; Davis et al., 2004; Wisner et al., 2012). For example, some participants were hesitant to voice their opinions, fearing potential repercussions, while others spoke freely without concern. More freedom of expression in both neighbourhoods especially in Assaca could be pivotal for gathering accurate information in order to foster a collective approach to disaster management planning. The lack of participation in decision-making can limit the community's ability to voice its main concern and collaborate effectively with the local administration to respond and prepare for urban flooding.

Structural barriers entailing political or physical constraints were responsible for the limited capacity of the Assaca community to act effectively. As mentioned above, individuals such as Participant 1 were unable to escape from flooding due to physical limitations, as the participant could no longer walk.

Table 6: Summary of finding and discussion (below)

Theme	Case Study 1	Case study 2	Local Administration	Discussion of findings and recommendations
<b>Infrastructure</b>	<ul style="list-style-type: none"> <li>Inadequate infrastructure, houses made of mud, cement bricks and roof made of sheet, unpaved streets and exposed electrical cables.</li> <li>Inadequate sanitation.</li> <li>Improper disposal of waste garbage.</li> </ul>	<ul style="list-style-type: none"> <li>Adequate infrastructure, houses are made of plaster and flood resistant.</li> </ul>	<ul style="list-style-type: none"> <li>The city is now going to requalification of the infrastructures, where people living in risk areas will be relocated to new projects.</li> </ul>	<ul style="list-style-type: none"> <li>Kibaúla meets urban standards with proper services, while Assaca lacks basic infrastructure and has unsafe construction.</li> <li>Improve Assaca with flood-resistant buildings, paved roads, and proper sanitation.</li> </ul>
Legal framework	<ul style="list-style-type: none"> <li>Not aware of any laws, regulations or programs.</li> <li>Lack of participation in decision-making.</li> </ul>	<ul style="list-style-type: none"> <li>Not aware of any laws, regulations or programs.</li> <li>Lack of participation in decision-making.</li> </ul>	<ul style="list-style-type: none"> <li>Limited laws and regulations for addressing urban flood disasters.</li> </ul>	<ul style="list-style-type: none"> <li>There is a contradiction between local authorities, who mention existing laws and programs, and the communities, which lacks awareness of them.</li> <li>To address this, establish clear laws and programs related to urban flooding, and implement awareness campaigns and community meetings to improve understanding and engagement.</li> </ul>
Early warnings	<ul style="list-style-type: none"> <li>Radio</li> <li>Verbally</li> <li>Television</li> <li>Tradition Knowledge</li> </ul>	<ul style="list-style-type: none"> <li>Radio</li> <li>Television</li> </ul>	<ul style="list-style-type: none"> <li>INAMET through radio and television.</li> </ul>	<ul style="list-style-type: none"> <li>Both case studies and local authorities rely on radio and television for early flood warnings, showing consistency in communication methods. To enhance effectiveness, diversify early warning channels by including SMS, mobile apps, and social media, and strengthen INAMET's role in localized weather and flood forecasting.</li> </ul>
Disaster preparedness	<ul style="list-style-type: none"> <li>Buckets to cover holes in roofs to prevent water drops into residences</li> </ul>	<ul style="list-style-type: none"> <li>Properly close doors and windows to prevent mosquitoes.</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance of Drainage Channels</li> <li>Solid Waste Management</li> <li>Power outage</li> </ul>	<ul style="list-style-type: none"> <li>Members of the community focus on immediate, individual flood responses, while the local government handles broader infrastructure and services. To</li> </ul>

	<ul style="list-style-type: none"> <li>• Sticks to reinforce roofs weakened by rainfall.</li> <li>• Storing water in containers due to water cuts</li> <li>• Placing sandbags in front of doors.</li> <li>• Constructing houses with pillars</li> <li>• Lack of preparedness programme.</li> </ul>	<p>bridge this gap, develop a formal disaster preparedness program that includes community training and public education, alongside the construction of resilient infrastructure.</p>
<p>Disaster response</p>	<ul style="list-style-type: none"> <li>• Buckets to cover holes in roofs to prevent water drops into residences</li> <li>• Sticks to reinforce roofs weakened by rainfall.</li> <li>• Storing water in containers due to water cuts</li> <li>• Placing sandbags in front of doors.</li> <li>• Constructing houses with pillars</li> <li>• Lack of preparedness programme.</li> <li>• Properly close doors and windows to prevent mosquitoes.</li> <li>• Maintenance of Drainage Channels</li> <li>• Solid Waste Management</li> <li>• Power outage.</li> </ul>	<ul style="list-style-type: none"> <li>• There is a mismatch between the local administration relocation efforts and community preferences. Displaced residents often avoid government-provided tents due to poor conditions, preferring nearby informal shelters. Additionally, both communities consider the overall support from local authorities inadequate.</li> <li>• To improve response, a comprehensive disaster program should be developed including evacuation, adequate shelter provision, public education on flood response, and improved firefighter training, equipment, and capacity for managing large-scale emergencies.</li> </ul>

