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Settling on water pathways: A case study of Setswetla vulnerability to flash floods.

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A research report submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science.

15 January 2020

Paulose Mvulane

DECLARATION

I declare that this dissertation is my own, unaided work except where acknowledged. It is submitted for the degree of Master of Science in the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree of examination in any other University.

_____

(Paulose Mvulane)

_____day of _____20_____in_____

ABSTRACT

Urban flooding coupled with unplanned urbanisation and urban population growth characterised by informality has enhanced the vulnerability of the urban poor to climate change and weather extremes. On the 9th of November 2016, torrential rains led to flash floods which affected the City of Johannesburg, Ekurhuleni and Tshwane. Informal settlements such as Setswetla, situated north of Johannesburg, between Alexandra Township and Marlboro Gardens, were heavily impacted by the storm. Using semi-structured interviews and Forensic Disaster Investigation methods, the current study aims to explore what are the factors that shape and influence the extent and impacts of vulnerability to urban flash floods.

The November 2016 flash floods were sudden and intense, businesses, roads and settlements were negatively impacted. According to News 24 (2016), there were people who never managed to get home after the 9th November 2016 torrential downpour in the city. The City of Johannesburg Disaster Management report (2016e) estimates that about 373 households with 862 individuals were severely affected by the November 2016 flash floods in Setswetla.

Vulnerability to flooding is a complex condition driven by socio-economic and physical environmental factors. To address vulnerability there needs to be transformative adaptation and proactive local governance. Such adaptation may help to shift the current drivers of vulnerability to create a more inclusive developmental paradigm, and proactive governance that will ensure the provision of basic services to the most vulnerable communities.

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This dissertation is dedicated to Alunamda Philasande Mvulane and Emisang Nokhalipha Mvulane.

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LIST OF ABBREVIATIONS

ALPOA:	The Alexandra Land and Property Owners Association
ARP:	Alexandra Renewal Project
ARS:	Automatic Rainfall Station
CBO	Community Based Organisations
CBD	Central Business District
CoJ:	City of Johannesburg
CWP	Community Work Programme
DMC:	Disaster Management Centre
DSTV:	Digital Satellite Television
EISD:	Environment and Infrastructure Service Department
EMS:	City of Johannesburg Emergency Services
FDI:	Forensic Disaster Investigations
FORIN:	Forensic Investigations on Disasters
GCI	Global Change Institute
GDS:	Growth Development Strategy
ID:	Identification Document
IDP:	Integrated Development Plan
IPCC:	Intergovernmental Panel on Climate Change
IRDR:	Integrated Research on Disaster Risk
ISC:	International Science Council
JMPD:	Johannesburg Metro Police Department
NGO	Non-Governmental Organisation
RADAR	Research Alliance for Disasters and Risk Reduction
RDP	The Reconstruction and Development Programme
SAWS	South African Weather Service
SDG:	Sustainable Development Goals
UNISDR:	United Nation International Strategy for Disaster Reduction
Urban ARK:	Urban Africa Risk Knowledge Africa

1. INTRODUCTION AND RESEARCH CONTEXT

Urban settlements are undergoing significant changes including population growth and growing informality. A range of other stresses, such as flooding, however, often lay bare the complex interaction of stress factors occurring in such contexts. Climate change, for example, is posing new and unique problems that will threaten environmental, social and economic systems around the globe (Doherty *et al*., 2016).

Urban areas are thus becoming a focal point of interest in the climate change discourse, since they have a distinct role in the climate change agenda in terms of both climate change mitigation and adaptation, and are also home to large populations and economic activities that may be vulnerable to climate change effects (Birkmann *et al*., 2014; Doherty *et al*., 2016). Vulnerability to climate change and weather extremes of urban areas and in particular urban informal settlements is widely studied in developing world regions (Murray, 2009; Bhuiyan and Dutta, 2012; Dewan, 2015; Mubaya *et al*., 2015; Amoako, 2016; Nwenweli, 2017; Allen *et al*., 2017). High inequality, low social and ecological resilience are the main features of the Sub-Saharan Africa urbanisation process. These features are all conducive for the production of vulnerability to climate change and the production of climate change risks, and risks accumulation (Boubacar *et al*., 2017). Vulnerability is thus usually made up of two components, the exposure to risk and hazard on the one hand and the inability, on the other hand, to cope with and avoid potential harm when confronted by a hazard (Pelling, 2003).

African urbanisation is characterised by large numbers of informal settlements found on marginal lands, with limited basic services and high population densities living in poverty. These factors compound the complexity of how risk and vulnerability are produced and, how vulnerability is manifested in the face of a hazard.

Niamey, for example, a capital city of Niger, has inadequate land use planning, limited infrastructure and has large populations occupying flood-prone areas (Boubacar *et al*., 2017). Frequent and intense floods have been observed in Niamey, with extreme floods occurring in 2010, 2012 and 2013 (Boubacar *et al*., 2017). In 2015, Niamey experienced floods that were classified as average, but the flood magnitude was enough to affect 1083 people and destroy 60 homes (Boubacar *et al*., 2017). The severity of a damaging flood does not only depend on the magnitude of the flood and the hazard but is also mediated by the context and adaptive

capacity in which a flood occurs such as the location, status of the community and the capacity of individuals to avert harm or to rebuild themselves after a hazard (Katsuhama and Grigg 2010).

As cities grow in size and populations, problems associated with urban growth also increase (Dhiman *et al*., 2018). The proliferation of informal urban settlements is one of the major problems facing the growing cities because urban authorities generally perceive them to be sites of undesired, uncontrollable and unwanted growth, since they do not conform to the ideal urban master plan or 'tamed urbanisation'(Allen *et al*., 2016). But informal settlements can also be construed as offering alternative forms of settlements to those who are not accommodated by formal urbanisation or the urban master plan (Allen *et al*., 2016). That is, informality is produced in ways that can challenge the dominant or mainstream urban planning that is underpinned by, for exmple, a capitalist agenda that prioritises property markets and consumption, by providing alternative settlements that are affordable and accessible to spaces of opportunities and livelihood (Allen *et al*., 2016).

1.1.The growth and changing face of the urban landscape and context

Currently, more than half of the world's population is living in urban areas (Beall and Fox, 2009, Williams *et al*., 2019). Africa is the world's fastest urbanising region, (Douglas *et al*., 2008). In 2005, 70% of the Sub-Saharan Africa urban population was living in slums (Beall and Fox, 2009), increasing to 90% as new urban slum settlements occurred in 2010 (Doytsher *et al*., 2010). Slums are informal settlements or neighbourhoods that lack security of tenure, often found in hazardous environments with limited basic services and do not comply with formal urban planning and building regulations (UN-Habitat, 2003). As will be detailed in the subsequent chapters, these settlements are usually vulnerable to a range of stresses including current and projected climate and weather extremes.

The Inter Governmental Panle on Climate Change (IPCC) projects that both coastal and inland cities may experience an increase in heat stress, storms and extreme precipitation, landslides, air pollution, drought, water scarcity, sea-level rise and storm surges (IPCC, 2014). This will pose significant risks to urban populations, economies, assets and ecosystems (IPCC, 2014). Rapid urbanisation characterised by informal settlements and growing urban populations will bring about significant environmental changes, which may exacerbate urban risk and vulnerability to climate change, related stresses and weather extremes (Culwick and Bobbins,

2016, Williams *et al*., 2019). Poor quality houses, for example, located on environments that are climate change and extreme weather sensitive could be severely impacted (IPCC, 2014).

Urban flash flooding is identified as one of the hazards associated with climate change and climate variability, which may endanger critical infrastructure, human life and has a potential to trigger other hazards (Miller and Hutchins, 2017; Pedrozo-Acuña *et al.*, 2017). As a consequence of climate change, the timing, magnitude and frequency of rainfall events is predicted to change and that may also alter urban flooding in many regions around the world (Miller and Hutchins, 2017).

Urban flash flooding is a particular growing concern for cities of the South since they are faced with a growing number of urban poor populations and at the same time have limited resources to service their growing populations (Ziervogel and Smith, 2009). Flood impacts have been observed in some African cities. For example, 'In poorer settlements, such as the 12 Mile settlement, Lagos, flash flooding can submerge entire streets causing traffic jams on main roads. In Benin City and Accra heavy rains hamper economic activities, flooding roads, inundating telecommunication systems, and causing factories to shut-down temporarily' (Douglas, 2017:35).

1.2. Multiple stresses contributing to urban flooding

Flooding in many African cities, as illustrated above, is becoming a problem for local government institutions that are tasked with providing everyday needs for urban dwellers. When viewed through a climate change lens the stress on local urban populations is shown to be heightened. The direct links and attribution between urban flash flooding and climate change are, however, not clear. Notwithstanding this lack of certainty and clarity, enhanced understanding of current exposures and vulnerabilities to periods of intense rainfall can enable some anticipatory adaptation and possible risk reduction to be considered. As is shown in this research, climate stress is only one of the stresses people face. A better understanding of the complex inter-relations between an intense rainfall event, aggravating stresses and impacts should, however, enable better risk reduction efforts going forward.

The African continent has been identified as one of the world's most vulnerable regions to climate change and variability (Chaillnor *et al.*, 2007, Serdeczny *et al*., 2017 and Doherty *et al*., 2016). Some parts of the African continent are expected to experience climate-related

extreme weather events such as drier conditions, increased temperatures and extreme precipitation. Southern Africa is one of the African regions which has been identified as being particularly vulnerable to climate change-related events such as extreme weather, droughts wildfires and in particular flooding (Figure 1.1; Davis-Reddy and Vincent, 2017).

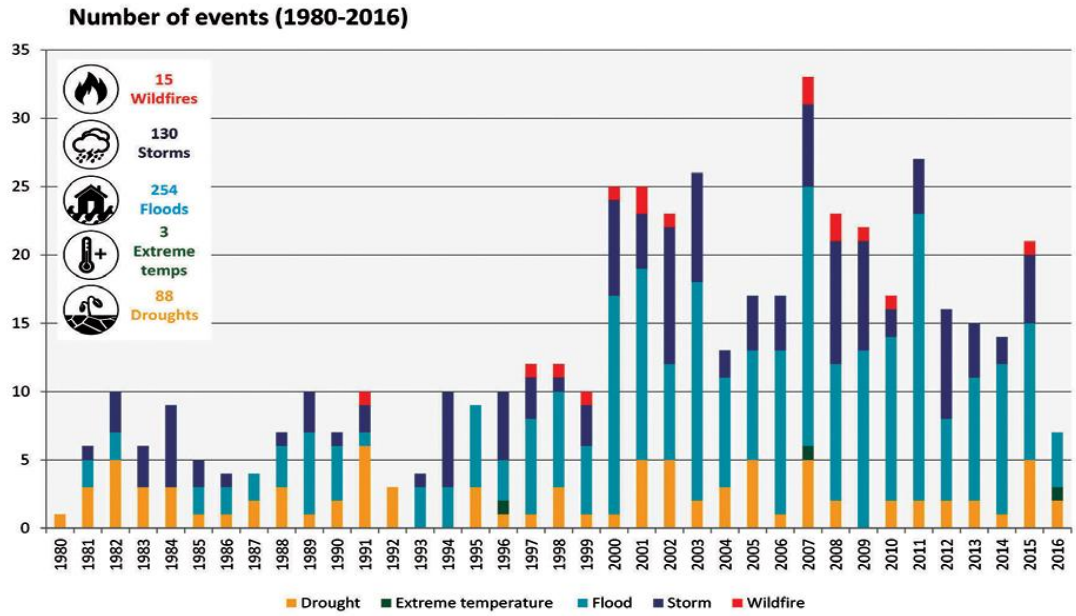


Figure 1.1: "Number of recorded climate-related events over Southern Africa since 1980 (Source: EM-DAT CRED, 2016). 'Wildfires' refers to any uncontrolled and non-prescribed burning of plants in a natural setting (Davis-Reddy and Vincent, 2017:31).

Henderson *et al*. (2017) note that many parts of the Sub-Saharan African region have been experiencing declines in moisture availability over the past 50 years. Climate models project that as a result of climate change and climate variability, the African inland tropics will experience frequent events of extreme heat, increase aridity and changes in rainfall patterns (Serdecnzy *et al*., 2017). The modelling projections also show that tropical east Africa will get wetter, while Southern Africa becomes drier (Serdecnzy *et al*., 2017).

The Sub-Saharan African region will be particularly affected by migration linked to climate change and climate variability effects, such as extreme weather events, changing climatic conditions and declining environmental services (Serdecnzy *et al*., 2017). The migration pattern is most likely to take a 'rural-to-urban' migration trend as urban areas are seen as spaces that can provide alternative livelihoods activities compared to rural areas. This migration pattern will be intensified by climate impacts as they exert pressure on rural livelihoods (Serdecnzy *et al*., 2017).

Climate change and climate variability will impact significantly on both the natural and human systems and will pose a challenge for disaster risk management in many cities around the world, particularly cities found in developing regions such as Africa (Serdecnzy *et al*., 2017; Davis-Reddy and Vincent, 2017). The rapidly changing urban landscape as a result of urbanisation and development will alter the distribution of flood hazards and their impacts. This will pose a challenge for flood risk management because as urban spaces are changed by urban development and in-migration, flood vulnerability 'hot spots' are concurrently changing.

In addition, the distribution and nature of the impacts remain uncertain as pre-existing conditions that may influence or alleviate the impacts of climate change and climate variability vary by locations within the African continent and are also changing rapidly. Urban population growth, as one of the stress factors and a force of rapid change in Africa, is also occurring at a rate that may overwhelm the ability of governments to provide essential services such as education, housing, drinking water, waste removal and electricity (Mutunga *et al*., 2012).

The 2003 UN human settlement report notes that rapid urbanisation has increased the prevalence of slum and squatter informal settlements around the world. These informal settlements are often vulnerable to a mix of both physical and human-induced hazards. Conditions of informal settlements are often sub-standard, because of high poverty rates, unemployment, lack of basic services and infrastructure and that they are found in environments that are exposed and sensitive to extreme weather events and flood hazards. These urban trends are also observed in the City of Johannesburg (CoJ), the City of focus in this study.

1.3.Introducing the case of Johannesburg through the lens of Alexandra

Johannesburg is one of the South African cities that attract a variety of urban migrants that may seek asylum, economic opportunities and better services (CoJ IDP, 2018/19). In Johannesburg, the urban poor and those living in informal settlements are also identified as the most vulnerable people to the impacts of flooding events (CoJ Climate Change Adaptation Plan, 2009). Flooding is a common hazard in the Johannesburg metropolitan area during rainy seasons (Disaster Management Strategic Action Plan, 2016/20), and it impacts negatively on livelihoods, most notably, of low-income communities.

The Johannesburg Growth Development Strategy 2040 (GDS) document states that the CoJ is faced with increasing weather changes, which has resulted in flash flooding, tornados and severe weather patterns (Growth Development Strategy, 2011). There are, however, few detailed studies and investigations on flooding or extreme weather events in Johannesburg (e.g. Mgquba and Vogel, 2004; Nwenweli, 2011 and McNamara, 2013). Most of the flooding events in Johannesburg are found in municipal reports and incident registers with minimal details as to what caused and excarbated flooding impacts.

For example, in 2000, various South African municipalities including Johannesburg experienced intense rains that led to flooding. In Johannesburg, Alexandra Township was estimated to have received rainfall of about 233mm within the first nine days of February 2000 (Mgquba and Vogel, 2004). It was found that those who were most affected and at risk were located along the banks of the Jukskei River (Mgquba and Vogel, 2004). Poor socio-economic conditions and high-density shack settlements contributed to the vulnerability to flooding (Mgquba and Vogel, 2004).

On the 26th of February 2009, flash floods occurred as a result of heavy rainfall in Soweto (McNamara, 2013). The Klipsruit River bursts its banks in Dube and Orlando, and the flash floods affected various low and high-income settlements in Johannesburg (McNamara, 2013). Informal settlements such as Dlamini and low-income government houses in Bram Fischerville were severly affected (McNamara, 2013). The underlying drivers of flood exposure included irregular maintenance of stormwater infrastructure, modification of the Klipsruit River which encouraged siltation and reed growth, and the concentration of poor communities, informal settlements and poor quality low-income government houses in low-lying areas (McNamara, 2013).

More recent flooding events have occurred between 2016 and 2019 in the CoJ. In November 2016, for example, a severe flash flood event occurred and affected several parts of the CoJ, in particular Alexandra. Six months later, the 2016 flash flood was followed by another flood in May 2017, but no fatalities were reported, only minor shack damages in Alexandra. On the 31st of December 2018, another storm swept through Alexandra; Setswetla was severely affected, but no fatalities were recorded (EWN, 2018). In 2019, on the 5th of March, a weather warning was issued by SAWS warning of possible floods around Gauteng, in particular, Alexandra in Johannesburg. After the rain, the Jukskei River was filled to its capacity, and a child was

stranded on a pipe crossing the Jukskei River. Vincent Cosa was hailed a hero for rescuing the child (News24, 2019).

It is against this background that this study explores one of the most extreme recent flash flood events that caused fatalities in Johannesburg; the flooding event of November 2016. The complex causes that drive vulnerability to flash flooding are, however, not well documented in CoJ official documents. Thus, there is a need to do in-depth studies into what drives vulnerability in areas that are constantly experiencing flash floods and determine any response and coping capacities. Such studies might help for future flood disaster preparation, mitigation and adaptation processes.

The flooding in Setswetla, Alexandra is therefore interrogated here to better understand the factors that are shaping vulnerability to flash floods. Futhermore, to identify some of the measures that residents and government officials undertake to minimise the impacts of floods in this settlement that is found along the Jukskei River banks, using the 9th November 2016 flash flood event as a case study.

1.4.Rationale and aims

On the 9th of November 2016, the CoJ and its surroundings experienced sudden and intense flash floods. In Setswetla, and the greater Alexandra, roads and houses were flooded, and some of the homes were swept away (Disaster Management Centre, 2016a). A DMC report shows that about 452 people were severely affected by the November 2016 flood and 141 of those people were children residing in Alexandra (Disaster Management Centre, 2016c). The flood disturbed everyday life; for example, individuals with chronic illnesses lost their medication. Some individuals were said to have experienced side effects from not taking their chronic medication, and they could not access health services since clinics are closed on Sundays (Public Safety Mayoral Committee Disaster Management, 2016b).

In surrounding areas such as Linksfield, a pregnant woman was reported missing; her body was subsequently recovered (Disaster Management Centre, 2016c). The Johannesburg Metro Police Department recovered eight vehicles from the flood incident. According to News 24, there were people who struggled to get home after the 9th of November 2016 torrential downpour in the city (Buick, 2016). After the intense rains, it was reported that insurance companies were inundated with claims following the flash flood event (Boucher, 2016).

Eyewitness News reported that at least 80 vehicles were stuck in the N2 and N3 highways and that authorities from Tshwane, Ekurhuleni and Johannesburg were working to assist those who were trapped (EWN, 2016). On the 13th of November it was confirmed and recorded that two females and one male had lost their lives on the N3 highway due to the floods (Disaster Management Centre, 2016c). These reports show how a single flooding event can cause devastation in a city, and provide the necessary basis to probe what drives the CoJ to experience such devastating flood impacts.

1.5.Research objectives

The aim of this study is to enhance understanding of vulnerability to flash floods in Setswetla informal settlement. The specific objectives are:

- To document the nature and extent and to identify impacts of the November 2016 Johannesburg flash floods on the Setswetla informal settlement.
- To identify some of the causal drivers of vulnerability to flash flooding in Setswetla.
- To examine the community and local disaster responses to flash flood events noting any barriers and opportunities for improved risk reduction.

1.6.Problem statement and research questions

Problem statement: Extreme weather events have significant negative impacts on urban settlements, especially informal urban settlements of Johannesburg which are already vulnerable to a number of social and environmental uncertainties. Extreme weather events, such as flash floods, bring about immense social, environmental and economic costs that impact on vulnerable urban informal settlements.

1.6.1. Research question

- Which factors, local and institutional, shape and influence the extent and impacts of vulnerability to flash flood risks?

1.6.2. Research sub-questions

- Which factors enhance vulnerability to flash floods in the settlement, and how does this vary spatially and by household?
- How did individuals or the community respond to the impact of flash floods?

- How prepared and effective was the CoJ Disaster Management in responding to the November 2016 flash flood?

1.7.Thesis outline

Chapter one provides an introduction and background for the study through a brief literature review on flooding, urbanisation and climate change. Furthermore, it provides the rationale, aims and objectives, problem statement, research question and sub-questions of the study.

Chapter two discusses the nature of urban flash flooding by focusing on both the biophysical and social factors that cause such floods, presents case studies from the developing world to highlight the severity of floods on urban communities, and provides a vulnerability conceptual framework to understand the factors that work together to configure vulnerability. In addition, adaptation and profiling are suggested as possible ways to address the vulnerability.

Chapter three outlines and discusses the methods and procedures of the study. It discusses ethical considerations, semi-structured interviews, the study area, the analysis of the results and the limitations of the study.

Chapter four presents and discusses the key findings of the study and a brief personal reflection of the settlement.

Chapter five presents an analysis of the key findings, links it to the literature and the conceptual framework of the study. Concludes and provides brief recommendations, and summarises how the study has contributed to the understanding of vulnerability.

2. UNDERSTANDING URBAN FLOODS AND VULNERABILITY CONCEPTUALISATION

2.1.Introduction

In this chapter, the nature of urban flooding is examined by focusing on the biophysical and social factors that cause flooding. Case studies from developing countries are provided to show the severity of flood impacts on communities. Furthermore, a vulnerability conceptual framework is provided to guide the study in the quest to understand vulnerability and the factors that work together to configure the vulnerability. Lastly, adaptation and profiling of settlements are suggested as possible ways to address the vulnerability.

2.2.Factors influencing and causing urban flash floods

Urban flash flooding is a type of urban pluvial flood. This kind of flood manifests itself as surface runoff and is generally caused by intense and persistent rains or storms (Few, 2003; Diakakis *et al*., 2016; Miller and Hutchins, 2017). Other instances such as melting glaciers, dam bursts, accumulation of rain water in low-lying areas with high water tables, inadequate stormwater drainage (Few, 2003), and a sudden release of water from a reservoir or a sewage system failure can also lead to urban flash flooding (Yu *et al*., 2016). Flash flood events and impacts are usually local in scale, but they have the potential to cause considerable damage (Karagiorgos *et al*., 2016a; Pharoah *et al*., 2016). In terms of duration, flash floods have a short lead time as they are sudden local floods of great volume which result from heavy rainfall (Pharoah *et al*., 2016).

Geophysical properties such as soil moisture, topography, land use, availability of vegetation and surface permeability can also influence urban flooding or flash flooding (Bodoque *et al.*, 2016; Few, 2003). The process of urbanisation alters natural landscape and fluvial processes to accommodate urban social and economic activities (Amoako, 2016). Urbanisation can aggravate flash floods by restricting and directing the flow of rainwater, obstructing natural water channels and infiltration by reducing surface permeability (Douglas *et al*., 2008; Few 2003). The creation of concrete surfaces and artificial water channels allows stormwater to rapidly flow into rivers or nearby low-lying areas than they would under natural conditions (Douglas *et al*., 2008). It is anticipated that floods will affect critical urban infrastructure that is exposed to flooding if flood adaptation and mitigation measures are not prioritised by local authorities (Kaspersen and Halsnæ, 2017).

Depending on the social and economic setting of communities, flash floods or flooding, such events do not always have negative impacts. For example, 'in many [rural] regions, annual flooding sustains current levels of agriculture, and residents may have different terms to distinguish beneficial floods from the more destructive ones' (Few, 2003:45). This is fundamental for understanding why certain communities have ambivalent attitudes towards flooding, and it also justifies policies of 'living with floods' over flooding prevention engineering interventions which are usually employed in urban areas (Few, 2003). But, Dewan (2015) notes that flooding is among the well-known disasters that have been threatening humanity for ages. In Europe, urban flooding is one of the major hazards that cause loss of human lives and economic assets (Karagiorgos *et al*., 2016b).

2.3.Impacts of urban flash flooding

Urban flash flooding is one of the hazards that can cripple urban development projects and programmes, of both developed and developing countries (Hall *et al*., 2005; Amoako, 2016). In the United Kingdom, the 2015-2016 winter flood impacts were estimated to be an excess of £5 billion (Miller and Hutchins, 2017). Urban flash flooding can threaten the prosperity, safety and security of cities and urban areas by destroying critical infrastructure and facilities of energy, economic activities, settlements and livelihood (Hall *et al*., 2005; Miller and Hutchins, 2017). Flash flooding comes with significant economic losses, casualties and poses a challenge for urban flood risk management because they are sometimes difficult to forecast (Karagiorgo *et al*., 2016a).

As a result, urban flash floods destroy urban settlements and can cause death, especially when they co-occur with poor development, poor urban populations and unplanned urbanisation (Williams *et al*., 2019). Urban land use change and population growth are among the main drivers of urban flash flooding because they increase surface runoff by creating hard surfaces that discourage infiltration (Dewan, 2015; Diakalise *et al*., 2016).

Having provided some background to the nature of urban flooding, attention now turns to defining the concept of vulnerability in detail and to provide some cases where researchers have tried to probe cases to better understand and tease out the impacts of flash floods on urban informal settlements and some factors influencing vulnerability.

2.4.Understanding vulnerability and its underlying features

The concept of vulnerability originates from both social and natural science studies. 'Natural scientists often view vulnerability in terms of the degree of loss to an element at risk as a result of the impact of a hazard based on a given frequency and magnitude' (Karagiorgos *et al*., 2016b:554). Socially, vulnerability represents a set of socio-economic factors that impacts on an individual or community ability cope, anticipate and recover from stresses (Karagiorgos *et al*., 2016a). In social studies, vulnerability is a condition determined by social, economic and environmental processes, which can increase exposure and sensitivity or susceptibility to the damaging effect of a hazard (Holloway *et al.*, 2010). Several definitions of vulnerability have been made by different scholars over time to promote understanding and provide insights on the nature of problems facing the world today (Razaee *et al*., 2018):

- Vulnerability is a possibility that an individual or group will be exposed to and adversely affected by a hazard (Cutter, 1993).
- Interaction between exposure to hazards and the coping capacity of the affected people (individual, group, and society) to external events (Bohle, 2001).

An understanding of vulnerability is important for assessing urban settlements and for developing a successful conceptual framework to enable appropriate interventions and risk reduction efforts (Salami *et al*., 2017). The concept of vulnerability is made up of three components; exposure, sensitivity and the inability of people to adapt or cope with external stresses such as floods (Figure 2.1; Bodoque *et al*., 2016; Karagiorgos *et al*., 2016a):

- Exposure refers to the existing hazards that people of a settlement are already exposed to (Lankao and Qin, 2011; Wamsler, 2014). For example, people living in flood plains and river banks can be exposed to flooding. Thus, exposure is the presence of people and their assets to environments that can be severely affected by hazards such as flooding (IPCC, 2014). Poor communities are the most exposed as they usually build their homes on marginal and hazardous environments (Douglas *et al*., 2008).

- Sensitivity refers to the susceptibility of people to external stressors that can easily harm the people or can cause serious damage (Wamsler, 2014). Communities are said to be sensitive if they are exposed and susceptible to the damaging effect of a hazard.

Susceptible people are those that have a high degree to suffer harm when faced with a hazard. Susceptibility to flooding in urban areas is not only a consequence of rainfall, but it is compounded on urban development that has modified the environment and has inadequate drainage systems (Douglas *et al*., 2008).

- Adaptive capacity refers to the ability of community members to withstand external stresses and still continue with their day-to-day routines (Wamsler, 2014). A community with no or limited adaptive capacity will not be able to withstand external stresses and will, therefore, be vulnerable. Adaptive capacity is also influenced by effective local institutional response such as proper adequate service delivery (Zievogel, 2019). Access to secure livelihood such as stable income can also boost adaptive capacity because it enables access to resources that can be bought or paid for to ensure the security of a person.

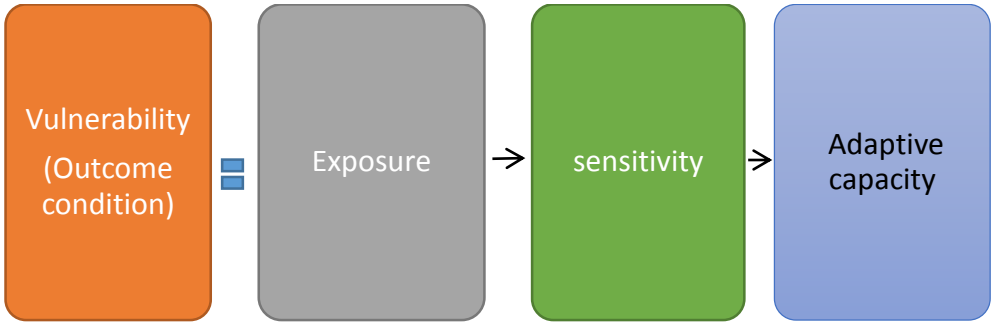


Figure 2.1: Features of the vulnerability condition (Wamsler, 2014).

2.5.Conceptualizing Vulnerability

A vulnerability conceptual framework can be useful to understand, and for analysing how different vulnerability factors link together to make a community vulnerable to impacts of weather extremes. Using a vulnerability conceptual framework one can obtain a more systemic view of the context in which vulnerability is embedded and a framework can assist in developing concepts, questions and answers to help probe and deepen an assesment of vulnerability in a given context (Wisner, 2016). Under the climate change and disaster risks discourse there are a number of vulnerability frameworks that have been developed and have been enhanced through new knowledge and research. The Pressure and Release Model (PAR),

for example, developed by Blaike *et al*. (1994) has now been enhanced by Salami *et al*. (2017) is used to understand vulnerability of African cities to flooding.

The Hazard of place model, as developed by Cutter (1996) was chosen for this study. The hazard place model has the ability to analyse vulnerability using both biophysical and social dimensions of vulnerability (Figure 2.2) (Cutter *et al*., 2000).

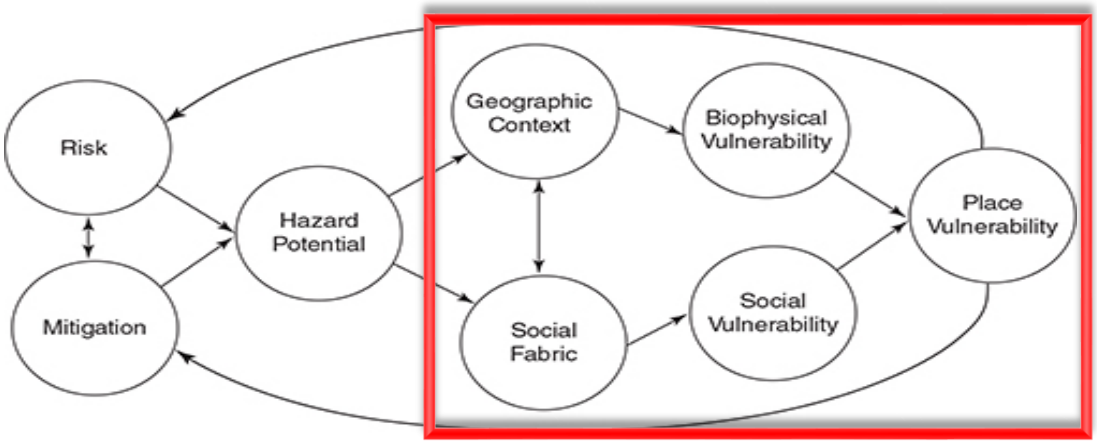


Figure 2.2: The Hazard of Place Model (Cutter, 1996).

Figure 2.2 shows the interaction of different vulnerability factors that interact to produce or alleviate the vulnerability of a place. The hazard of place model provides a framework to assist in identifying clusters of biophysical and social factors that can amplify vulnerability (Cutter *et al*., 2000). Importantly, Cutter *et al*. (2000) note that the hazard of place model appreciates that vulnerability is not a static condition, but a constantly changing condition which can be altered through the process of mitigation or through the change of the variables of risk. Vulnerability varies geographically, overtime and among different social groups (Cutter, 2003). To capture the geographic and socially specific factors that drive vulnerability in Setswetla, the current case study will focus on the five highlighted elements of the Hazard of place model as shown in Figure 2.2.

2.5.1. The Social fabric and social vulnerability

The social fabric of a given place is made up of factors such as demographic composition, socio-economic elements, social organisation, social institutions, behavioural issues and social networks (Atkinson *et al*., 2016). Simply put, the social fabric are the unique social

characteristics of people found in a particular place which includes people's everyday perceptions and experiences of the place in which they live (Cutter *et al*., 2000; Atkinson *et al*., 2016). In the case of Setswetla perceptions and experiences can inform how people found in a particular place respond to flood hazards (Cutter *et al*., 2000). Furthermore, social fabric is further underpinned by other factors such as sense of belonging, social justice, communal participation, attitudes of acceptance and, safety and security (Atkinson *et al*., 2016). These factors are fundamental in shaping the overall communal capacity to respond to hazards (Cutter *et al*., 2000).

All these social fabric factors combined can inform whether a given community is vulnerable or resistant to flood hazards. This can be achieved through a detailed focus on each of the factors above. For example, social networks and institutions can inform the interaction between the society and natural environment in terms of when, where and how people get resources and who are the custodians such resources. Thus, social relations and processes become important in understanding the social fabric of vulnerability, as they shape social relations and how resources are accessed (Bohle *et al*., 1994).

Santha and Sreedharan (2010) argue that power relations are central in understanding vulnerability, since they create unequal exposure to risk by making some people more exposed to hazards such as floods than others. One of the key findings in their study of landslides in Kerala, India is that the lack of access to political power, decision-making and resources are among the major factors that contribute to vulnerability at the very local level (Santha and Sreedharan, 2010). The investigation of the study found that a significant portion of those affected by landslides were Scheduled Tribes or Caste, and were excluded from mainstream development (Santha and Sreedharan, 2010). Powerlessness can lead people to live in precarious conditions with low self and social protection in attempt to secure livelihood.

Generally, as illsutrated in the overview above, the fundamental cause of social vulnerability is a lack of access to resources, political power, social networks and social capital (Cutter *et al*., 2000; Cutter *et al*, 2003; Dintwa *et al*., 2019). The poor are considered to be the most vulnerable to hazards such as floods because of their general lack of resources, they reside in poor quality housing located on marginalised environments and have little capacity to recover after an impact (cutter *et al*., 2000). Even the rich can be vulnerable. Cutter *et al* (2000) note that rich households may suffer material loss, but through wealth they have social safety nets

such as insurances that enables them to absorb the material losses and recover quickly after a shock or hazard. Therefore, investgiations of social vulnerability is concerned with those factors that can enable individuals and household resist or suffer the impacts of a hazard.

The intersection of vulnerable people and vulnerable environments, wihout effective buffering and adaptive capacity, can lead to disasters (Fatti and Patel, 2013). Marginalised settlements are often scattered in hazard-prone areas such as flood plains with poor or no formal infrastructure. In such settlements, real and perceived vulnerability to flood hazards is shaped by a myriad of complex socio-economic factors, political alliances and the various urban development actors (Amoako, 2016).

This is particularly true for a number of informal settlements around the CoJ region. Some of the resettlement behaviour in informal settlements has been stimulated by calls to occupy and invade unused or vacant land in the City (Postman, 2019). Settlements, such as the new Waterworks section, which is found along the railway line in Lenasia, south of Johannesburg, is situated close to Oupa Fats wetland making it highly exposed to flooding impacts. Vulnerability of such a settlement can be shaped by political alliances as people are occupying land not certified for settlement resulting in a complex informal settlement of often competing and contradictory social, political and economic systems (Bull-Kamanga *et al*., 2003).

As more people come into urban areas, formal and informal settlements expand, and this can change the conditions that drive vulnerability either by intensifying or alleviating vulnerability. Vulnerability can be alleviated when there is effective planning for urban settlements alhtough delineating the contours of this planning in complex informality settings is exceedingly difficult (Mubaya *et al*., 2015). In the case of Dar es Salaam, for example, sometimes planning is not possible or it is inadequate because of rapid population growth resulting in burgeoning informal settlements. In instances where urban authorities try to enforce strict regulations to prevent informal settlements from encroaching into well-planned settlements (Amoako, 2016) urban informality may still continue to grow. Therefore, it becomes necessary to employ a number of strategies to alleviate vulnerability such as *in situ* upgrade and servicing of informal settlements.

Furthermore, some of the demographic factors such as age, gender, minority groups and race can also amplify social vulnerability (Cutter *et al*., 2000, Cutter *et al*., 2003 and Aksha *et al*.,

2019). Elderly people and children are generally considered to be vulnerable by virtue of their age. Socio-economic factors such as occupation and education can also facilitate the vulnerability of a place (Cutter *et al*., 2000). People working part-time jobs may have unreliable incomes and an impact of a hazard might erode earnings especially if the nature of the job is reliant on the natural environment.

2.5.2. Geographic context and Biophysical vulnerability

Context plays an important role in vulnerability studies because it provides the basis to understand contextual specific factors that create the condition of being vulnerable. 'Context includes the geographical features of where a hazard plays itself out and is usually the expression of the driving factors of vulnerability including the physical properties of the hazard, as well as aspects of the social, political, spatial, temporal, organisational and economic milieu within which the hazard takes place' (Cutter *et al.*, 2000:715). Therefore, vulnerability is a contextual and place specific concept (Salami *et al*., 2017).

The geographical context of the Hazard of Place model is concerned with the location and characteristics of the place. "The geographic filter includes the site and situation of the place and the proximity to hazard sources and events, and interacts with the hazard potential to produce biophysical vulnerability" (Cutter *et al*., 2000: 717). Thus, the geographical context is composed of landscape features of the place, for example a settlement situated in a low lying area or flood plan. Such a settlement will thus be proximate to a flood hazard. The geographic context can translate into biophysical vulnerability when interacting with a potential hazard (Cutter *et al*., 2000).

Biophysical vulnerability is the exposure of the human environment to natural extreme events or hazards (Weninger, 2010). To identify and examine biophysical vulnerability one has to look at the frequency, magnitude, duration, severity and locational impacts of the hazard (Cutter *et al*., 2000; Weninger 2010). Thus, biophysical vulnerability is a result of natural factors that manifest as hazards and can have detrimental effects on the natural and human environments.

Biophysical vulnerability can be driven, for example, by local weather, climatic and environmental conditions (Letsie, 2015). These local conditions can disturb the prevailing natural equilibrium by compromising the normal functions of the community and when severe,

the conditions could cause destruction (Weninger, 2010). Therefore, biophysical dimensions of vulnerability are concerned with the drivers and configurations of the natural hazard and the subsequent damage (Weninger, 2010 and Letsie, 2015).

2.5.3. Place vulnerability

Place vulnerability is the overall vulnerability of a location as a result of the interaction between geographic context and social fabric that has led to both biophysical and social vulnerability (Cutter *et al*., 2000). In Cutter *et al*. (2000) study of the vulnerability of Georgetown, it was found that the overall vulnerability of the area was a function of medium levels of biophysical risk interacting with medium to high level of social vulnerability. The less vulnerable areas were said to be located inland of Georgetown and away from industries, waterways, transportation corridors, and were less populated (Cutter *et al*., 2000). Place vulnerability is thus usually a function of the prevailing biophysical and social conditions working together to produce vulnerability of place. In the next section these interacting causes of social, biohysical and place vulnerability are examined for various African settings namely Ghana, Mozambique, Tanzani and South Africa. The combined stressors usually result in signifcant impacts that then require a range of interventions across scales.

2.6. Impact of flooding on vulnerable communities: Cases from the developing world regions

2.6.1. Ghana, Accra

Amoako and Inkoom (2018) and Aboagye (2012) list a number of flooding events which have had devastating consequences in Accra, Ghana. Aboagye, (2012) found that the severity and loses associated with flooding is growing in Accra. In the 1995 floods, about seventeen people were reported dead and over 1000 families were displaced (Aboagye, 2012). The 2001 June torrential rains killed twelve people, left over 100 000 people homeless and seriously disrupted traffic in Accra (Amoako and Inkoom, 2018). Between the 2001 and 2015, floods killed over 250 people, displaced closed to 200 000 people, caused damage worth about $50 million and destroyed livelihoods of people living in informal settlements (Amoako and Boamah, 2015; Amoako and Inkoom, 2018).

Amoako and Inkoom (2018) note that over 90% of flood-prone communities are informal, who live in poor and vulnerable physical and socio-economic conditions. The interaction of poverty and vulnerable physical conditions increases exposure to flood hazards. The study found that exposure to flood impacts was a result of a number of factors including in-migration and the reclaiming wetlands for development of settlements, poor housing developments, poor waste management and the absence of the state in providing infrastructure for flood management (Amoako and Inkoom, 2018).

The rapid growth of informal settlement often drives people to settle in high-risk areas (Amoako and Inkoom, 2018 and Williams *et al*., 2019). Urban migrants often build their homes on unstable hillslopes, river banks, dump fills, along railway lines, flood plains and former mangrove swamps and these environments have exposed them to the impacts of urban flash flooding (Douglas *et al*., 2008; Fatti and Patel, 2013; Asumadu-Sarkodie *et al*., 2015; Serdecnzy *et al*., 2017). Therefore, to understand vulnerability to urban flooding of urban slum dwellers, we must first contextualise and examine informality and how it produces and creates vulnerability (Amoako and Inkoom, 2018).

Inappropriate methods of solid waste disposal, inadequate drainage capacity, urbanisation and unregulated settlements have been identified as factors that expose communities to flooding in Accra (Asumadu-Sarkodie *et al*., 2015). Some settlements in Accra are built close to watercourses such as streams, and they dump their solid waste directly into the rivers, drains and culverts (Asumadu-Sarkodie *et al*., 2015). This results in water blockages and reduced inflow, which then leads to increased surface runoff that may lead to flooding.

2.6.2. Mozambique, Maputo

Mozambique experienced one of the most devastating floods in 2000. One of the most popular pictures of the flooding event was of a woman who gave birth in a treetop. In February and March 2000, Mozambique was hit by cyclone Eline that led to the worst flooding, which brought widespread devastation in Maputo (Douglas *et al*., 2008). About one million people were affected by the floods; services, such as sanitation and water, were severely disrupted leading to the outbreak of waterborne diseases such as cholera (Douglas *et al*., 2008). Residents from Luis Cabral slum pointed out that the 2000 flood completely destroyed their area (Douglas *et al*., 2008). Flooding is becoming worse around Maputo; when it rains for three days to a week the water on the surface can take about a month to disappear (Douglas *et al*., 2008). This

could be a result of overcrowding and building of structures on water pathways, which results in the diversion of water flows or waterlogging (Douglas *et al*., 2008). This exposes people to floods and prolonged wet periods leading to saturated surfaces.

2.6.3. Tanzania, Dar es Salaam

Dar es Salaam is the largest commercial city of Tanzania (Sakijege *et al*., 2012). Between 1988 and 2002, Dar es Salaam experienced considerable population growth on unplanned settlements at a rate that the city planners could not keep pace with (Mubaya *et al*., 2015). As a result, Dar es Salaam is exposed to many social and environmental hazards such as floods, sea-level rise, coastal erosion, water scarcity and disease outbreaks (Mubaya *et al*., 2015). A significant portion of Dar es Salaam's population live in informal settlements situated on low-lying areas making residents prone to sea-level rise and flooding (Mubaya *et al*., 2015). These conditions, coupled with climate change and weather extremes, can result in disasters, which may require the diversion of limited resources.