## Disaster recovery

- Relocation to acquaintances and relatives
- Usage of basin and basket to drain water from roofs
- Mosquito nets
- Burning egg cartons for mosquito control
- Support sticks on roofs
- Bailing water out of the house with buckets
- Turning off circuit breakers and appliances
- Lack of response programme or education.
- Properly close doors and windows to prevent mosquito.
- Power outage
- Evacuation and Shelter for Displaced People
- Firefighter team
- There is a mismatch between the local administration relocation efforts and community preferences. Displaced residents often avoid government-provided tents due to poor conditions, preferring nearby informal shelters. Additionally, both communities consider the overall support from local authorities inadequate.
- To improve response, a comprehensive disaster program should be developed including evacuation, adequate shelter provision, public education on flood response, and improved firefighter training, equipment, and capacity for managing large-scale emergencies.

## Summary

This chapter discussed the main findings of the research, including infrastructure, early warnings, legal framework, disaster preparedness, response and recovery. Additionally, chapter five also addressed the disparities in government and both neighbourhood perspectives. The analysis of the communities and local administration perspective on urban flooding highlighted a few controversies between both groups. While the government has made continuous attempts to solve issues associated with infrastructure deficiencies, waste management, disaster preparedness, response and recovery, these measures are often long or insufficient to deal with the emergency needs of the communities. The Assaca community, on the other hand, remains susceptible due to lack of adequate infrastructure, limited law or regulation, education awareness, and the lack of effective disaster management programs.

## Practical Recommendations

To improve Sumbe's capacity to handle flood-related disasters effectively, there are several recommendations based on the two case studies as well as the literature review:

- Relocation of all the people living in prone risk zones to a safer area in order to prevent fatalities.
- Invest in drainage systems such as road maintenance and waste management, which will follow the population growth.
- Conduct effective awareness campaigns and environmental education programs to inform residents about flood risks, legal frameworks, and sustainable urban development practices.
- Allocation of financial resources for disaster risk mitigation
- In order to develop Capacity Building, provide training and resources to local government officials and community leaders to enhance their capacity for disaster preparedness, response, and recovery.

## **Recommendation for future research**

For future research on urban flooding disaster in Sumbe or similar areas:

- A detailed flood risk mapping through GIS (Geographic Information Systems) as well as remote sensing in order to comprehend flood-prone zones and impact of future flooding.
- Study the impact of urbanization on flood vulnerability, mainly in terms of changes in land cover, impervious surfaces such as roads and buildings, and the reduction in natural drainage systems.
- Conduct comparative case studies of cities with successful urban flood management strategies, both within Africa and globally, to extract best practices that could be adapted to Sumbe.
- Analysis of the challenges faced by firefighters in Sumbe in order to address the capacity to meet the rising demand for disaster response.

## **Limitations of the Study**

The study encountered significant difficulties and limitations, including restrictions in accessing meteorological and cartographic documents due to bureaucratic issues, which led to data acquisition primarily through the internet. Furthermore, adverse weather conditions, such as the overflow of the Longa River on National Road (EN) 100 in the Capolo commune, Porto-Amboim municipality, resulted in the flooding of 90% of the Hogiua neighbourhood, blocking access to the study area. Additionally, the rising volume of rainwater led to the temporary closure of the bridge in the Eval Guerra region, reducing the available time for data collection and further complicating access to the city of Sumbe. Additionally, difficulty in collecting geographical information about Assaca was also one of the limitations of the study.

## Chapter 6: Conclusion

This research investigated cities' capacity to manage urban flooding disasters, with a specific focus on the city of Sumbe (Assaca and Centralidade da Kibaúla). It aimed to identify indicators of urban flooding disasters, determine urban disaster drivers, evaluate existing legislation, and propose recommendations if necessary.

Summary of chapters:

Chapter one- introduced the research with a specific on urban flooding capacity of the Sumbe, Angola. This chapter addressed the research problem, objective and the two case studies areas (Assaca and Kibaúla). Additionally, the study aimed to assess the capacity of the city to manage urban flooding disasters by identifying fundamental indicators, legal frameworks and recommendations for improvement.