In a case study that was done in Bonde la Mpunga, an illegal settlement in Dar es Salaam, it was found that vulnerability to climate hazards such as flooding was a function of the interaction between biophysical risks and social vulnerability dynamics that enhance exposure to hazards (Mubaya *et al*., 2015). Bonde la Mpunga is compact with dwelling structures with no clear streets, and this exacerbates the sensitivity of the settlement to flooding (Mubaya *et al*., 2015).

Since informal urban settlements are not planned, they lack proper infrastructure such as roads and stormwater drainage channels that are designed in accordance with urban engineering standards (Sakijege *et al*., 2012). In the case study of Keko Muchungwa in Dar es Salaam, it was found that the absence of basic services such as sanitation, reliable water supply and lack of proper solid waste removal were the main factors driving flood vulnerability in the area (Sakijege *et al*., 2012). For example, as result of haphazard disposal of solid waste, water from elevated parts of the settlement carry the disposed solid waste to the already uncoordinated stormwater drainage systems (Sakijege *et al*., 2012).

2.6.4. South Africa

a) Eastern Cape, Missionvale settlement

A case study carried out in Missionvale settlement in Port Elizabeth, examined flood hazard vulnerability by looking at factors such as awareness of the floods by residents, impacts associated with flooding on local livelihoods, official response, official flooding management and recovery plans, and local people coping strategies during a severe flood (Siyongwana *et al*., 2015). Informal settlements are sometimes strategically positioned to be accessible to nodes of livelihood. In Missionvale, about 87.7% of the respondents were aware of the fact that the settlement is vulnerable to flooding but were not willing to relocate as it might disturb their livelihood (Siyongwana *et al*., 2015).

The 2012 flooding that affected Port Elizabeth was estimated to have caused infrastructural damage of approximately R1 billion (Siyongwana *et al*., 2015). Houses and shacks from Missionvale were submerged in water for days, while walls and electricity infrastructure were severely affected (Siyongwana *et al*., 2015). The vulnerability of the settlement to flooding was ascribed to high poverty rates, inadequate disaster management structures, poor service delivery and setting on low-lying areas (Siyongwana *et al*., 2015).

b) Western Cape, Cape Town

The Western Cape generally gets most of its rainfall from winter, mid-latitude cyclonic events. Such events can result in high impact weather events that affect the informal, formal, urban and rural parts of the Western Cape. The RADAR 2016 synthesis report recorded twelve cut-off low events that caused flooding, which affected various parts of the Western Cape Province (Pharoah *et al*., 2016).

In June 2011, cut-off low weather event affected the Cape Winelands, Central Karoo, Eden and the Overberg (Pharoah *et al*., 2016). More than 1400 people from informal and low-cost housing were evacuated, one death was recorded in Hessequa and the direct damage of the event was estimated to be R348 million (Pharoah *et al*., 2016). The event also caused flooding in the Knysna central business district (Pharoah *et al*., 2016).

In November 2013, a similar event also affected the Cape Winelands, the City of Cape Town, the Overberg and Eden (Pharoah *et al*., 2016). The event was associated with a warmer-tropical

temperature trough and a low-level pressure system (Pharoah *et al*., 2016). More than 19000 people from informal settlements and low-cost housing were affected, services such as water supply were disrupted and 121 patients from Medi-clinic Vergelegen had to be evacuated (Pharoah *et al*., 2016). The damaged amounted to approximately R167.5 million and two people lost their lives (Pharoah *et al*., 2016).

In both of the cut-off low events, it was found that the weather event was of an extreme nature as it was heavy rainfall compounded with other potentially damaging events such as snow and hail, and that some of the infrastructure was severely impacted as a result (Pharoah *et al*., 2016). Thus the driving force that led to massive damage was location on flood sensitive and exposed environments together with the extreme nature of the events.

The proliferation of informal urban settlements or untamed urbanisation, the development of settlements and other structures on flood-exposed environments together with climate change will bring greater challenges in managing urban risks and vulnerabilities to extreme weather and social events. Informal settlements, because of their ability to exist within, between and beyond planned urbanisation, have been exposed to hazards such as flooding. An understanding of what drives vulnerability and how it is distributed in such settlements is of particular importance because it can inform actions directed to flood vulnerability alleviation.

The previously mentioned cases all illustrate that flooding impacts are as a result of both physical and socio-economic interactions. Such interactions can influence the exposure, sensitivity, and adaptive capacity of communities by either making the community resilient or vulnerable to a hazard. The case studies have shown that an extreme flooding event can cause massive damage when it occurs in settlements with poor infrastructure, poverty and located on flood sensitive environments. Before one can design interventions to redcue vulnerability one therefore needs to understand what are the factros that are driving vulnerability in such places.

2.7. Reducing vulnerability

One of the ways of addressing vulnerability is through adaptation. Adaptation refers to the adjustment actions that are undertaken by people intentionally or incidentally as a response to hazards and their impacts (Hernández-Guerrero *et al*., 2012). Unlike coping strategies which are usually reactionary, adaptation is a long-term and forward-looking kind of adjustment

(Razaee *et al*., 2018). Coping is an interim measure that is taken to deal with external stresses in a reactionary manner, and it does not address vulnerability (Nwenweli, 2015).

To address vulnerability in urban settlements, there is a growing focus on transformative adaptation (Pelling *et al*., 2015; Zievogel 2019). In terms of climate change, transformative adaptation are those actions that are aimed at shifting socio-economic systems to alternative development pathways that will enable decision-makers and those assessing adaptive capacity, to look beyond proximate causes of risk and vulnerability, and to examine the structural or root causes of vulnerability (Pelling *et al*., 2015). This adaptation process may enable the appreciation that vulnerability is a complex concept and that a shift in urban development processes towards a more social inclusive developmental pathways can address injustice and achieve equality.

This idea of urban transformational adaptation is also underpinned by a perspective that there needs to be a change across institutional, social, ecological and physical dimensions of urbanisation (Zievogel, 2019). This change is deemed necessary as it requires a shift from exclusionary urban economic growth to reframing the city as inclusionary (Zievogel, 2019). Marginalisation has proven to be toxic as it breeds social and spatial inequality, and this can result in areas being vulnerable to hazards (Zievogel, 2019). If such transformation can be achieved, cities are most likely to give effect to human rights obligations, meet their sustainable development goals (SDG) and significantly alleviate the exposure of the urban poor to climate change impacts (Zievogel *et al*., 2017; Zievogel 2019).

To effectively reduce vulnerability of urban populations to flood hazards, a collaboration of different stakeholders will also be needed. Collaboration of different city departments with Community Based Organisations (CBOs), development agencies and low-income communities has proven to be difficult because such an exercise requires time, meaningful engagements and trade-offs to be made in order for certain decisions to be taken (Bull-Kamanga *et al*., 2003). Where such collaborations are successful, the consequences are usually positive as communities become less exposed to flood hazards. For example, Green Park informal settlement in Cape Town was vulnerable to frequent winter floods (Zievogel, 2019). Through the collaboration of the settlement leadership and the City of Cape Town, gravel platforms were implemented to reduce flood risk in Green Park informal settlement, which paved the way for the electrification of the settlement (Zievogel, 2019). The gravel platforms

raised the ground level so that shacks were no longer on flood prone area (Zievogel, 2019).The work done in Green Park is in line with SDG 11 which requires the upgrading of slum settlements to make cities safer.

Identifying, understanding and profiling vulnerable communities will be a crucial step for initiating adaptation processes to climate change and extreme weather events. Such identification may enable meaningful intervention and response since circumstances that put people at risk are identified and profiled in their context (Crick *et al.*, 2012).

In South Africa, the City of Cape Town seems to be amongst the leading cities with regards to the profiling of communities that are vulnerable to extreme weather events such as floods. The City of Cape Town has collaborated with RADAR, a research unit at Stellenbosch University (Holloway *et al*., 2010). RADAR has done in-depth research on environmental, economic and social impacts resulting from natural and human-induced hazards. RADAR collected data from the Cape flood events of 2003 to 2008, and has provided a detailed analysis on the various categories of weather event (e.g. cut-off lows) that contributed to the flooding (Holloway *et al*., 2010). It has further provided data on who was affected; the social impacts, and the loss and damages suffered by the affected municipalities. The latest synthesis report providing details of cut-off low high impact weather events from 2003-2014 was published in 2016 (Pharaoh *et al*., 2016).

Such examples provide the basis for greater attention to be given to local research and institutional efforts, as they can provide data which may assist in understanding where the needs and interventions are for building the resilience of local systems and institutions to effectively deal with flood-related disaster (Otto-Zimmermann and Balbo, 2012). Understanding of local conditions, livelihoods and urban socio-economic contexts of informal urban settlements can also provide insights about what opportunities and resources exist, which can stimulate urban adaptation capacity for climate change and weather-related extremes (Pelling and High, 2005). Good governance and the provision of basic infrastructure remain a critical component of poverty reduction and capacity building that will enable vulnerable urban communities to adapt and mitigate the impacts of weather extremes (Doytsher *et al*., 2010).

Local government also needs to become actively involved with vulnerable communities to create necessary conditions to alleviate vulnerability. Government response on informal

settlement flooding events tends to be reactionary and humanitarian. In Missionvale, respondents argued that officials sent them to public halls, which further exposes woman to sexual crimes (Siyongwana *et al.*, 2015). Such responses do not address the root causes of vulnerability of informal settlement, but can further enhance other vulnerabilities.

Traditionally governments have relied heavily on infrastructural interventions to solve flooding problems such as building houses and stormwater drainage systems (Zievogel *et al*., 2016). The growth of urban settlements and the rapidly changing environmental and social conditions creates complexity in the distribution and location of flood risks (Zievogel *et al*., 2016:1). To deal with flooding complexities, Zievogel *et al*. (2016) suggest that there must be a collaboration of all flood stakeholders (e.g. local governments, academic, communities, community leader, urban planners, urban officials, disaster managers etc.) to avoid the traditional top-down approach that has excluded flood vulnerable communities from participating in decision-making processes. Such collaborations can enhance co-creation and bring about holistic approaches to deal with flooding, and all the stakeholders who are involved will all own the outcomes of the collaboration.

3. DATA METHODS AND DATA COLLECTION

3.1.*Introduction*

The processes and procedures of data collection, dataset management, data analysis, and study design are presented in this chapter. Setswetla is an informal settlement, located in Alexandra, north of Johannesburg. During rainy seasons, Setswetla is repeatedly confronted by flooding events, usually leading to severe losses of livelihood. This study is a mixed method study that draws heavily on personal interviews. The study, however, draws heavily on qualitative case study methods relying on detailed interactions with local community members and their 'stories' to better understand the 'lived experiences' in the place of vulnerability that they occupy.

3.2.Case study design

In this study the objective was to investigate and understand the underlying drivers that influence flash flood vulnerability in Setswetla informal settlement, using the 9th November 2016 flash floods as a case study. A case study approach is useful when a researcher seeks to focus attention on a single instance of a given social phenomenon (Babbie, 2012). An instance or a case can be an event, individual or entity that can be described as a unit of analysis to be explored (Yin, 2009).

Case studies are usually based on a constructivist paradigm (Baxter and Jack, 2008). In case studies research, a case is compiled drawing on and informing the narrative through the lens of its participants. Thus, constructivist's claim that the truth and ontology of the unit of analysis are relative, and place emphasis on the human subject as the creator of meaning and reality (Baxter and Jack, 2008).

A case study design is suitable because a case study further examines and explores complex real-life issues within their local context (Montana, 2016). Case studies are usually concerned with answering the *how* and *why* research questions (Yin, 2009). The current study, however, is also concerned with a *what* research question; it aims to understand the driver of flood vulnerability in the settlement by considering the context of the settlement.

3.3.Sample size and characteristics

Forty-two participants were interviewed, three of whom were officials from the CoJ (two from Disaster Management and one from Environment Infrastructure Service Department). The remaining 39 were individuals who were affected by the November 2016 flash floods from Setswetla. All of the participants who took part in this study were adults (over the age of 18) with a fair mix of gender (Figure 3.1 and Appendix 6)[1]. In addition, the majority of participants provided that they were South African citizens (Figure 3.2). It was intended that more interviews be conducted, but on reflection, the information collected was decided to be adequate as the stories were already yielding rich and thick narratives of the flooding incident and also providing useful insights into the contexts in which residents were finding themselves.

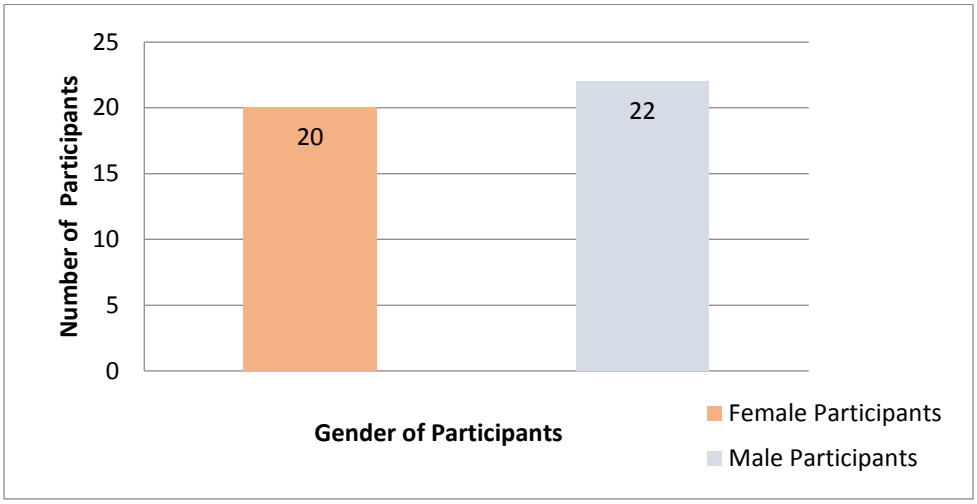


Figure 3.1: Gender of participants

[1] All names of participants used in this study are pseudonyms.

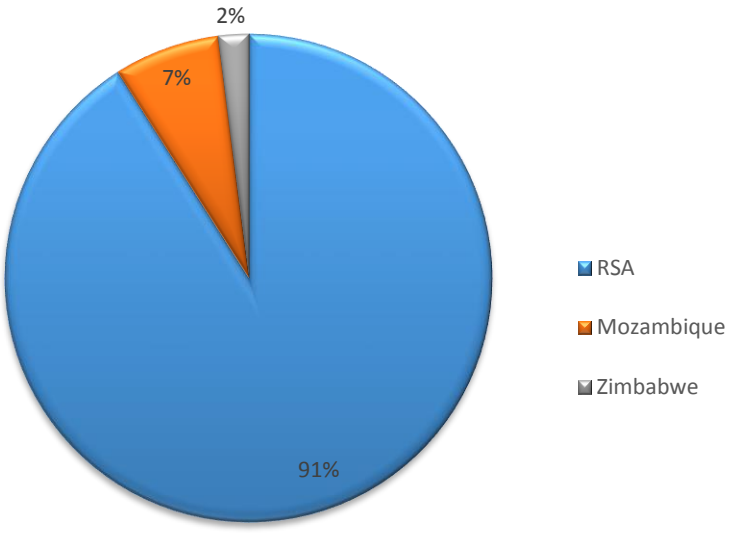


Figure 3.2: Nationality of participants

3.4.Unravelling the story using relevant tools

3.4.1. Posing the relevant questions: The FORIN method

Disasters were once predominantly perceived as events that were beyond human control and were seen as a physical hazards e.g. a drought and or a flood (Cutter *et al*., 2000). This perception, however, removes the history, social standing, culture, politics in which hazards play themselves out and it also portrays the affected people as homogenised disaster victims without human agency (Oliver-Smith *et al*., 2016). This perception is sometimes dominant in institutions of governance and disaster risk management, tending to de-contextualises disasters and disaster impacts (Oliver-Smith *et al*., 2016).

To give effect to the context of the current case study and to pose context relevant questions, the Forensic Disaster Investigation (FORIN or FDI) research method, as developed by the Integrated Research on Disaster Risk (IRDR) of the International Science Council (ISC), was used as a guide to frame semi-structured interview questions (Appendix 1). FORIN aims to take the *natural* out of natural disasters by doing in-depth research into the complexity and underlying drivers of flood vulnerability and disasters losses (Burton, 2010). 'The FORIN

method is based on the idea that the magnitude of losses and damages can in large part be explained by human actions and choices when faced with a physical hazard, including the choice to ignore them or dismiss their significance' (Oliver-Smith *et al.*, 2016: 19). This approach is based on the premise that disaster loss and damages can be explained by examining various contextual and circumstantial drivers that shape a locale and context, for example, environmental degradation, social and economic inequality, poorly planned and managed development with weak and ineffective governance (Oliver-Smith *et al.*, 2016).

3.4.2. Talking to the people: Collecting primary data using semi-structured interviews

The use of interviews (Appendix 1), which assisted in exploring the context and drivers of vulnerability in the area is common in qualitative research (Burk, 2005). Interviews initiate conversations and lead to an exchange of ideas about perceptions, feelings and experiences. Semi-structured interviews can offer an understanding of how and why people 'order' themselves in particular ways (Hove and Anda, 2005). Interviewing people for research purposes can be done using a set of questions as a guideline to ensure that specific areas of the research are covered, but at the same time leaving room for valuable feedback (Burck, 2005) and further additonal question from participants.

In this study, semi-structured interviews were used to collect primary qualitative data from both city officials and community participants. The interviews were recorded using a voice recorder and were conducted using a mixture of English, Xitsonga, IsiZulu, IsiXhosa, Sepedi and TshiVenda. Most of the participants in Setswetla felt more comfortable when engaging and responding in their home language, and the majority were Tsonga and Pedi speaking. A research assistant was used to help with translating and interpreting questions in a language that was understood by participants. The recorded interviews were then transcribed and coded, and sometimes, if needed, supplemented with additional field-observations.

The semi-structured interviews were used to collect primary data and in particular the shared narratives and personal stories that helped in profiling participants and to understand their individual perceptions about the flash floods (Corbetta, 2003). Profiling here is used as a way of recording characteristics and identifying features of the participants that are distinct or similar to other participants. Questions related to profiling included, for example, duration of stay in the settlement, livelihood activities and the number of dependants the participant

supports in his and/or her household. These questions were asked to ascertain issues of capacity and resource access. Questions about what participants thought had caused the flash floods were also explored. This exploratory approach helped in identifying some of the respondents' perceptions of flooding, such as whether they see flooding as purely a physical phenomenon or a combination of physical, political and social aspects.

3.5. Observing research protocol

3.5.1. Ethical considerations

There are ethical considerations that researchers should remember when doing a qualitative study, such as the decisions they take and the relationships they might have with the participants (Babbie, 2012). This means that when conducting research, the research must be carried out ethically or in a manner that does not degrade, coerce or use undue influence to both the researcher and participants.

Before this study could commence, an Ethics Clearance Certificate was obtained from the University of the Witwatersrand ethics committee. The clearance certificate certifies that the researcher has met the University required ethical standards to carry out research on human subjects. For this study a clearance certificate was obtained on the 17th of September 2017 and its Protocol number is H17/07/20 (Appendix 5).

It is essential for a researcher to be aware of ethical issues throughout the process of data collection, because the research has the potential of intruding into the space of target participants (Nwenweli, 2015). Ethical considerations were taken into account for this study, since the participants of this study were considered vulnerable because of the loss they might have suffered as a result of flooding. An arrangement with the Wits Emthonjeni Centre was therefore made to ensure access to counselling services if any participant should require such assistance (Appendix 4). The Wits Emthonjeni Centre offers counselling services to the Wits community and general public.

A letter of permission was also obtained from the two CoJ departments that participated in the study (DMC and EISD). The officials who participated in the study were made aware of the nature and main objectives of the study. Importantly, the issue of anonymity and confidentiality was clearly explained to them as it could not be guaranteed by virtue of their position in the city.

Setswetla participants were fully informed that this study is purely academic, that participation in the study was voluntary, that they may choose not to answer some or all of the questions, and that there will be no direct advantages or disadvantages in participating in the study.

3.5.2. Collecting primary data from participants

The primary data of this study relied on the memory of participants about the events in November 2016. The flash floods occurred on the 9th of November 2016 and the interviews were conducted from the 22nd of January to the 3rd of July 2018. Reasons for the lag in time of event and survey included time taken to setting up the study, gathering data from various sources which needed time to be collated, and gaining ethical clearances. The time lag, however, also meant that participants were able to reflect more on the incident and thereby recall significant information.

Participants were asked to recall and tell what loss and damage (direct impacts) they had suffered as a result of the flash floods, what measures they used to minimise or divert impacts and what conditions they thought are the main drivers of flood vulnerability. Technical terms such as vulnerability were simplified to mean a condition that renders a person defenceless to the impacts of floods. Primary data from the CoJ official's was also collected using semi-structured interviews. The interviews aimed to ascertain the CoJ's capacity to effectively deal with flooding in informal settlements, the dissemination of timeous warnings and, how CoJ officials perceive Setswetla in relation to flooding vulnerability.

3.5.3. Collection of secondary data: enhancing the context and case study

Public documents, such as the City of Johannesburg Growth and Development Strategy, CoJ Climate Change Adaptation Plan, CoJ IDP and, national and international documents such as National Disaster Framework, Disaster Management Act and the Hyogo Framework for Action, were studied to enable a better understanding of some of the complex drivers of flooding in their *wicked* context (Rittel and Webber, 1973). The DMC provided secondary data about the November 2016 floods in the form of reports, maps, spreadsheets and minutes from meetings. Furthermore, EISD also provided reports about previous flooding incidents and maps that occurred in Soweto 2009.