Chapter two focused on the review of flood types (riverine, flash, urban, coastal and compound), hazard and exposure. A high vulnerability of children elderly and women, mainly women in rural areas completely dependent on flood-prone agriculture. Resilience framework entailed natural resources, built environment adaption and knowledge systems as key capacity in order to respond to disaster.

Chapter three used interpretivist philosophy and a qualitative case study approach of Assaca and Kibaúla to compare both neighbourhood flood management. Interviews. Field observations and document analysis applying thematic analysis to identify key patterns.

Chapter four revealed that Assaca is more vulnerable than Kibaúla due to infrastructure, drainage, and weak enforcement of laws or policies. There is a lack of awareness of flood policies, despite shared municipal governance. Early warning in both neighbourhoods are similar, however, it was noticed that response varied in both neighbourhoods due to infrastructure, education, finances, and social vulnerabilities.

Chapter five found gaps in the infrastructure drainage, and flood barriers in Assaca. Weak policy enforcement in both neighbourhoods and lack of community awareness hinder

effective flood management in the city. Disparities in government vs. community perspectives were also found.

### **Addressing the research objectives and questions.**

The findings highlighted hydrological (drainage), infrastructural (poor roads), institutional (weak enforcement), and socio-economic (poverty, education) factors which are the primary indicators of flood capacity as well as the Most influential factors. Additionally, inadequate policies due to weak implementation and awareness. There is a need to upgrade infrastructures, policy enforcement, and community training as a recommendation.

### **Overall Conclusion**

This study assessed the capacity of Sumbe to effectively manage urban flooding disasters. The research revealed critical gaps in infrastructure, policy enforcement, as well as community preparedness. While there is the existence of legal frameworks, the implementation is weak, leaving increasing areas like Assaca disproportionately vulnerable. Key solutions include: Immediate infrastructure upgrades (drainage, flood barriers); Stronger policy enforcement & community engagement; and inclusive, science-backed disaster planning.

This research contributes not only to urban flood resilience literature in Angola but also to African cities facing similar climate adaptation challenges and offers multiple insights for policymakers, disaster managers, as well as researchers. Future efforts have to prioritize equitable, sustainable solutions in order to minimize flood risks in Sumbe and similar regions.

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## Appendix

Table 3: Interview guideline

<b>Table 3: Interview guide.</b>	
	1. Does your neighbourhood experience flooding during the rainy season?
• <b>Stage 1</b> <b>(Kibaúla and Assaca)</b>	2. What do you believe are the main factors that contribute to urban flooding in Sumbe?
	3. How would you describe the current state of your house in relation to flood management?
	4. Are you vulnerable to floods? How do socio-economic conditions influence your community vulnerability?
	5. What is the most significant impact of urban flooding in your community and how it personally affects you?
	6. Which neighbourhood do you believe is more and less prepared to respond to urban flooding disaster?
	7. What policies or laws exist to prevent or minimise urban flooding?
	8. Why do you believe some neighbourhoods are more prepared than others to respond to and mitigate urban flooding disasters?
	9. How does the local community receive information regarding urban flooding disasters in Sumbe?
	10. In case of an urban flooding disaster, how long do you think it takes for your neighbourhood to recover from the stress?

	11. What resources or support are available for response and recovery here?
	12. Could you share any experiences where flood response was effective or inadequate.

Table 4: Interview Guide for the local administration

<b>Table 4: Interview Guide for the local administration</b>
Are you aware of the existing regulations and policies related to urban flood management in Sumbe? (Yes/No). If yes, please provide some examples of these regulations and policies
How effective do you believe the current legal frameworks are in mitigating the impacts of urban floods in Sumbe?
Have you or your community ever been involved in flood management activities or projects supported by the local government or NGOs? (Yes/No)
What improvements or changes would you suggest in the existing legal frameworks or strategies to better address urban flooding in Sumbe?
Is there any annual budget or funding for urban flooding damages in the city?
Do you believe that there is a well-established structure to deal with urban flooding disaster in a long or short term?
Could you provide information on the infrastructure projects aimed at reducing the impact of urban flooding in our community?
What emergency response plans are in place to address urban flooding disasters, and how often are these plans reviewed and updated?
Can you describe any early warning systems or alerts used to notify residents about potential urban flooding events?
Are there any community engagement or education programs aimed at increasing public awareness about urban flooding risks and mitigation measures?

In some African countries like Nigeria, one of the causes of urban flooding is precisely associated with the lack of a functional drainage system. Is this the case in Sumbe? Is there a lack of drainage system?

Is the drainage system capable of adequately handling heavy rains and flooding events?

Are there specific areas in Sumbe where drainage is particularly problematic?

Is the drainage system prone to frequent blockages or obstructions? If so, what are the main causes?