3.6. Thematic analysis: Data handling and analysis

Thematic analysis is a method of analysing data by identifying and reporting patterns in the data (Braun and Clarke, 2006). All information received in African languages was translated and transcribed to English. All voice recordings were transcribed and then uploaded into NVivo, a qualitative data handling software. NVivo software allowed the researcher to create data nodes and sub-nodes, which means dividing data into themes that meet the specific objectives and the research questions. Dividing data into themes helped in identifying patterns in the data and ensured that the objectives of the study are thoroughly met and that the research questions are answered.

3.7. Study area

Alexandra (Alex) is a township in the north of Johannesburg. The township was established in 1912 and is situated a few kilometres away from the Johannesburg Central Business District (CBD) (Nyapokoto, 2014; Wilson, 2017). In 1904, Alex was a farm owned by Mr Papenfus, who wanted to establish a suburb for white people and name it after his wife Alexandra (Wilson, 2017). At that time, Alex was perceived to be far from the CBD and was not marketable to white buyers (Wilson, 2017). Furthermore, the land was unsuitable for habitation (Bonner and Niftagodien 2016). As a result Alex became an area where black people could buy land and hold freehold titles before the 1913 Land Act (Wilson, 2017; Nyakapokoto, 2014).

Alex, as a township, was initially created for about 30 000 people, but its population has been increasing over the years (Nyapokoto, 2014). A participant who is in her early thirties, was born and grew up in Alex explained that the township was planned before many people came to Alex. She explained that as a result of population growth, people have encroached and settled on water and power servitudes, which has made it difficult for the municipality to perform maintenance and repairing of critical infrastructure in the community (Beauty, Interview,06/06/2018). Alex has been functioning without proper municipal services and this has led to the deterioration of the settlement, which is characterised by stinking drains and overflowing dustbins (Nyakapoto, 2014).

Alex, notwithstanding its past and current situation, is described as a ‘special’ place in the context of South African urbanism as it has survived a number of urban formalisation and development methods of the apartheid and democratic government, and yet has maintained its distinct flavour of a South African black urban world (Bonner and Nieftagodien, 2016). Under

the apartheid regime, the Mentz Committee was tasked with giving substance to the 1950 Group Areas Act, an Act which segregated people along racial and ethnic lines (Bonner and Nieftagodien, 2016). The committee recommended that Alex should not be allowed to grow and that its residents should be limited to people working in the northern suburbs (Bonner and Nieftagodien, 2016). Despite the recommendations, Alex grew because the township is strategically located close to residential areas, factories and commercial opportunities (Cirota, 2017).

The traces of the old and new forms of urbanisation thus are visible in Alex, and it is a place to live for an ever-growing Johannesburg population. Population growth in Alex coincides with the projected trends of urbanisation. The township has high rates of informality, unemployment, poverty, social violence and is constantly vulnerable to social and weather extremes. The growth of Alex has grown past the the 'taming' strategies of the Mentz Committee of apartheid, and the Alex Renewal Project (ARP) of a democratic South Africa. ARP aimed at revitalising Alex's physical, economic and social environment but it failed because of alleged corruption (Cirota, 2017).

In the 1980s and 1990s, Alex experienced an increase in population, and high levels of political conflict and mobilisation. This was a period signified by negotiation for a democratic South Africa (Onatu and Ogra, 2013). Alex is now divided into three parts, namely:

- The old Alex, is situated on the west bank of the Juskei River. It is the poorest part of Alex, made up of old hostels and informal dwellings, such as backyard shacks.
- The East Bank was developed in the 1980s and is occupied by middle-class people. East bank is made up of a mixture of RDP houses, social housing flats and houses.
- The Far East Bank, which is now called the 'Tsutsumani' (Mere, 2011; 03) is occupied by middle-class people and is well developed.

The area of interest in this research, as shown in the introductory chapters, is Setswetla informal settlement found on the north-west and partly east bank of the Jukskei River, in the old Alex (figure 3.3*a* and *b*). One of the oldest residents of Setswetla said that the settlement was established in around the 1980s:

> *Setswetla was established in the 1980s…around 1984 and 1987... UmaGogo paid a permit in 1987. They were placed here and they had to pay to the municipality…In 1994*

> *and 93 we used to pay at ext. 12 [our] permits. We paid 12 rand for ashes…* (Mam'Nongena, Interview, 08/02/2018).

It should be noted that it is somewhat contested whether Setswetla is part of Alex or not. For the purposes of this study, Setswetla is assumed to be part of Alex, because most of the official reports from the DMC and literature used such as Bonner and Niftagodien (2016) and Mere (2011) treat Setswetla as part of Alex. The 'sense of place in Setswetla is critical to understand vulnerability because some residents felt that the settlement is marginalised and excluded from development that takes place in the greater Alex (Bonner and Nieftagodien, 2016).

Setswetla settlement lies on an unstable, dangerous illegal dump infill and lies below the 100-year flood line (Onatu and Ogra, 2013). Many people who reside in Setswetla are unemployed and are said to be coming from the rural parts of South Africa and some from Southern African countries such as Mozambique and Zimbabwe (Official 3, Interview, 31/05/2018).



Figure 3.3*a*: Alexandra in relation to Johannesburg (Google Earth, 2017)



Figure 3.3*b*: Area of interest, Setswetla section (Google Earth, 2018)

3.7.1. Presenting a case of Setswetla: The naming of informal settlements

In South Africa, informal settlements, such as Setswetla, are largely a consequence of apartheid forceful removal, segregationist policies and white racial supremacy systems (Montana, 2016). But, in the current era of global change, rapid urbanisation and population growth also contribute to the proliferation of informal settlements in Africa as noted by Beall and Fox (2009) and Doytsher *et al*. (2010).

It is common for South African informal townships to be given names of apartheid struggle heroes such as Mandela, Tambo or to have positive African names which denote some level of hope such as *Zakhele*[2], *Vukuzenzele*[3] *Khayelitsha*[4] or *Imizamano yethu*[5]. But, Setswetla settlement has an odd name, which means 'nakedness'. The name also comes from Spoke H song titled "*Stjwetla*" a song about a modern dance, which is twerking while naked. The name of the settlement provides some indication of the vulnerability context of the area, as people are settling where they are 'naked' and exposed to social and extreme weather vulnerabilities.

3.8. Access to the Setswetla community and the City of Johannesburg

3.8.1. Setswetla

Access to and engagement with residents in Setswetla can be limited to outsiders because of fear and distrust between a researcher and the community. I was introduced to Setswetla by the Microscopia team in 2017. Microscopia is a non-governmental organisation (NGO) that was conducting community workshops with the people who were affected by floods with the aim of building communal capacity and creating social networks that will enable community members to deal with issues around vulnerability to extreme weather events and social violence. This study was introduced in the workshops, which then enabled me to establish relationships with some key community members and leaders, and that built some level of trust between myself and the host community. In addition, the use of a local resident to assist with data collection further lowered any barriers of engagement between myself and the participants.

[2] Build it yourself as section in Bekkersdal, Westrand
[3] Wake up and do things for yourself, in Westrand Randfontein
[4] New home
[5] Our efforts in Cape town

The process of identifying relevant participants was a challenge because when data were being collected, some of the people who were affected by the 2016 floods were still building shacks and others were coming to see if they could find space to live. Some of the flood-affected people, maybe because of their status[6], fear victimisation or think that their participation might be traced back to them. Therefore, they refused to sign participatory forms, give their names or participate in the study. Some of these participants wanted to know who participated before them and how did they respond to the questions that were asked. They wanted to answer the interview questions in a similar manner to the previous participants and maybe to ensure that they did not provide deviating information. It was explained to the participants that they cannot access information from previous participants because the information was confidential. It was further explained to them that their experience and perception of the 2016 event was important for the study. They were then given an opportunity to proceed or withdraw from the study.

3.8.2. The City of Johannesburg

I was introduced to the CoJ officials by my supervisor Professor Coleen Vogel. I maintained contact with the officials and attended several meetings arranged by the CoJ to keep up to date with the latest information regarding flooding in the city and to have access to key information.

Through the relationship between the Global Change Institute and the CoJ, I was also able to access key information about the 2016 flash floods from DMC, and attend CoJ meetings at DMC offices. I also gained access to previous flooding reports at EISD offices, such as the 2009 floods that affected Orlando West, Soweto.

The key information from DMC came in the form of minutes, reports, pictures and disaster incident registers. A disaster incident register is a spreadsheet that records events that are of a magnitude that requires the intervention of disaster management, and the prominent incidents in the study were flooding, shack fires and xenophobic attacks[7]. In addition to the official DMC documents, an interview was secured with the DMC awareness officials who were heavily involved in Setswetla before, during and post the 2016 floods. The interview covered the role of DMC, the issuing of early warnings, official's perceptions of Setswetla, drivers of flood vulnerability in Setswetla, profile of the settlement and, the capacity of DMC currently and in

[6] Citizenship in particular
[7] No xenophobic attacks were recorded during the 2016/17 year in the area.

the future to cope with similar events. Similar themes were also covered in the interview with one of the officials at EISD.

Towards the end of writing up the research, I also obtained an internship at the CoJ, under EISD which commenced on the 3rd September 2018. My internship has not biased my research but has rather enabled me to enrich my understanding of the role of city officials and the CoJ regarding issues of flooding and vulnerability.

3.9. Who am I dealing with? Participant identification and characteristics

After obtaining an Ethical Clearance Certificate, community participants were identified using a snowballing research technique and with the help of a research assistant. After an interview, some interviewees were asked to refer us to other people that they may know who were affected by floods. The research assistant was a local and was familiar with the dynamics of the community. The research assistant was identified through the recommendation of local leadership.

The research assistant undertook transect walks with me to areas that I would not have accessed if I was working alone or with someone from outside the community, areas such as where the shacks were previously located before the floods. The transect walks helped me in understanding the layout of the settlement, to see how basic services such as water, electricity and toilets are located, and how the community has modified the services to meet their needs. Transect walks enabled me to 'live' in Setswetla and engage with the settlement and its people.

The majority of the participants from Setswetla are originally from Limpopo Province, from regions such as Malamulele, Giyani, Thoyandou, Pietersburg, Polokwane, and a few participants are from the Eastern Cape and Kwa-Zulu Natal Provinces, and neighbouring countries such as Mozambique and Zimbabwe. Various life circumstances have brought the participants to Setswetla. The main common reasons that drove them to settle in Setswetla are poverty, livelihood opportunities and avoiding paying high rent. Most of the participants' livelihoods are based on piece-jobs such as working as domestic workers, casual construction work and informal trading. Informal trading is the major supplier of household food supply and income in the settlement:

> "*I came to Setswetla to find work, so that I can take care of my kids. There is no one to work and look after my kids beside me…I [sell vegetables] to ensure that my kids are taken care of*" (B Lady, Interview, 05/05/2018).

> "*For now I am not working. I make a living out of piece-jobs; sometimes one of my guys takes me to assist in DSTV installation. Others take me for wiring, I do many things. I do not sleep with an empty stomach. For now I am alone, my girlfriend is at home.*" (Bricklayer, Interview, 12/04/2018).

The participants had different aspirations in relation to the settlement. Some aspired to move out of the settlement when they have enough money to buy or rent a house. Mabunda, for example said, that when he affords another place, he would like to stay in a place that is spacious and has proper sanitation and water infrastructure (Mabunda, Interview, 07/04/2018). On the other hand, Bricklayer felt more comfortable in Setswetla and said that if development was to happen, it must happen in Seswetla (Bricklayer, Interview, 12/04/2018).

3.10. Limitations

This study was carefully planned and carried out, but there were some unavoidable limitations. Conducting research in an informal settlement has some challenges (Montana, 2016). Participants, who stayed together as partners were interviewed together. There is a possibility that responses might be influenced in such situations. When data were analysed, I was cautious of this possibility by supplementing the responses with field notes.

The flooding event happened in November 2016, and data collection began in January 2018. Thus, there might be a possibility of telescoping and exaggeration on the responses. Telescoping is recalling of events that happened at one time as if it happened at another, such as recalling an event that happened long ago as if it happened recently (Prohaska *et al*., 1998; Ziniel, 2011).

Participants were asked to recall what happened before, during and after the floods. The participants may have recalled events chronologically incorrectly. During the analysis the response of participants was compared and those that listed a similar chronological order of events, was taken as supporting a more accurate timing of events – a form of triangulation.

Another dimension is trying to capture the costs and loss and damages of flooding events. Establishing the costs of flooding events is, however, extremely difficult, both direct and indirect costs. Participants were asked to recall and estimate the cost of damage caused by the

floods. There is a possibility that some of the participants might have estimated the lost significantly high to attract sympathy and receive attention. During data analysis, participants'responses were read and analysed holistically, taking into consideration previous and current livelihood activities to ascertain whether livelihood matched the losses.

4. THE FINDINGS FROM THE SETSWETLA CASE STUDY

4.1.Introduction

The results of the study that were gathered through semi-structured interviews are presented in this chapter. The results are presented with reference to the research questions and are guided by the vulnerability framework proposed in section 2.5 and the 'hazard of place' Model areas as highlighted in Figure 2.2.

Below is a description of what happened on the 9th of November 2016, the impact of the flood event, the nature of losses, perceptions of flooding by the residents, the drivers of flood vulnerability and some of the coping mechanisms and responses used to avoid flood impacts.

4.2. Biophysical vulnerability: The impacts of the November 2016 flash floods in Setswetla, Alexandra

Flash flooding in Johannesburg is a result of high intensity Highveld storms on urban catchments. Many of these events trigger emergency responses as property and life are threatened or tragedy occurs. While everyone in the city is at risk of experiencing these high intensity storms, there are areas where the hazard risk will be higher such as in densely populated areas, economically marginalised communities, high traffic areas, river crossings, developments on flood zones, and others' (Dunsmore *et al*., 2017:1). With climate change, the intensity and frequency of extreme weather events are projected to change, which might also make it hard to predict storms (Dunsmore *et al*., 2017; Poolman *et al*., 2014).

The impacts of the 9th of November 2016 flash flood event that occurred in the late afternoon, when most people were making their way home from work, were widely reported and documented on various online media platforms by individuals and news reports. The flash floods affected both the formal and informal sectors, and human dwellings in Johannesburg. People who witnessed or experienced the impacts of the flooding event, shared pictures of the event on social media platforms, such as twitter (Figure 4.1-4.4).

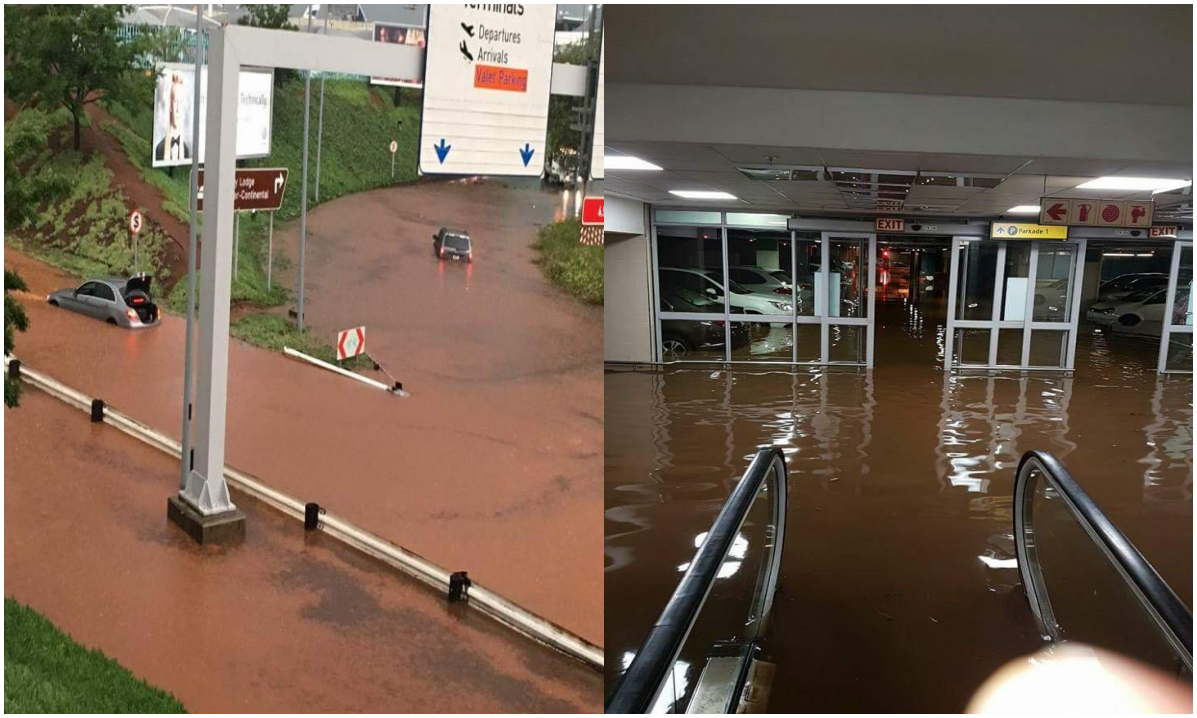


Figure 4.1: Twitter images: The routes and parking at Oliver Reginald Tambo airport were affected (Tendai, 2016).



Figure 4.2: Twitter image: A flooded home (Sindy, 2016)

The DMC reported that some of the Johannesburg homes were flooded and that at least about three people lost their lives along the N3 highway in Linksfield, a suburb surrounding Alex

(Disaster Management Centre, 2016c). About 80 vehicles were stuck on the N2 highway near Linksfield, and motorists were forced to abandon their vehicles on the submerged roads (EWN, 2016). Some Twitter users shared pictures and videos depicting the spirit of *Ubuntu* (humanity) which is the founding principle of the democratic South Africa. They shared pictures and videos of people forming a human bridge to rescue those who were stuck on their vehicles on the flooded N2 and N3 highways (Figure 4.3 and 4.4).



Figure 4.3: The spirit of *Ubuntu* (Emer-G-Med, 2016). **Figure 4.4: The spirit of *Ubuntu* (Mareme, 2016).**

4.2.1. CoJ Disaster Management official reports

The CoJ DMC released a situational report on the 20th of November 2016 to update all relevant stakeholders about the impacts of the flash floods, and the actions that were taken to respond to the needs of the affected communities. Table 4.1 shows the impact of the extreme weather event on the N3 Highway and Alexandra Township, which were areas that received wide media coverage in the northern parts of Johannesburg and are proximate to the area of study and the Jukskei River basin.

Table 4.1: Extreme weather conditions disaster incidents monitoring situational report (Disaster Management Centre, 2016c)

Incident date: 09 November 2016 20 November 2016 as at 17h00

Affected areas: Ward number and Address	**Concern**	**Impact**

N3; Linksfield off-ramp	Roads flooded	• 3 fatalities:
		  ○ 2 Females = 1 African and 1 Indian,
		  ○ 1 African male.
		• Cars washed away: 08 cars were recovered and kept at Wemmer Complex, JMPD.
		• Traffic congestion.
		
		Status quo
		• All 3 bodies were claimed by their families
		• 7 cars were collected. 1 not yet collected by the owner.

Ward 109, Setswetla	Roads and houses flooded Some houses were swept away	• 3 year old girl missing • No fatalities confirmed yet • 373 households • 862 individuals
Ward 116, Alexandra, No. 60,1 9th Avenue, Rev. Sam Buti Street Old Zenzele Church Ward 76: 20th Avenue Ward 105: 20th Avenue	Houses flooded	**Latest statistics:** • South Africans 258 Adults and 109 children impacted • Foreigners Zimbabwe: 40 adults and 09 children Mozambicans: 25 adult and 09 children **Total number: 452** Adults: 323 Children: 141 Households: 168

The impacts of the floods as recorded above provide a view of some of the risks and losses. The impacts recorded, however, are largely comprised of impacts categorised from a biophysical understanding of drivers of risks and loss. Understanding of how the social fabric and social vulnerability are shaped and configured and, how they drive impacts remains a key concern and challenge. By focussing on the local scale (e.g. household level) the magnitude and severity of the impacts and the role of how social drivers configure and shape the vulnerability that ultimately translate into losses is enabled. Incident registers that are kept by

the DMC are, for example, one form of evidence and information that is used to recapture the flood event and guide plans for future events.

4.2.2. Capturing loss – disaster management inventories

The DMC incident register recorded two flooding incidents in Alex region E, ward 105 and 109 (Figure 4.5) (DMC, 2016d).

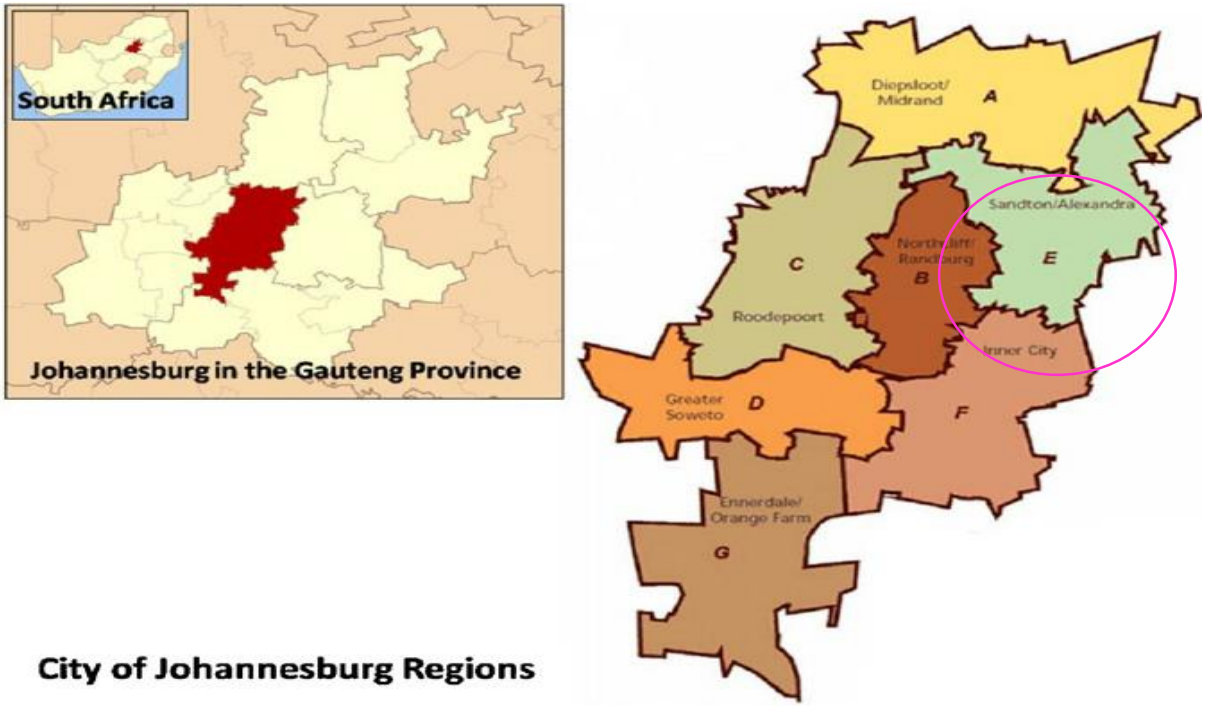


Figure 4.5: Johannesburg regions (Nastar and Ramasar, 2012:14).

In region E Setswetla (Figure 4.5), floods damaged about 450 dwelling structures (shacks), displaced 988 individuals, and one person lost their life (Disaster Management Centre, 2016a). The Disaster Management team went to the affected communities to do a need's analysis and damage assessments. A needs analysis is used to evaluate the extent of the flood impact on the livelihood of people, and it was used to establish what interventions are required to ensure that basic human needs such as food and shelter are not disrupted (Public Safety Mayoral Committee Disaster Management, 2016b). Damage assessment is used to try and determine where most loss and damages occurred and then determine the extent of such damage.

It is imperative that information about disaster impacts, loss and damages be thoroughly recorded and understood from both a biophysical and socio-economic drivers of vulnerability perspective. Such understanding is important forinforming interventions (e.g. helping restore normality in a situation). Probing such records may also help in longer-term disaster risk reduction, in climate change mainstreaming, and for assisting in one of the core tenants of the Sendai Framework namely 'building back better' after a disaster (Menoni *et al*., 2016; Sendai Framework, 2015). To build back better, local governments need to prepare and review their preparedness and contingency plans by taking into consideration climate change scenarios, past events, vulnerability context and engaging with relevant stakeholders (Sendai Framework, 2015). This can only be possible through adequate and reliable available data.

The DMC, for example, found that most of the people who suffered severe flood impacts were located along the Jukskei River banks in Setswetla (Public Safety Mayoral Committee Disaster Management Centre, 2016a). A Joint Operation committee was activated to coordinate stakeholders and to ensure concerted response and planning (Public Safety Mayoral Committee Disaster Management, 2016b). A verification process was also conducted on the affected people by the DMC working with community leaders and the Department of Housing, social development and home affairs (Public Safety Mayoral Committee Disaster Management, 2016b).

The affected people were then divided according to their gender and were then placed in temporary shelters. Males were placed in a tent owned by a local church while the women and children were housed in a local crèche (Public Safety Mayoral Committee Disaster Management, 2016b). Participants who were accommodated in these temporary shelters expressed dissatisfaction with the temporary accommodation arrangement noting that they were at the mercy of the parents who paid the crèche for their children and the pastor who owned a tent.

The temporary accommodation arrangement for some was a severe and sudden dislocation from everyday life, and it interferred with private family life. Respondents said that living in temporary shelters was a strenuous arrangement that strained private family life and also fed uncertainty and fear as it took longer than necessary to restore life back to some sense of normality. Esihle and Jabu recalled how their lives were impacted, living in a temporary shelter after losing everything to the floods:

> "*After everything was swept away by the floods, women were sent to a crèche and men to a tent. It was hard! When you woke up you had to take your belongings. You can't leave them there, it is a crèche…kids [had to come in and] study. We had to [go to] The Greenhouse to bath. It was actually stressful, was stressful! We stayed there from November 2016 to April 2017*" (Esihle, Interview, 30/01/2018).

> "*I stayed in the tent [for] a few days…you know we have partners. You cannot take [your] lady to a tent. I ended up going to my brother's place*" (Jabu, Interview, 23/01/2018).

Some of the people who were affected by the floods made private alternative accommodation plans with friends and families. Baba H, a 55 year old man, went to stay with his in-laws and Sweetness, a female, went to stay with her friend. They also recalled how life differed when they were living in someone's home:

> "*When I lost my shack I did not stay in a tent. I went to stay with my in-laws. This body is not for a tent. [At] the tent when you sleep, they steal your stuff. It is hard to stay there. I lived well with my in-laws, but [it is more comfortable when you stay] at your home…No one could visit [me] at my in-laws. I had [to] wake up at a particular time determined by my in-laws. [I] could not be free there. It [was not my] place; everything [gets] done for me*" (Baba H, Interview, 30/01/2018).

> "*I heard that people were accommodated in a tent. I was not comfortable with that arrangement because I had to wake up and go to work. That would have required me to go around asking for a place to bath. Then I realised that I would stay with a friend for a while. Nothing much changed when I was living with [my] friend*" (Low voice, Interview, 7/04/2018).

The affected residents were later allocated spaces to rebuild their new homes several months after the flood event occurred. The community leadership of Setswetla identified a space within the settlement that was used for food gardening, and then allocated it to people who were affected by the 2016 flash floods so that they could rebuild their shacks and lives (Figure 4.6*(a)*and (*b)*). People who were already utilising the garden spaces took advantage of the situation and started selling portions of spaces to any person who wanted to erect a shack and could afford to buy a space (Community leadership, Interview, 08/02/2018). Consequently, this brought a variety of people from in and around Setswetla, who were looking for a place to stay:

> "*When we removed people from the tent/ [crèche] to the garden…. [That] opened a flood gate of people taking advantage of the situation [because] People who were already there, before the victims started selling spaces for R3500 to R4000*" (community leadership, Interview, 08/02/2018).



Figure 4.6*a*: The garden space before being given to people to build shacks (Google Earth, 2018a)

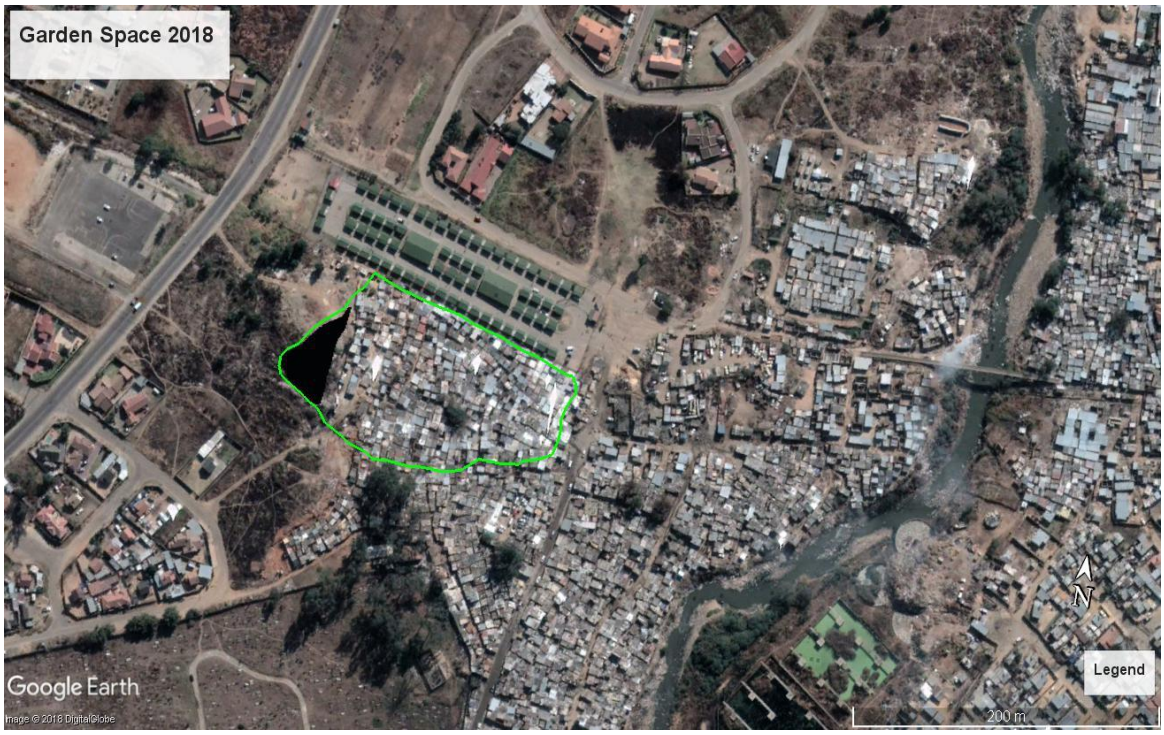


Figure 4.6*b*: The garden after those who were affected by floods moved in (Google Earth, 2018b).

After the community leadership allocated spaces to the people who were affected by floods so that they can rebuild their dwelling structures away from the Jukskei River banks, a variety of building materials were used to rebuild dwelling structures. The materials included plastics,

wooden boards and bricks, depending on the means of each family or individuals. In addition to the loss and damages from the floods, the people who were affected by floods had to buy building materials and sometimes hire people to build their shacks. Other participants, because of desperation and fear of going back to Jukskei River banks, admit to having bought spaces to speed up the process of securing a safer home. It was not clear in the interviews as to why those who had the means of buying portions of land could not do so earlier.

Rebuilding came with a significant cost which further disrupted the resource pool of the participants. They were cases when people would build and the municipality would demolish their shacks. It was mentioned that JMPD came with Red Ants to demolish the new shacks:

> "*We used corrugated irons and wood as pillars. I do not know how much it cost to rebuild because we did not build once. We marked and built the first time and the police came and destroyed. The wooden boards broke and some were taken away. We built again the second time; they came again and demolished the shacks. We rebuild the 3rd to the 5th time and they came to demolish the shacks again. On the 6th time, we did not put much effort into building a proper shack as you see, because we anticipated that they will come and demolish the shacks again. The shack is built in a way that will make it easier to dismantle it. These guys come with trucks to take the material we used to build, so it will be easier to disintegrate this shack before they get to it. This time they did not come back to destroy, because we have a couple of months staying here. The wooden boards are about R600, therefore it should be around or more than R7000*" (Big Shack, Interview, 01/03/2018).

The community leadership negotiated with the city's law enforcement agencies and other interested parties to find common ground and allow the flood-affected individuals to erect shacks (Community leadership, Interview, 08/02/2018). Other participants were constrained by the selling of spaces that were already sold to other people:

> "*We bought the space at a cost of R2500.Not sure about the cost of rebuilding, because we would build and they*[8] *will destroy. I estimate that building alone costs about R2000. It started from the person we bought the space from, he dismantled the shack. We had to take the material and look for another space. He doubled sold the area before. I hired people to build. I used wooden board and cemented the floors*" (Chickens, Interview, 01/03/2018).

Allen *et al*. (2017) notes that invisible everyday risks and small-scale disasters, such as floods, fires and landslides, occur frequently and have significant impact on livelihood and assets of

[8] The other buyer and the seller

low-income communities. What was significant about the 2016 floods is that they were big enough to be declared a local disaster. Small flood incidents usually do not make it to the media and incidents registers, and they are the ones that have cumulative effects because they go unnoticed and pave the way for bigger disasters.

In Setswetla, sixteen households provided a detailed account of what it had cost them to rebuild their new homes. The estimated expenditure of rebuilding included buying building materials, hiring people and transportation (Figure 4.7). The majority of people spent between R0 and R2000. Two participants explained what they used to build their new shacks and how much they paid:

> "*The current shack is made up of wooden boards, corrugated iron, and cemented the floor. The cost depends. I didn't buy the wooden boards. The roof [corrugated iron] was R600; transportation cost was R250, paid R50 to some guy who helped the transport person. The whole process was around R2000*" (D' bongz, Interview, 22/01/2018).

> "*To build the current shack we used corrugated iron and wooden boards, [floors are] not cemented. We got the materials in bits and drapes. I think it is approximately R500 because some of the things we got them from neighbours. I only [just] started working* " (Zola, Interview, 30/01/2018).

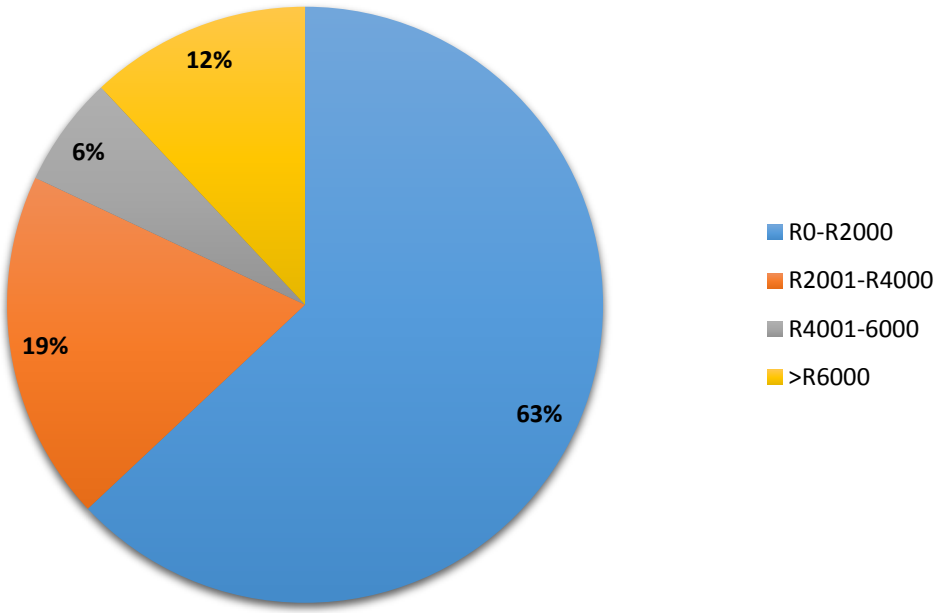


Figure 4.7: Estimated expenditure of rebuilding the sixteen households.

Wooden boards were the most used material because they were easy to get since Setswetla is near Wynberg, an industrial area (Figure 4.8). Furthermore, wooden boards are cheaper than corrugated iron.

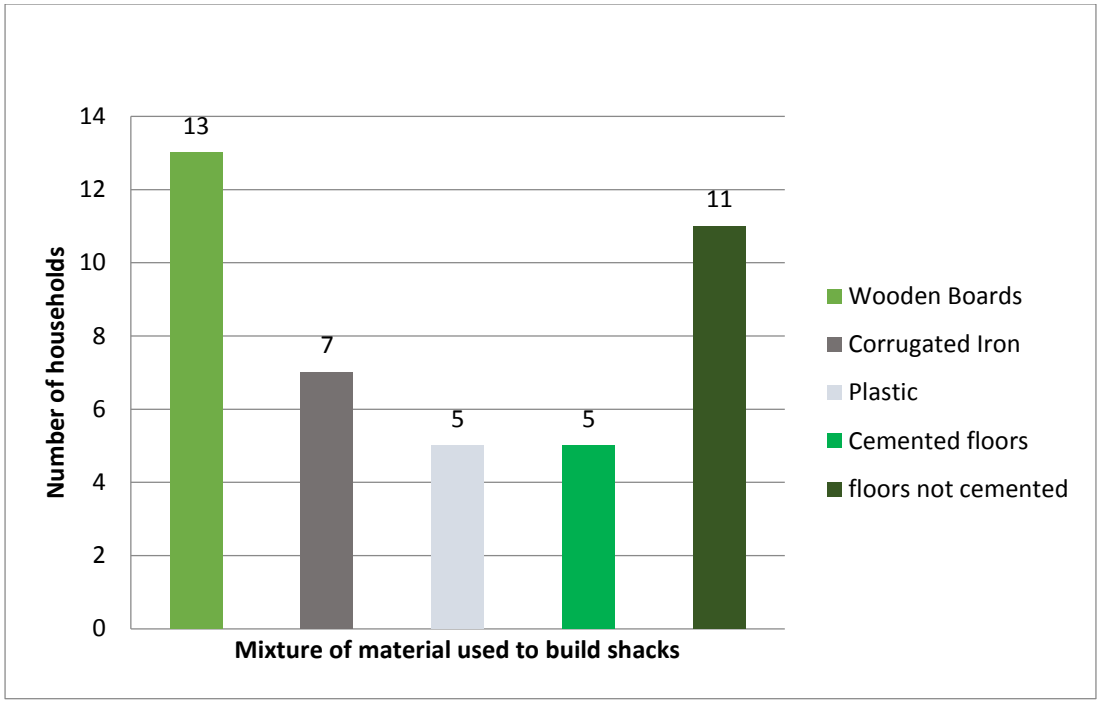


Figure 4.8: Material used to rebuild shacks.

Other costs were incurred for repairing damaged items. A business lady, who is not a resident in Setswetla but who owns a business situated along Jukskei River bank on 20th Avenue, stated that her business continued and that the only problem was that the working space was dirty from flood debris and that her generators need to be repaired. The cost of repairing both of her generators was about R13 000. She further noted that she had insurance which she could use to try and recover the costs of the items that were completely destroyed or lost. Another lady, living in the same street with the business lady had to do everything for herself and to rely on family and friends said:

> "*The situation was tough my brother...very tough!...Because many of the stuff I have already bought were damaged. I felt as if I am working backward. Like an expensive [TV] stand just collapsed...How will you fix it?... [But] the fridge was fixed because my husband asked his friend who knows how to fix it. We tried to patch there and there. Another brother gave us that cupboard… we had two wardrobes…You can see now we*

> *have patched [it] so that we can have a place to store our clothes*" (Ma20, Interview, 06/06/2018).

The aformentioned records captured the extent of the flood impacts in Setswetla. Participants' responses however provide a more nuanced first-hand experience and also provide a more personal insight into the flood impacts at both a personal and household level. Participants' responses have also captured the insidious nature of flood impacts, which usually do not make it to the disaster registers of the CoJ. The insidious nature of impacts takes many forms and they are often not recognised and may persist during and after official disaster interventions.

4.2.3. The nature of the flood loss and damages

Setswetla settlement suffered massive loss and damages as a result of the 2016 flash flood event. Some residents were displaced and lost most, if not all, of their belongings to the floods. The flash floods affected the community in various ways and scales, both directly and indirectly. According to the Public Safety Mayoral Committee Disaster Management report, a girl aged 8 years lost her life. A participant who witnessed the moments before the death of the girl told of how the father was trying to save his children from the floods by climbing a tree. A branch broke and they fell back to the shack that was already filled with water, and the girl was swept away. After two weeks, the body of the girl was found by construction workers in Burchleu, a few kilometres from the settlement (Public Safety Mayoral Committee Disaster Management, 2016b).

The timing of the flash floods seems to have also coincided with a period when many individuals had saved their monetary resources for the end of the year. Thus, the flash floods destroyed already accrued materials and financial resources. Most of the participants said that the floods dragged them backwards, as they had to start over again to cover the loss ources of income and livelihood were also dramatically disrupted by the flooding event. A female who owns a vegetable stall could not sell anything after the floods. She converted her stall to be her temporary shelter after her house had collapsed.

> "*The flooding event affected me immensely. I had already bought myself, kid and wife some clothes. All those things where swept away, and that required me to start afresh. At that time we were close to December and I have already received my pay. I was only left with one month payment and some minor bonuses. I tried patch were I can but I could not do everything*" (Peace, Interview, 30/01/2018).

> "*I lost blankets, fridge, TV and, groceries from the society (Stokvel) Peanut butter (6 pack) worth R300*" (Esihle, Interview, 30/01/2018).

Some of the people in the settlement did not have access to financial services, such as banking, because of the nature of the work that they do. They also did not have legal documents such as proof of residence, identification documents and proof of income to ensure access to financial services. As a result, they keep all of their earnings at home. These social dimensions are revealing for they show where and what is contributing to the vulnerability of residents. One resident, for example, recalled how a Zimbabwean resident cried because all the money that was stored inside a shack got swept away with the shack by the floods.

4.2.4. Numbers do not lie: Some of the main losses

The main direct losses were home items and the destruction of dwelling structures in the community (Table 4.2). Some community members suffered partial destruction while the majority of dwelling structures along the Jukskei River banks were totally destroyed. Out the total of forty two participants, ten Participants were asked to estimate their loss in monetary values (Table 4.3). One of the participants estimated that his loss in monetary values was between R18000 and R27000 because he was a business man and that he had items such as a stove, double bed, wardrobe and some other furniture (Nyiko, Interview, 22/01/2018).

> *I had 8 new corrugated iron that I bought, from Langlaagte. The R20000 you telling me about is money I can use to buy booze on a weekend and relax for a month. I am a business man, I own a taxi* (Nyiko, Interview, 22/01/2018).

Table 4.2: The main items lost to the flood

Bed	Kettle
Kitchen cupboards	Computer equipment
Fridge	Groceries
Music systems/equipment	School stationary/materials
Shacks (dwelling structure)	Wardrobes
Clothes	Cooking appliances
Identification documents	

Table 4.3: Loss in monetary values

Loss in monetary terms	Number of people
R0-R9000	3
R9000-R18000	2
R18000-27000	1
I lost a lot/unquantifiable/I do not know	4

Material loss was generally considered to be minor compared to the loss of life. Some participants expressed that material things could be replaced or repaired, but not life. The loss of a child's life was seen as a major loss:

> "*The ones that lost a child are the ones that lost a lot, us [who] lost belongings are better; they won't see or give birth to the same child*" (Big Shack, Interview, 01/03/2018).

> "*In my opinion the people who have lost more than anybody, are the ones who lost a child as a results of the floods*" (Rhulani, Interview, 7/04/2018).

> "*The only person who can feel a sense of severe loss when thinking about the event is the person who lost the child*" (Baba H, Interview, 30/01/2018).

The above notions of loss are also essential to capture as they are direct losses, and they all show, however, that losses can take different forms and that major losses cannot be just a 'number' and or 'statistic'.

Direct losses were also felt at a municipal level. The DMC recorded that services such as transport, water and electricity were interrupted around ward 105 and 109 (Public Safety Committee Mayoral Disaster Management, 2016a). For the municipality to repair damaged infrastructure and restore services it was estimated to cost millions of Rands (Table 4.4). To restore the proper functioning of the road infrastructure in Region E the CoJ personnel had to work overtime to clear blocked kerb inlets and patch damaged road surfaces (Disaster Management Centre, 2016d).

Table 4.4: Cost estimates for direct damage to municipal Infrastructure (Dunsmore *et al.*, 2017).

Infrastructure	Estimated cost of repair
Bridge repair or replacement	R64 million
Parks facilities, including some river repair	R7.3 million
City Power (no breakdown)	R0.3 million
esburg water (water and sewer)	R3 million
Sub-total	R74.6 million

The former President, Mr Jacob Zuma visited Setswetla to address the affected people, to instil hope and to affirm that the community will be assisted. Following the visit, the event was declared a provincial disaster since the impact affected the City of Tshwane, Ekurhuleni and Johannesburg (Public Safety Mayoral Committee Disaster Management Centre, 2016b).

4.2.5. Hidden losses

Intangible, hidden loss and damages, often difficult to gather and interpret, are also a key part of the social fabric and social vulnerability dimensions when using a 'hazard of place' approach. Issues such as feelings, trauma and other psychological disturbances are an integral part of informing what types of interventions may be required. Indirect losses arise from the occurrence of an event (e.g. delays, disruption of supply, lost working hours, earnings, etc. as a result of flooding), which can be quantified if data are available (Pelling and High, 2005). Participants expressed trauma and hardship as a form of intangible loss when they were asked how it was to be homeless and to lose all that they have worked for to the floods:

> "*When [your] shack is swept away, you feel pain. It changes the whole routine. You become so stressed because there is nowhere else to stay. You go to neighbours just to get yourself clean. Sometimes you use tins to bath yourself*" (Big Shack, Interview, 01/03/2018)

> "*Imagine staying in a crèche with a 3 week old baby. By 5am you should be up. Where do you go to after waking up that time with a 3 week old baby? The people at the crèche were only helping us to have a sleeping place. It is a crèche; there are people who have paid so that their kids can attend there*" (Mbali, Interview, 07/04/2018).

> "*We were like mad people after the floods, we had no ID books. We had absolutely nothing! Life changed a lot, they did try to get us new ID documents but life still remained changed. Life was difficult, we had to start from scratch and look for a place to stay*" (Mama Z, Interview, 05/05/2018).

'Human mental health and wellbeing, is increasingly being jeopardised by the rising trends in population exposure to severe natural hazards and extreme climatic events' (Reifels, 2018:1). Loss of a dwelling structure and identity documentation has a significant bearing on human dignity and self-worth as elaborated by Mama Z. Disaster impacts on mental health are rarely interrogated and reported upon, though it facilitates recovery and rebuilding (Reifels, 2018). It is documented in the DMC reports that the city did offer psychological services to the family who lost a child, but nothing was reported about extending such services to the wider community that was affected by the floods. Having provided some of the impacts that occurred attention now turns to further investigate the social fabric and social vulnerability dimensions that emerged.

4.3. The social fabric and social vulnerability – drviers of vulnerability in Setswetla

4.3.1. Perceptions of officials and citizens on Setswetla's vulnerability to flooding

As it will be shown below some of the city officials perceived Setswetla settlement as a transient community that attracts the lower working class of South and Southern African rural citizens who want to access the city for a better life. South African rural and foreign migrants often see an opportunity to reside in Setswetla because it is cheap to live in the settlement and a person can survive with minimal resources in the settlement. Two participants, for example, explained how cheap it is living in Setswetla and Alexandra:

> "*It is better [for] a person to leave renting [and] find his own place. Because when you are at your own place …The money you earn, can be effectively used, you can budget! You can send half at home or even [more than] half of your salary can [can be sent] home…Here in Alex if you have R50 is like you have R5000, you can buy chicken feet and intestine for as little as R5…You eat, sleep and [then] prepare for another day of work*" (Baba H, Interview, 30/01/2018).

> "*I do not like it here... [There are] piece-jobs at least…in other areas people are suffering. You see here, you can get a cabbage for R2... If I can go and live in Braamfischer, I will not get these things... You see!*" (X lady, Interview, 06/06/2018).

Thus, living in Setswetla, was considered to be a more viable option by the participants as it is cheaper or free. Setswetla was also thought to be accessible to livelihood opportunities such as piece-jobs compared to being relocated in faraway places like Braamfischer. Similar to the case study of Missionvale, Port Elizabeth, participants reconciled themselves with flooding because the settlement was accessible to services such as schooling (Siyongwana *et al*., 2015).

In Setswetla a livelihood was said to be affordable because people were able to afford basic food products and even send money to their families in rural areas with their piece-job's income. Setswetla is part of Alexandra, and therefore relatively, closer to Sandton and the Wynberg industrial area. These areas offer employment opportunities to some people in Setswetla. Therefore, Setswetla is strategically positioned close to spaces of work opportunities and livelihood as was the case in Missionvale (Siyongwana *et al*., 2015).

Economic capacity and stability plays a major role in vulnerability and risk reduction for informal settlements because it can alter personal and household vulnerability status. It can also broaden people's choices; people with money can pay rent and live in less vulnerable or secured locations. Thus, being cramped in an informal settlement, to sustain personal and family livelihood seemed to be feasible for the participants because it enabled them to access economic opportunities, and to fend for themselves and their families in rural areas.

Furthermore, one CoJ official gave a detailed official perception that the City has about Setswetla, which can potentially enhance vulnerability to flooding:

> "*[Setswetla] community could be transient. They may be here now and [not tomorrow]…Also the city has this thing at the back of its mind that these people are not supposed to be [t]here in the first place…They are supposed to move! So as a result it becomes a catch 22 for you to have sustained programs [with such] communities…Your priority is to…try and move them from what you consider to be harm. [Setswetla] is not connected to services in the city like roads. I could see when we went to just check [the settlement, that] gaining access to some of those spaces was actually difficult. There was a sense as well that there [some members of the community] are from other parts of the world… [Like] Mozambique. So they may not have readily available connections around them and the city at large…Socially they then only have to cling together only as [immigrants] and they may feel that they want to be withdrawn from the city [and] not even engage [with it]. The sense that these people need to be documented and things like that could [also]…lead people not to go out and seek information or be part to*

> *whatever that could be done to improve that situation*" (Official 1, Interview, 29/06/2018).

The CoJ official has highlighted some crucial points and perceptions about informal settlements in Johannesburg, in particular Setswetla. As noted in the cited cases of urban flooding in Chapter 2, a number of informal settlements including Setswetla are found on vulnerable marginal environments. As a result, when the CoJ is dealing with disaster incidents in informal settlements, the main priority is usually to remove the people from what the city deems as unsafe environments that are exposed and sensitive to flooding. Removing residents, however, is not always possible, especially in the CoJ because of limited appropriate and available land for human settlement to accommodate the ever-growing population.

The settlement is also perceived as an entry point for the poor to access the city, which makes it more difficult for the city to have solid vulnerability alleviation programs because once the people are stable in terms of livelihood they move out of Setswetla. The DMC highlighted that they conduct disaster risk education and awareness programmes in Setswetla, which are designed to make the community aware of the dangers associated with settling in the low-lying areas and along Jukskei River banks. But, these awareness campaigns may be fruitless if the individuals in the community keep changing overtime.

Lastly, the issue of citizenship also emerged as a key theme in this research and will be detailed in the next section. The perceived citizenship status of residents may have a bearing on how the city responds to the needs of Setswetla residents. There is a sense that the city's priority is to service South African citizens first. Even the current CoJ mayor (Mr Herman Mashaba) has been vocal on various media platforms about the issue of undocumented immigrants, saying that they are many in CoJ municipality (Radio 702, 2018).

4.3.2. South Africa belongs to all who live in it: Citizenship and belonging drives vulnerability

Citizenship or lack thereof was highlighted as one of the underlying drivers of flood vulnerability in the community. For the purpose of this study citizenship is used as one and the samething as dentity because they can both denote some level of belonging or a legal status that is granted to individuals by state bodies which allows people to hold and access rights (Sant *et al*., 2016).

Community leaders, city officials and residents have repeatedly expressed that it is foreign nationals who occupy the most vulnerable locations of the settlement. It was also argued by some residents that foreign immigrants, because of their limitied financial capacity and resources, are encroaching on living conditons in the community, pushing South African citizens into vulnerable locations. Two participants explained why they see foreign nationals as a problem and drivers of vulnerability:

> "*Foreigners are a problem; I am not scared to say it! They are stubborn! Even if they are told it is dangerous to build here, they will continue building…They know that if they can be affected [again] we will give them attention…Even now we can go and look around Jukskei, you will notice that all of them are foreigners! They even build [using] bricks because they have strength, and they know you will not demolish it because it is against the law*" (Mme T, Interview, 08/02/2018).

> "*The first thing that creates overpopulation is because foreigners who have more money than us…you can [even] see there are upstairs [structures] and most of them belong to foreigners…Sometimes they do not even stay here. They want us to pay rent as South Africans*" (Mbali, Interview, 07/04/2018).

Mbali further explained that even if the government were to grant access to the documented foreign immigrants, the settlement was already densely populated and that the issue of house provision is already backlogged. About 335 681 people who lived in the CoJ were African foreign nationals and a significant portion of them, about 311 255, are from Southern African Development Community (SADC) countries (Stats SA, 2016).

One foreign migrant who participated in the study held that they were marginalised by the community and leaders during times of need, when they were affected by the 2016 floods, because they were not South Africans. Interestingly, as noted in the methods section, the majority of people who participated in the study provided that they were South Africans, and were occupying the space that was allocated to people who were affected by the 2016 floods.

Similarly, the DMC Setswetla beneficiary list shows that the highest number of people who were affected by the floods was mostly South Africans (Figure 4.9). However, the beneficiary list seems to be only accounting for people who were accommodated in the temporary shelters[9] and does not include those who had made private accommodation arrangements with friends

and family.

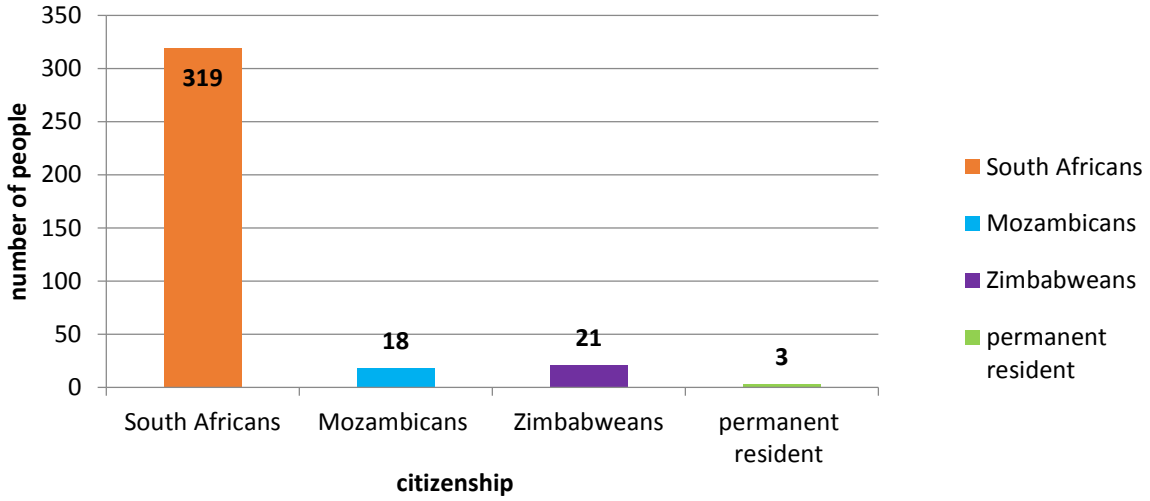


Figure 4.9: Setswetla beneficiaries (CoJ DMC, 2016a)

There were other departmental reports that were quoted in DMC meetings which show different numbers of people who were affected by the floods. For example, the Department of Home Affairs report noted that about 262 South Africans and 7 legal foreigners were impacted, particularly those who lost their identification documents due to floods. Another report from Disaster Management notes that 450[10] families with 988 individuals were affected by the floods in Setswetla. The number of South African citizens still remained high but was lower than that of people who had no form of identification and cannot be classified as foreign or national citizens (Figure 4.10). Because of separate Departments and actvities, the number of people that are helped by the DMC might vary to that of home affairs, and this may make it difficult to have the exact number of people who were impacted by floods or staying in an informal settlement in a given period of time.

[10] Only one family member ID was used to compile the list.

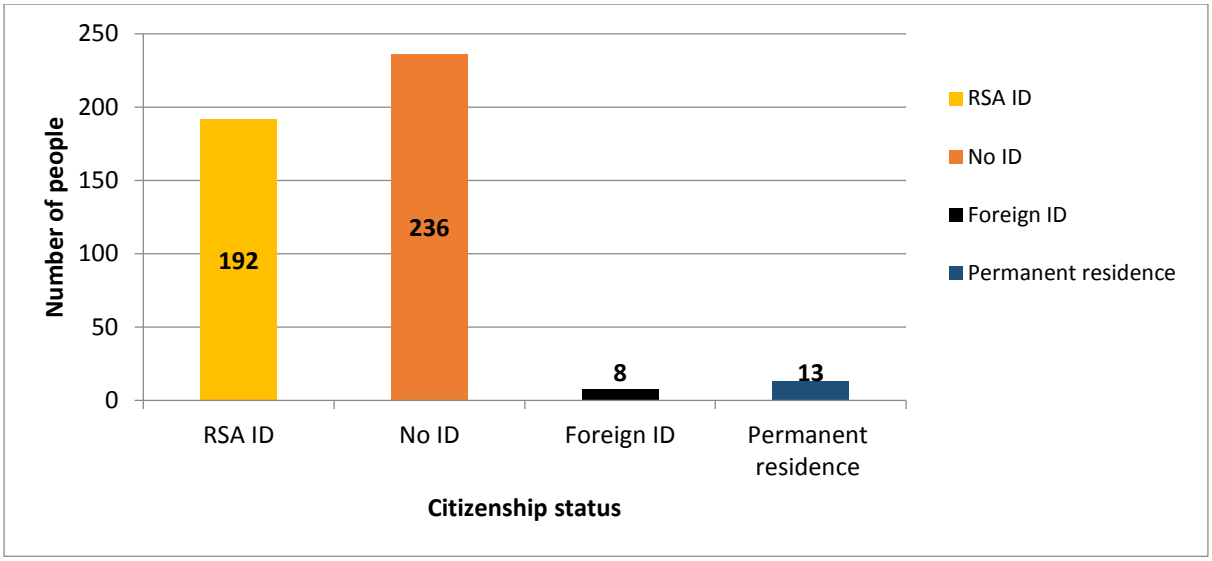


Figure 4.10: The 450 families that were affected (Ward 105 and 109) (CoJ DMC, 2016b).

Setswetla residents raised concerns about the high number of undocumented foreigners in the community. A female resident said that foreign nationals commit crimes in the community and get away with it because they are undocumented and cannot be traced.

> "*Foreigners can kill and nothing can be done because they are untraceable. If a South African kills a foreigner [he] gets a 10 year or life sentence. [Foreigners] run away. How do you trace them?"* (Mam'Nongena, Interview, 02/02/2018).

A prominent community leader held that people who were affected by the floods were a mixture of South Africans and foreigners. He added that the majority of victims were South Africans, with a few Mozambicans and Zimbabweans. A 40 year old female from Mozambique provided that, by virtue of her being a Mozambican citizen, she had to endure hardship after being affected flash floods:

> "*When they provided food [to victims], they were people who handpicked people to feed and not to feed. Other times we did not get food, we did not even receive blankets. We were told to step aside because we are foreigners*" (Business lady, Interview, 01/03/2018).

The issue of citizenship, as shown above, emerges as a key factor in both driving vulnerability and in shaping how interventions, to address some of this vulnerability, are designed and who gains access to such interventions (e.g. who gets priority during the times of need and can expose certain segments of the community to hardship).

4.3.4. Failed governance: Corruption influences vulnerability

Another dimension of the social fabric that is playing a possible role in enahcning vulnerability to flooding in Setswetla is that of failed governance. The allegation of corruption within the CoJ's departments and community leadership was seen as a catalyst for heightened vulnerability to flooding in Setswetla. A 43 year old woman believed that methods that were used to relocate people, who were staying along the Jukskei River banks before the 2016 floods, were unjust. She said that officials relocated people to the Greenhouse settlement without following a process to clearly identify those who are at risk and in need of assitance. When she, for example, was not relocated after the flood, she decided to build herself a brick house which collapsed and was swept away by the 2016 floods.

The Greenhouse settlement was a project between CoJ's department of Housing and the Gift of the Givers, which aimed to relocate people away from the Jukskei River banks (Official 2, Interview, 31/05/2018). Mama Z argued that people who are tasked with developing Setswetla are corrupt; because they sell things[11] that are meant to improve local infrastructure and livelihood of the community.

Further indications of how people receive assitance and benefits arose. Houses that were built under the Alexandra Renewal Project (ARP), for example, were apparently sold to foreigners and people from other parts of Johannesburg. The DMC was of a view that the ARP officials committed a lot of mistakes because they were not strategic in the implementation of the programme. The programme got overwhelmed by the numbers of people who needed houses after being relocated to make way for development. The Setswetla community leadership and residents alleged that corruption and greed of the people who were supposed to implement the ARP was the main problem:

> "*In 2002, the Alexandra Renewal Project was initiated by former President Thabo Mbeki to redevelop Alex. About R2 billion was provided for Alexandra Renewal Project. They made a lot of blunders those guys, you cannot Eeh! Appoint a person from Alex to run a project in Alex. That was a big mistake*" (Official 2, Interview, 31/05/2018).

[11] The 'things' seems to mean 'stuff' that is given to the community during humanitarian interventions such as building materials and food.

> "*It is true that houses were sold to people. One time I was at Ext 9, I told some guy that I have to leave and go home to Setswetla. He asked, where is Setswetla. Is there a person who can be a beneficiary of a house in Alex and not know where Setswetla is? I asked where was he from…he provided that he was from Krugersdorp, and got the house through connections. He does not even know London Road, but he got a house here in Alex!*" (Alpha, Interview, 02/02/2018).

The community leadership was also of the view that the Department of Housing sold houses to people who were not supposed to benefit from the ARP. One community leader argued that the majority of Extension 7 houses are owned by foreign citizens who are not even documented, while South African citizens live in shacks (Figure 4.11).



Figure 4.11: Extension 7 in relation to Setswetla (Google Earth, 2018c).

Some community members alleged that corruption was not only at the City governance level but also in the community leadership. They explained that it is the responsibility of the community leaders to take care of the community and to protect it, but the Setswetla community leaders were driven by self- rather than communal interests:

> "*[Community leadership must] ensure that people do not live by the river banks. But [our leaders] are selling spaces. There is also one committee member, [who] has built [a house] under power lines…Why would I not do the same, because I see one of my leaders doing it? I [understand] he is trying to make a living in his own way, but under power lines? The issue of erecting structures under power lines has been dealt with intensively by city power*

> *on many occasions. And you know what they do now? They build using bricks…even if law enforcement can come, they would not demolish it*" (Mbali, Interview, 07/04/2018).
>
> "*You know what causes corruption? You see by Jukskei River, there are other people whom their shacks were marked that they will be allocated shacks up here. But they still live by river banks because the new shack was sold to some foreigner. The Department of Housing might record that such and such person has been moved, but he/she [not moved]*" (Papalaza, Interview, 07/04/2018).

Governance therefore emerges as a critical component for vulnerability alleviation in municipalities and communities. The results gathered here have shown how corruption within local and communal governance structures interacting with socio-economic factors has influenced the vulnerability of the community to flooding. The alleged corruption has burdened and delayed the provision of housing and pushed people to vulnerable locations.

4.4. The Geographical context and socioeconomic conditions: Location and Poverty enhancing vulnerability

Another dimension or theme arising from the Hazard of Place approach is 'geographical vulnerability' (Fig. 2.2). The location of people and their assets can easily expose them to flooding. Their physical location places people and their assets in harm's way (Pharoah *et al*., 2016). Specific conditions such as high population densities, the quality of the environment, the quality of dwelling structures and infrastructure will determine the degree of exposure and the sensitivity of the settlement (Wamsler, 2014).

For example, in the case study of Keko Muchungwa, in Dar es Salaam, houses, that were located in a valley, suffered severe flooding impacts compared to those who were located further uphill (Sakijege *et al*., 2012). Therefore, the location of houses was one of the primary factors that exposed the community to flooding. In such a case even a moderate storm can have severe impacts on those located in flood sensitive locations as noted in Niamey, the capital city of Niger (Douglas *et al*., 2008, Boubacar *et al*., 2017).

The urban poor often live on vulnerable environments such as flood plains and low-lying areas with minimum or no basic infrastructure (Sakijege *et al*., 2012). It was highlighted in most of the interviews that people who settle on low-lying areas or by the river banks are those who

cannot afford to pay expensive rent, and that they are driven to vulnerability by life circumstances that are beyond their control:

> "*You know when you are pregnant there are times were there are misunderstanding between a woman and the father of the unborn child. I did not have money to pay rent seriously! Serious! I was in a dire situation. That I even reconciled myself to the risk of flooding. You see, I did not have money for rent and [I was] pregnant. Who would I stay with while I am pregnant? There is no one to stay with… Even this guy, knows that I would give birth to a child [that is not his] …will he support the kid, knowing very well that it is not his?*" (Mbali, Interview, 07/04/2018).

> "*You know, Setswetla is actually inside [flood line] not [just] near Jukskei River. The difference is that other shacks are [far] from the river. Like me, 'I was inside the river you see'. But I needed a place [to stay]. I am a South African; I was born and bred here! You hear! I see no need of being busy paying rent. How will I make it [in life while] paying rent? The rent is expensive! Now…I do not work! How would I pay rent? You understand? It is a must that I have a place to stay... That is why people even force to stay close to the river*" (Jabu, Interview, 23/01/2019).

Rubble dumping was also identified as narrowing the river banks, and has led people to believe that there was ground to build shacks and houses on (Figure 4.12). Two participants explain how location and rubble dumping has exposed them to flooding:



Figure 4.12: House built on layers of rubble and next to servitude of a sewerage pipe (23/03/2018).

> "*I can say that floods affect places differently. Where we use to stay by Jukskei, it was a river bank and a low lying area. It is unlike here. That is why when you live there you will notice that floods are destructive and that water comes with force. If Setswetla was*

> *level everyone would have been affected by the 2016 floods. But because others are higher up, they were not affected*" (Chickens, Interview, 01/03/18).
>
> "*Where I lived, there was some ground to build on because of dumping, so I was a bit distanced from the river banks, I was 5 to 10m away [After the floods, some of the dumping debris were eroded(Figure 4.13).] Now I was like 1metre away from the river bank. Because I was almost swept away… [Community leadership] relocated me here*" (Mabunda, Interview, 07/04/2018).

The above responses explain why significant damage occurred in the lower lying areas of Setswetla near the Jukskei River banks. People who have built further away from the river banks, and were on higher ground were not as impacted by the 2016 floods. Therefore location was found to be a major determining factor of household's exposure to the impacts of the floods.



Figure 4.13: The collapsed river bank, Alexandra (Dlangamandla, 2016).

A family of six people from Mozambique that was affected by the floods in 2016 was never relocated. Although they have been warned by the community leadership, they decided to go

back and live in the same area, which is considered to be highly vulnerable to flooding. The family acknowledged their exposure to floods impacts due to their location:

> "*We [are] still where the water swept people away. When it rains now and then it scares us…because we are still near the river*" (Ma, Interview, 01/03/2018).

When it rained on the 23rd of March 2018, the family said they did not sleep. They had to move themselves and their belongings around their shack so that they should not get wet from water coming through their roof which was made out of carpets, wooden boards and plastics (Figure 4.14). Alex News, a local newspaper reported that on the 23rd of March 2018 the Jukskei River was filled to its capacity but did not overflow its banks, and the event was labelled 'A lucky escape' since there were no fatalities (Figure 4.15).



Figure 4.14: Roof from the inside made out of wooden boards (01/03/2018).



Figure 4.15: Alex newspaper published on the 30th March 2018 (13/04/2018).

Poverty was said to be the main factor that forces people to come into the city and look for opportunities. Migrating into the city is a strategy employed by rural migrants to have access to monetary resources, that is then sent back home to sustain their rural families. The urban poor, because of limited choices and resources, often end up settling on marginal vulnerable land to secure both personal and family livelihood (Dube *et al*., 2018; Douglas *et al*., 2008):

> "*Poverty drives people to such conditions and [that] they don't have a choice. The thing that drives people to leave home is to look for work and feed themselves and their families. When you get to Johannesburg, you [will] need …a place to stay and work. When you get [a job] you then rent a place to stay. Then the landlord [can] ask you to pay R1000-R1300 rent. How much do you earn? You earn about R2000, how much do you want pay for rent? What do you eat? What do people at home eat?*" (Baba H, Interview, 30/01/2018).

The ever-growing urban settlements coupled with the rapidly changing urban environments and social conditions have led to increased flood vulnerability and risks, as more people settle in flood-prone areas in a quest to secure livelihoods (Zievogel *et al*., 2016). According to Business Tech, the CoJ receives approximately 10 000 people per month (Business Tech, 2016). In Accra and Dar es Salaam, rapid population growth was also identified as a major contributing factor that drives the urban poor to settle on marginal environments in search of accessing urban livelihood opportunities (Mubaya *et al*., 2015; Amoako and Inkoom, 2018).

Poverty, coupled with the need to secure and to have access to sources of livelihood, can be seen as a potent factor that drives people to settle on marginal vulnerable environments. It becomes a balancing exercise to some individuals in Setswetla after getting a job, whether to get secure better accommodation or to live in precarious conditions to ensure personal and family livelihood. People in Setswetla are aware of their vulnerability to flooding as a result of settling on marginal flood-exposed location in the settlement.

4.4.1. Bare necessities of life: Access to basic services and safety of person

Another key vulnerability that is emerging in the community is the concern of access to basic infrastructure in the geographical context of Setswetla. Setswetla settlement, for example, lacks proper road infrastructure and only has a few paved roads that are used to access the settlement. Access to water, sanitation and energy is limited, and the community uses communal taps[12], mobile toilets, legal and illegal electric connections (Figure 4.16-4.19). Most of the taps in the garden space were installed by residents who had contributed money to hire a person to connect the pipes so that the distance travelled for fetching water -can be reduced:

> "*The taps you see! We donated R20 each to install them. All of us here we use 4 toilets. During weekends, the queue to use the toilets is so long that you rather go and relieve yourself in the bushes. Even taps are so packed you will need to wait until you have water*" (D'bongz, Interview, 22/01/2018).

> "*What I find challenging here, is that when I go to fetch water by the pipe you find dirt, food debris, condoms etc... Fetching water there is disgusting*" (Slender, Interview, 12/04/2018).

Service delivery was noted as lacking in the settlement, and respondents affirmed that lack of service delivery was bad to the extent that they have to do things for themselves to gain access to Johannesburg services:

> "*For now things are messed up in Setswetla, the electricity is problematic. There is no street. This is not a street! It is just paving…We want better services! Yes! What is that thing? It is not a street, look at the mobile toilets you can use it 2 times the 3rd time it stinks*" (Brick Layer, Interview, 12/04/2018)

> "*The toilets, and the water here is problematic. Sometimes we have and sometimes we do not*" (Rhulani, Interview, 7/04/2018).

[12] Some taps are installed by the community and other by the municipality.



Figure 4.16 Paved road and mobile toilets (23/01/2018).

Through observation and transect walks it was found that some taps do not close properly and that the material used may be of low quality, which may lead to dripping taps (Figure 4.17*a*). As a result, there was always water flowing or accumulating in passages between settlement dwellings and on the streets. The saturated surface is further exacerbated by household waste or grey water (Figure 4.16). Thus, this may mean that surfaces are always saturated and this contributes to water pooling in most of the upper areas of Setswetla because some water gets trapped in the dug trenches and roadside culverts that are expected to drain water.



Figure 4.17: (*a*) Leaking community installed tap (01/03/2018) and (*b*) illegal electric connections (03/07/2018).



Figure 4.18: Legally electrified section of Setswetla (07/06/2018).



Figure 4.19: Municipal installed tap (01/02/2018).

The limited access to basic services has exposed some community members not only to weather extreme vulnerabilities, but also to a number of personal health and safety hazards and vulnerabilities:

> "*It would be better if we have houses and proper infrastructure. The electricity would not be connected like this. Last year a guy who lived in this shack died inside the shack. We only saw by flies around the shacks. People behind [his shack] thought the smell [was] from [dead] rats. There is no street here, an ambulance, police and the undertaker [could not] come [inside] to collect the body. We had to pick up the body by [our] hands…We picked up the body, going through the passages in front of peoples doors. A dead body is very heavy. The body had already started to decay. When we took [out] the body [people] started to run away because of the smell even those on the street who sell food. If we had a proper infrastructure the body would have been handled properly. Though they say the government is helping us, with what exactly? They are not helping!*" (Baba H, Interview, 30/01/2018).

Furthermore, the absence of basic infrastructure, for example, can enhance vulnerability and expose the community to the devastating impacts of flooding such as waterborne diseases, as was the case in the Mozambique year 2000 floods. A health report cited by the DMC, noted that there were cases of cholera outbreaks that were recorded after the 2016 flash floods in Alexandra (Public Safety Mayoral Committee Disaster Management, 2016b). More detailed investigations of these health and sanitation dimensions are required and fall outside the remit of this research.

A woman, in her late 40s, said that where she was previously situated they had access to toilets and water, even though they were a bit further from her house. At night she opted to use a bucket to relieve herself, because going out in the dark can expose her to harm like possibly 'getting a stray bullet'. The community leadership added that they were engaging local government authorities on proper electricity installation in the new shacks, to protect human lives especially children since there is always water flowing around and between shacks with exposed live electrical wires.

It should be noted that installation of sufficient basic infrastructure requires planning and proper settlement design which has followed a set of standardised building codes. The informal character of Setswetla has implications in terms of what kind of basic services the Johannesburg municipality can provide and to what extent. Responses from participants showed that the communty isstill experiencing a severe deficit of basic services and requires more actions for enhancing the living conditions in the settlement. There was an implicit understanding by respondents that if the settlement was formal and had access to basic services, the impact of the floods would have been less. That is why they expected the government to deliver basic services and infrastructure that will enable the settlement to be less vulnerable (Esihle, Interview, 30/01/2018).

With the current population influx in the CoJ it must be expected that further strain will be added on the provision of basic services such as housing, other critical infrastructure and adequate employment opportunities (IDP, 2018/19). In Keko Muchungwa and Bonde la Mpunga in Dar es Salaam, for example, it was also highlighted that informal settlements were experiencing high population densities in areas that were vulnerable to flooding and had no proper services and infrastructure to shield them from flood impacts (Sakijege *et al*., 2012; Mubaya *et al*., 2015). The ever-growing population in Niamey also led people to settle on flood-prone areas that had limited infrastructure (Boubacar *et al*., 2017).

In addition, the absence of infrastructure, such as well-maintained streets and adequate houses, exposed Bonde la Mpunga, Dar es Salaam, to flooding (Sakijege et al., 2012, Mubaya *et al*., 2015). The availability of infrastructure such as streets and drainage systems are usually found in well-developed settlements such as suburbs and townships. Such settlements are often

financially inaccessible for the urban poor because they have to pay higher rents or because they are located far from sources of livelihood and places of employment.

4.5. Vulnerability of place: Seasonality of flooding and the prevailing conditions in Setswetla

Using the Hazard of Place (Fig. 2.2) approach the 'vulnerability of place' enables the beginning of a synthesis of interacting vulnerability factors in Setswetla. Vulnerability to flooding is not only a consequence of intense rainfall but a compounded effect of social and environmental conditions that act together and expose communities to flood impacts. As noted above communities are said to be vulnerable if they are exposed, sensitive and susceptible to the damaging effect of a hazard taking into consideration factors such as the social fabric, geographic context, social and biophysical vulnerability (Cutter *et al*., 2000; Wamsler, 2014; Rezaee *et al*., 2018).

It is through the impacts of extreme tragic events such as the 2016 flash floods that the living conditions of the urban poor become more visible. The everyday precarious conditions of informal settlements are often hidden from the ordinary day-to-day urban functions until they are affected by and exposed to a disturbing event (Murray, 2009).

Flooding is a seasonal event which usually occurs during the summer rainfall season in Johannesburg. One resident explained that due to the seasonality of flooding, it only becomes a problem when it happens or emminent. Therefore as a priority, one has to deal with day-to-day social vulnerabilities and struggles and, only when an extreme event occurs will they deal with it:

> "*Vulnerability to flooding and weather events are of concern during their seasons. Everyday danger and fear of violence is [our] major concern. Yesterday we found a body of a new-born baby [dumped along Jukskei River banks]* (Figure 4.20)*…Should we blame the mother? With all this poverty, drug abuse…I do not know... If a man [has] money, [he] belongs to us all. That is why we have so much HIV here… [The] abuse of women. The issue of floods, you think about [it] when it rains…Having something to eat, shelter and clothes on my body is a daily struggle*" (Off the record conversations, 23/03/2018).



Figure 4.20: CoJ EMS collecting the body of the abandoned baby (Shitiba, 2018).

Flooding, and flash flooding was generally understood to be a physical phenomenon caused by intense rainfall and storms, mediated through inadequate urban drainage systems, limited basic services and urban land use and land use change (Dunsmore *et al*., 2017). Thus, most of the participants asserted that the cause of flooding is rainfall:

> *"[Floods] occur after a heavy rain...isn't like that? Yes! After the rain then there are floods*" (X lady, Interview, 06/06/2018).

> "*I have been living in Alex since 2008. I know floods and they are caused by an intensive rainfall and rivers overflowing their banks. The last floods were the first I have ever seen or experienced since I came to Alex*" (Mama Z, Interview, 05/05/2018).

Disaster Management provided data from Automatic Rainfall Stations (ARS) installed around flood-prone areas of the CoJ. Alex received was estimated to have received significant amounts of rainfall compared to other areas between the 9th and the 10th November 2016 (Table 4.5).

Table 4.5: ARS Rainfall readings/ data in Johannesburg: 09 November to 15 November 2016 (Disaster Management Centre, 2016a)

ARS Location	09 - 10 Nov Reading in (mm)	11 - 12 Nov Reading in (mm)	12 - 13 Nov Reading in (mm)	14 - 15 Nov Reading in (mm)	Total (mm)
Alex	60.4	No reading/ data due to network failure on station	No reading/ data due to network failure on station	No reading/ data due to network failure on station	Estimated above 100
Dobsonville	0.6	16.0	3.6	6.6	26.8
Dube	0	21.4	3.6	6.8	31.8
Ivory Park	45.0	31.6	0.2	12.0	88.8
Diepsloot	0.6	16.0	0	7.0	23.6

A number of participants said that the biggest rainfall was on the 7th of November 2016, and that the 9th of November 2016 flood was a result of stormwater accumulation from other areas around Johannesburg.

> "*The rain did not even [last] for 3 hours, it was only about 30 min. Maybe it rained for hours in other areas. Water comes from the top…When it rains around Germiston… [or] …Johannesburg. The runoff from these areas drains to Jukskei, and you will start to see the river swelling up*"
> (Baba H, Interview, 30/01/2018).

> "*It started to rain on Monday. Jukskei was almost full. We went out to check if it is going to overflow its banks. We found out that the water was subsiding instead of rising. On Tuesday, it rained and, Wednesday the 9th it did not rain that much. I was coming from some house to collect my phone, were I used to charge my phone because we did not have electricity. I heard people shouting at me Get out! Get out! It was raining but not as intense as [the] Monday rain*" (Mbali, Interview, 07/04/2018).

Setswetla is located downstream of the Jukskei River and the flood-producing rainfall might be occurring upstream (Dunsmore, personal communication, 2018). Therefore, river flooding might not have been caused by stormwater accumulation as argued by participants:

To get a sense of whether participants understood or are bothered by extreme weather patterns, they were asked what they thought caused the floods to be so destructive in their community, and whether they had experienced similar or worse rainfall compared to the 9th of November 2016 rainfall. The dominant response among participants was that rubble is narrowing the river

bed, causing the river to overflow its banks and to flood nearby shacks. Other participants were bothered by the weather becoming more extreme because it has a potential to destroy property, livelihood and take lives.

With regards to past experience of extreme weather events, a participant from Mozambique argued that the November 2016 floods were nothing compared to what he had experience in the 2000 floods in Mozambique. A female who owns a hair business and grew up in Alex recalled that there had been floods when she was young:

> "*There have been floods a long time ago when I was still a child. People found their houses swept away…A person comes from work to find that there is no house…It has once happened, but it happens once after a long time. Like since it happened in 2016, maybe I do not know, maybe it will come again in 2030...Yeah! It does not happen all the time*" (Beauty, Interview, 06/06/2018).

A mother of two young adults said she has been living in Alex for the past 30 years and this must be the second flooding event of note. She recalled that there was once a flooding event in the 1970s. Therefore, in this case study flood risk was perceived as severe but rare, and a thing to be attended to when it is about to happen or is happening. Other participants recalled that there were massive rains between the periods of 2009/10 but no damage was sustained in the community.

A CoJ report shows that in December 2010 and March 2011, 22 houses were destroyed by floods in Orlando West, Soweto (CoJ Mayoral Committee report, 2011). The damage and relocations of the affected people was estimated to be R3 561 570 (CoJ Mayoral Committee report, 2011). Thus, flooding impacts come with significant costs for the CoJ municipality, from both formal and informal settlements.

4.6. Response and recovery: the nature of help from in and outside the settlement

Having described some of the vulnerability dimensions using a Hazard of Place approach, attention now turns to examine the resposne and recovery that occurred during the flooding event and what lessons were learnt that can improve interventions.

During the flooding event, some participants provided that they did get help from other members of the community while others said they did not get any help because everyone was

trying to save themselves. Those who were affected recalled the kind of help that they got or offered during the flooding incident:

> "*…I ran away with a child to the bridge. The water was knee-high and rising. I could not wait anymore. I took the child from my neighbour and ran, I left the mother behind and told her she must figure stuff all by herself I am taking the kid*" (Mpumi, Interview, Interview, 22/01/2018).
>
> "*During the floods, it was every man for him-self*" (Mpofu, Interview, 30/01/2018)

The CoJ Public Safety Mayoral Committee report states that the main response from the city was humanitarian intervention. The report lists a number of Departments and NGOs that responded via the DMC. The response from the CoJ and NGOs was mainly in the provision of blankets, food, toiletries and clothes. The community members acknowledged such response:

> "*Social Development…tried because people did not have a thing [after the floods]. [They] supplied the victims with food, so that they cannot go to bed with an empty stomach. DMC… assisted with securing sponsors, which ensured that food was available daily and they assisted with blankets and sponges. DMC is always here to do awareness campaigns to people [who live by] Jukskei River*" (Alpha, Interview, 08/02/2018).
>
> "*The government did assist because we did not go to sleep with an empty stomach* (Big Shack, Interview, 01/03/2018).

The respondent and community leadership said that the CoJ Department of Housing failed to provide alternative land to the affected people so that they can rebuild their lives. It was also argued t that the Department of Housing should have assisted with the rebuilding of shacks by providing building materials, since building space was allocated to the flood-impacted individuals by the community leadership. The community leaders further explained that if the garden space was not enough, the Department of Housing would need to deal with the leftover people and provide them with alternative land. The community leadership held that it was important for the affected individuals to be given their own space because the pastor who had accommodated them in a tent was constantly complaining to the community leadership.

The process of relocation was also marked by the politics of citizenship, and the unauthorised buying and selling of residential plots as highlighted previously. Though the allocation of building space was for people of Setswetla, it was alleged that some of the people who got plots were from the more central areas of Alex. A female participant was told to wait but ended

up not getting a space. A male participant who was reluctant to comment on the allocation of building space, mentioned that some people did not get spaces and that could have been caused by the politics of nationality and ethnicity. A participant who did not get space in the garden, said

> "*My own shack was also that side... I was not living here… they sent us to the Greenhouse…from there they helped us get a place to sleep. Since then…There have saying heee! Housing this! Housing that! Housing! And then from there, they did not call us to allocate us space. That is why ended up coming back here [Jukskei banks]*" (Mfundisi, Interview, 07/06/2018).

One of the participants who received a building space argued that they were just given spaces and the government did not assist them with anything to help them rebuild themselves. It was said that assistance with building materials was needed because people had lost everything:

> "*[A] Truck came, and they said the truck had building materials. What happened to it, we do not know? What they told us is that funds were released and [needed to] be signed for by someone. Even now there is no form of development regarding the matter. They said we are placed here temporarily. I do not know what kind of temporary they referring to, because we approaching another*" (Mbali, Interview, 07/04/2018).

It was futher elaborated that whenever incidents such as fires and floods happen, people are relocated to a place, and this is done with the impression that they will settle at that given place temporarily until a permanent solution is found. A male resident explained in detail what should happen before the 2016 flood-affected individuals can be relocated permanently:

> *"…What about those in waiting rooms? We cannot be the first to be moved without the ones from the waiting rooms. They have to start with those from the waiting rooms. You get me! And there are still those who were told to stay like us and that they will be relocated too. You might find that us here, we would be the last ones to be relocated*" (Papalaza, Interview, 07/04/2018).

The response from within and outside of Setswetla was basically humanitarian as it aimed to ensure that basic necessities, such as shelter and food, were available. The responsibility to provide such basic necessities was perceived to be mainly that of the municipality because it was expected that the CoJ needed to provide alternative land or building materials for those who were affected. The informality of the settlement seemed to be of no significance to most of the respondents, especially those who said there were South Africans.

Therefore, there was no clear proactive response plan from the DMC. A proactive response usually will anticipate the future and employ certain measures beforehand to reduce future losses or vulnerabilities (Choudhury and Haque, 2016). In the case of Setswetla, a proactive response would have been to enforce CoJ dumping by-laws to prevent rubble dumping on the Jukskei River banks, since such dumping narrows the river bed and encourages people to believe that there is sufficient ground to build shacks on. Other options could include a more proactive approach such as DMC working very closely with community leaders in managing and monitoring the establishment of shacks close to the river banks, and an effective flood warning plan for informal settlements.

Thus, a proactive response usually builds local adaptation and resilience to climate-related hazards and challenges, and must have a longer life span in the community (Weldemichel and Etana, 2016). In Setswetla, there is currently a pressing need to move away from the linear and unsystematic approach to flood-related disasters, emergencies and vulnerabilities to a more and coherent, coordinated and systematic approach (Marin and Naess, 2017).

The appreciation of social, environmental, political and economic factors as underlying drivers of vulnerability by the DMC would have allowed for proactive actions, preparedness and a move away from reaction (Marin and Naess, 2017). Such action will be in line with the precepts of the Sendai Framework which encourages the understanding of underlying causes of vulnerability and to build better after a disaster impacts.

In addition, the South African Constitution provides that everyone has a right to an environment that is not harmful to the wellbeing and a right to adequate housing. With the advent of the Constitution and democracy, local governments are tasked with the responsibility to provide adequate housing or do *in situ* upgrading projects for informal settlements (Drivdal, 2016). *In situ* upgrading is promoted as more responsive to poverty and vulnerability than relocation (Drivdal, 2016). One of the 2018/19 CoJ IDP priorities is to ensure 'pro-poor development by creating more sustainable and liveable settlements where resource deprived areas once was, through encouraging *in situ* improvements to informal settlements' (IDP, 2018/19:61). In the case of Setswetla relocation will still need to be considered as large areas of the settlement are located on a former dump fill near a disused waste water treatment plant, and the settlement is exposed to a number of hazards, such as unstable ground which is worsened by floods.

4.7. Communicating with the vulnerable timeously

As shown above Setswetla is vulnerable to floods. This section will establish whether the community did receive any form of warning about an anticipated weather event that may damage property and cause harm. Early warning systems are created to help those who are in danger of a potential weather hazard to get information with regards to the expected hazard on time so that they can evacuate or make informed decisions in response to the expected hazard. This information is disseminated through institutions such local disaster management centres, to allow communities in danger to make informed and effective decisions to avoid harm and minimise risk (Holloway *et al*., 2010; Dent, 2016).

The CoJ DMC pointed out that upon receiving warnings from SAWS about an anticipated storm it circulated the information to all relevant community leadership via WhatsApp:

> "*…Our role is to disseminate the information to community leaders. Eh! We did that, but we know very well that it is not easy [to] evacuate [people] if they do not see any flooding. It becomes very difficult for the community leaders to say to the people evacuate and [then] people follow [those] instructions. It becomes very difficult! They wait for the impact*" (Official 2, Interview, 31/05/2018).

A CoJ official was of the view that early warning information was not circulated in time to allow the vulnerable community members to make informed decisions and evacuate:

> "*I do not think [That the information regarding the floods was disseminated]. In fact we get hammered a lot about this, even by the politicians they ask us the very same question you asking... were those people aware? Will they be aware in future? No! I do not think we were particularly…Quick to let those communities aware well ahead of time. Well ahead of time could just be a day actually in situations like this. SAWS will let us know a day ahead that there is something like this that is likely to happen and on the day itself. So I doubt if we would have disseminated information to those communities so that they are aware. So basically they were sitting ducks* (official one, Interview, 29/06/2018)".

It was further explained that the flood event could have taken everyone by surprise because South Africa was coming out of a drought as a result of *El Nino*, and that people could have underestimated the predicted rainfall and its intensity.

The community leadership when asked about early warnings, they seemed to be confusing the

difference between early warning systems and awareness campaigns. The community leadership mentioned that DMC and SAWS came in September 2016 to warn them. During the visit, the DMC and SAWS surveyed the area and it was recommended to the DMC that sirens should be installed that will alert people about rising water levels. They further advised that people settling along Jukskei River banks should be moved. A participant confirms this visit by DMC:

> "*Earlier, prior to the event people came to tell us that when rains we need to go up the hill. They issued out papers, they went house to house*" (Chickens, Interview, 01/03/2018).

A number of participants contend that no warning was issued to them, because the community leadership usually use a loud hailer to communicate matters of urgency and importance to the community. The participants suggested that the flooding issue should be regarded as one of the important communal issues, and that a loud hailer must be used to disseminate flooding information. Furthermore that the use of a loud hailer be supplemented with flyers or pamphlets to ensure information gets to people:

> "*There is a community committee, but I did not receive a warning regarding the weather event. Information we get it via flyers, that there is a something coming*" (Low voice, Interview, 7/04/2018).

> "*We did not get a warning about the weather events. It's better to use a loud hailer to issue a warning*" (Big Shack, Interview, 01/03/2018).

The DMC has a good working relationship with the Setswetla community leadership (Dent, 2016; Official two and three interviews, 2018). Dent (2016) found that the best way to disseminate early warning systems in Setswetla was through community leadership, newspapers and radio. This study concurs with Dent (2016) because the participants preferred the use of a loud hailer for the community leadership to communicate anticipated flood events

4.8. Setswetla resident's coping strategies in the face of a flood

Having examined the drivers of vulnerability using the Hazard of Place approach and determined ways of issuing early warnings, attention finally turns to investigating coping responses to periods of extreme flood risk. People in the settlement are aware of the risks associated with intense rainfall. In Setswetla, every season carries a potential hazard for the community. In winter shacks are likely to catch fire and summer rain brings a possibility of

flooding. A number of personal strategies are employed by the community members to avoid their houses being flooded or house items getting soaked such as using basins to catch water inside the shack and covering shacks with plastic sails (figure 4.21). Most of the materials used to cover or build shacks may fuel a fire, such as plastic and wood.



Figure 4.21: Buckets and basins used to catch water inside the shacks (23/03/18) and a plastic sail to cover the roof (30/01/2018).



Figure 4.22: Rebuilding with bricks after a shack was burnt down (03/07/2018).

Building using bricks was considered to be an ideal long-term, coping strategy because material such as wooden boards, plastics and corrugated iron are easily swept away by floods or burnt down by fire (Figure 4.22). Through observation, it was found that although rubble dumping is a problem in the settlement, the disposed bricks were also used by some community members to build brick houses. A number of houses were built by using pieces of bricks from rubble dumping (Figure 4.23). Those who could afford to buy new bricks bought blocked bricks which were locally produced in Setswetla (Figure 4.24).



Figure 4.23: Houses built with rubble bricks (03/07/2018).



Figure 4.24: Houses built from new blocked bricks that were purchased in Setswetla (03/07/2018).

To cope with flooding, the community has taken measures to channel the water to the nearest street which has some form of stormwater drainage system or to the river. The water is channelled through dug trenches which are sometimes cemented or have been installed with old industrial pipes (Figure 4.25 *(a)* and *(b)* and Figure 4.26 *(b*)). Owners of shacks that are far away from a street would design and build their own drainage system. In this case study, a drainage system that was aimed to drain water away from the new shacks in the garden was

unsuccessful because it was just a hole holding water, without depositing it anywhere (Figure 4.26*(a)*). The participants stated that the stagnant water started to smell, and it became a potential health hazard.



Figure 4.25: Water channel trenches.(*a*) Not cemented (23/01/2018) and (*b*) Cemented (23/01/2018).



Figure 4.26: (*a*) failed drain design (30/01/2018) and (*b*) pipes draining water to Jukskei (01/02/2018).

4.9. Where to from here: lessons learnt from the flood event and Setswetla in future

It is imperative to appreciate that flooding vulnerability and impacts are complex. They are a result of many factors, such as biophysical environment, socioeconomic and political drivers amongst others coupled with rapid urbanisation and population growth.

Urbanisation in the Sub-Saharan African context is increasingly characterised by the production and accumulation of risk because of socioeconomic and political conditions of marginalisation, and the development of settlements on hazard sensitive and exposed environments (Allen *et al*., 2017). Climate change will exacerbate the impacts of weather extremes, and it will be important for authorities and communities to reflect on lessons learnt on every climatic event to build understanding and better response systems for future extreme climate events.

A prominent biophysical hazard 'lesson' and practice that came out from the flooding event was that rubble dumping is a serious issue, as it interferes with the Jukskei drainage system by narrowing the river bed causing it to overtop the banks during rainy days (Figure 4.27; Official

2 interview, 31/05/2018). In addition, the CoJ was busy conducting a study and engaging with engineers to ascertain whether the widening of the river bed and installation of gabions could help in reducing flooding and flood risk (Official 2 interview, 31/05/2018). DMC alleged that Setswetla residents are encouraging rubble dumping by allowing construction trucks to dump rubble for a fee and that this made it difficult for law enforcement such as JMPD. It was not clear whether collecting money for rubble dumping was part of the alleged greediness and corrupt communal leadership or a coping mechanism of generating income.



Figure 4.27: Trucks dumping rubble on the Jukskei River banks (07/06/2018).

Another biophysical and geographic 'hazard of place' (Fig. 2.2) lesson, which was expressed by both the DMC and the community participants, was that floods severely impacted people who were located along the Jukskei River banks. It was suggested that people who live by Jukskei River banks be removed from the vulnerable area, so that the area can be barricaded to prevent anyone from erecting a dwelling structure (Official 3, Interview, 08/02/2018).

With these lessons learnt, the CoJ has said that it was in a better poition to be better prepared to deal with similar events in the future (Official 2, Interview, 31/05/ 2018). The city has a contingency plan, such as a task team, an NGO forum and an advisory forum which meets on a frequent basis to prepare themselves in case there is an incident that may lead to a disaster

(Official 2, Interview, 31/05/2018). One official was of a view that the city has not identified or learnt any lessons from the 2016 floods, he stated:

> "*To be honest, I do not think we have picked up [a] great lesson. For me I am worried we might be hit by something similar again and suffer the same. I have not gotten the sense that we have done something differently as the City. Yes the mayor has paid particular attention to it. [For example] we had another situation in Protea Glen Last year December. There was tornado that ripped many houses there and the mayor really focused [on that situation]...I think that if anything, that one of Protea Glen it was actually seen differently. It received a lot of attention than the one you working on now. The mayor got everybody in a room and really was pushing certain things to be done; looking into, let's say the structure of housing in [Protea Glen]…So there was a lot of heads rolling when it came to Protea Glen [incident]. However, there was not really concerted effort to look into Setswetla...He went there…but the kind of energy and the focus for me it was different…So basically I am saying, we seem to be having [a] sort of piece meal approach to each sort of flooding event. I am not getting a sense that we having this very strategic and coherent approach to dealing with flooding. [A plan] DMC would argue that they do have one...but I am not really convinced. For me I think …we have bit a pieces of what ought to be done and we do those things. But I think we still need to organise this thing properly and have a line of march so that we know what fits*" (Official 1 interview, 29/06/2018).

Informal settlements should receive serious attention, similar to that given to those in more formal settlements. There must also be a plan that will help the municipality to deal with extreme weather event disasters, particularly for informal settlements, to ensure a coherent approach when responding to a disaster event and that will help in collecting data to inform future interventions.

4.10. Personal reflection on the future of Setswetla

Setswetla settlement is growing by size, numbers of dwellers and the complexity of the driving forces of flood vulnerability (Figure 4.28). Though location remains one of the fundamental drivers of flood vulnerability, vulnerability is also mediated through social and personal characteristics such as ethnicity, access to financial resources and citizenship. A future flooding event might be similar in magnitude but the impacts may be different in terms of numbers of people who might be impacted and dwelling structures that might be destroyed as more people are beginning to settle on severely sensitive locations, that may expose people to flooding, fires and structures that may collapse (Figure 4.28).



Figure 4.28: New shacks under the foot bridge at Jukskei River banks (03/07/2018).

5. ANALYSIS AND CONCLUSION

5.1.Introduction

This study explored some of the drivers of flood vulnerability in Setswetla. The objectives of the study were firstly, to identify and document the nature of the impacts of the 2016 flash floods in Setswetla and secondly, to identify the causal drivers of vulnerability to flash flooding. Lastly, the responses of both the CoJ officials and local Setswetla residents to the impacts of the floods were examined.

5.2.Urban flooding a challenge

Urban flooding is a significant challenge in the CoJ. With the expected increase in frequency and magnitude of weather extremes, this will pose a major threat to urban systems of commerce, livelihood and environment. Local municipalities will need more comprehensive and relevant methods to cope with the expected change and the drivers of urban vulnerability to urban flash flooding. One of the first steps is to profile the vulnerable settlements and form collaborations with relevant stakeholders to enable meaningful and context-based interventions for vulnerability alleviation.

In the current case study, vulnerability was recognised as a context-based condition, that is created over time by multiple socio-economic and environmental factors that act together to weaken the ability of communities to defend themselves and their assets. Such weakness is manifested when the community is faced with a hazard that damages infrastructure, disrupts basic services and displaces people to an extent that the community requires an external intervention to restore some level of normality. Using the Hazard of Place model (Chapters 2 and 4), it was found that the vulnerability of Setswetla was a composite effect of geographic context, social vulnerability, social fabric and biophysical vulnerability resulting into specific locational vulnerability. These factors rendered the community susceptible to flooding overtime, which became apparent through a trigger event, namely heavy rainfall (Sakijege *et al*., 2012; Mubaya *et al*., 2015; Eriksen *et al*., 2017).

The Hazard of Place Model enabled the appreciation that impacts alone are not conclusive in determining whether or not a community is vulnerable to a hazard, but that the impacts can be a starting point of the vulnerability inquiry. Through the impacts, it can be determined *where*,

who and *what* was affected by the hazard. To understand whether or not people or communities are vulnerable; a vulnerability a framework or an approach is needed to examine factors that contribute to weaken the community's ability to defend itself when threatened by a hazard. If such an examination becomes successful, then one can begin to better understand which factors drive vulnerability and what possible actions can be undertaken to reduce vulnerability. Herewith are the key findings of the study using the Hazard of Place Model.

5.2.1. Key impacts of the 2016 floods

Setswetla residents suffered massive loss and damages as a result of the 2016 flash floods especially those who had shacks situated along the Jukskei River banks. The floods also damaged municipal infrastructure such as roads and bridges. Besides these material losses and damages, an eight-year-old girl lost her life in Setswetla, and this was classified as a major impact of the flood when compared to material loss.

Those who were affected by floods were accommodated in temporary shelters. These arrangements, however, took longer than necessary and it started to interfere with private family life since people were accommodated according to gender, meaning that families were separated. Some participants' expressed their pain and trauma as a result of losing all their belongings, felt as if they were 'nothing', as they did not have a home and had to wander around.

5.2.2. Key drivers of vulnerability in Setswetla

The ever-present threat of a disaster occurrence is recognised by the 2005 South African National Disaster Framework. The framework notes that there is an increasing level of risk nationally; South Africa is exposed to a number of climate-related hazards such as droughts, storms, cyclones and the weather extremes (National Disaster Framework, 2005). Notably, the framework acknowledges that a significant number of South Africans live in precarious conditions and environments that are disaster-prone, ecologically fragile, underserviced and are constantly under threat of physical and human-induced hazards (National Disaster Framework, 2005). In the case study of Setswetla, an assessment into what drives vulnerability to flooding in the settlement reveals that precarious urban living conditions contributed significantly to the impacts of the 2016.

- The geographic context and social vulnerability

The key drivers of vulnerability in Setswetla were location specific conditions such as population growth, poor quality housing structures, the absence of basic services, poverty and erection of dwelling structures on flood exposed and sensitive environments (Chapter 2 and 4). These locational conditions were found to be exposing and making Setswetla highly vulnerable to flood impacts.

Urban informal settlements exposure and sensitivity to flooding can be ascribed to poor quality housing structures (De Risi *et al*., 2013; Drival, 2016). Most of the shacks are built using low-quality building materials such as wooden boards and plastics, which can allow rain water seepage through the roof and floors (De Risi *et al*., 2013). The water coming through the house can lead to the deterioration of furniture and affect the health of occupants (De Risi *et al*., 2013). As was the case in Setswetla, when it rains rainwater seeps into shacks and people have to move their belongings to dry corners or use buckets and containers to catch the water coming through the roof (Chapter 4).

Furthermore, the unavailability of a proper drainage system to channel water away from the settlement, the haphazard building of shacks to an extent of building them along theJukskei River banks because of high population densities, and limited space, exposed Setswetla to the damaging effect of the 2016 floods. Having access to sufficient basic services such as a drainage system, can improve the quality of life in the settlement in terms of health. Having an officially approved drainage system may also limit the use of already strained personal resources by local residents, who sometimes pay individuals to bring basic services closer to shacks.Therefore, these locational factors, combined with the prevailing local socio-economic conditions, such as unemployment, and the lack of basic services have enhanced the sensitivity of the community of Setswetla to the impacts of the 2016 flash flood (Chapter 2 and 4).

- The social fabric and subsequent social vulnerability

Disasters are critical moments in the life of societies (Chhotray, 2014). A disaster can either bring people together or create rifts. It is often through a disaster event that the relationship between individuals in a community and individuals and the state are developed (Chhotray, 2014). These relationships, for example, between individuals in the community or individuals with the state, can either enhance or decrease vulnerability through inclusion and exclusion of particular people (Chapter 2).

The issue of citizenship came out strongly in discussions with some of Setswetla's community leaders and residents. Illegal foreign nationals were said to undermine law enforcement because they are untraceable. Communal and local government institutions were alleged to be weak in enforcing restrictions on the ever-growing Setswetla community, by allowing foreign nationals to build on vulnerable land.

Furthermore, government interventions can also have unintended consequences that may undermine the building of communal capacity, by creating communal fragmentation and cleavages (Drival, 2016). For example in the current case study, it was found that housing projects initiated by the government were one of the main factors that created communal fragmentation in Setswetla. It was found that the allocation of houses for The Greenhouse project was poorly executed and it was also alleged that Extension 7 houses were sold to foreigners (Chapter 4). This has undermined the efforts of reducing vulnerability by providing decent housing for Setswetla residents through relocations and has allowed the the settlement to grow rapidly.

Issues of inclusion and exclusion are thus key in shaping impacts and also responses during times of acute disaster such as the event that occurred in 2016. Inclusive coordinated communal efforts are necessary for building capacity in vulnerable settlements. Community action and organisation is important in reducing vulnerability because the impacts and benefits are shared by all who take part in initiatives of vulnerability alleviation (Pelling and High, 2005).

Setswetla has a large number of people who are unemployed and this has led to competition for opportunities in the settlement. The competition for employment opportunities has led to some of the residents accusing foreign immigrants from other African countries of bringing unfair competition and adding strain on already limited resources. This has created a lack of

communal cohesion. Communal cohesion, however, can also be minimal in informal urban settlements because few people are living close to their relatives (Drival, 2016). Individuals living in informal settlements sometimes struggle economically because of the high competition for jobs, and they are also dealing with poverty. Given these challenges, they tend to employ individualistic mechanisms to cope with external stress such as flooding (Drival, 2016). For example; some people commented that they relied on themselves for survival during the flood disaster, while others helped people that they were familiar with. As summarised below, these actions are reactionary and do not build capacity to withstand future flooding events.

- The biophysical vulnerability and subsequent impacts of the 2016 floods

The 2016 floods affected Setswetla and the CoJ in various ways. The impacts were both direct and intangible. At a settlemt level, direct loss and damages were composed of a variety of household items such as furniture and the destruction of dwelling structures. At a municipal level infrastructural damage was estimated to be R74.6 million, which was composed of damaged bridges, disrupted power and water distribution (Chapter 4).

Intangible damage and losses included the psychological effects that the flood had on participants, such as hardship, pain and trauma. Such impacts of flooding can be expected to worsen as a result of increasing populations found on marginal and sensitive environments. This is because more people and their assets are being exposed to the damaging effects of flooding, as a result of a lack of settlement planning and poor house construction on marginal and vulnerable land (Douglas *et al*., 2008; Mubaya *et al*., 2015). Proper settlement planning has the potential to effect equitable and sustainable urban settlements because such planning can require engagement with the urban poor in decision-making processes, which is a useful technique for enhancing the wellbeing of the poor (Mubaya *et al*., 2015) (Chapter 2).

After the impact of the flood, the people of Setswetla expected some form of official and/or municipal intervention to aid them in rebuilding their lives, but because of their ‘illegality’ they were unable to realise their expectations (Murray, 2009). Their inability to realise their expectations further exposed them to vulnerability after the flood event. They lacked dwelling structures and this led some of the residents returning to flood exposed and sensitive locations

(Chapter 4). This further recreates the cycles of flood vulnerability and risks and undermines progress made on flood vulnerability reduction.

- Place Vulnerability

Setswetla residents were aware that settling on the lower parts of the settlement increases their exposure to flood risk and impacts. The poor quality of materials used to build their shacks further aggravated their plight. Settling on exposed locations was a result of limited choices because of poverty, for securing rent free or cheap accommodation, and securing livelihood (Chapter 4).

This is consistent with the findings of Siyongwana *et al*. (2015) in a study of the Missionvale flooding. In this study, it was found that respondents from Missionvale, had knowledge that the lower parts of Missionvale, were prone to flooding (Siyongwana *et al*., 2015). Despite such knowledge, the people of the area gave priority to areas that enabled a secure livelihood thereby disregarding the fact that they were prone to flooding (Siyongwana *et al*., 2015). Extreme climatic events, such as flash flooding, coupled with the prevailing poor socio-economic conditions heighten vulnerabilities in poor settlements because they have limited capacity to avoid harm (Nyakundi *et al*., 2010 (Chapter 2).

5.2.3. Community and official responses to flooding

- Communal

Individuals in Setswetla employed a variety of coping mechanisms, such as digging trenches, placing containers inside shacks to catch water seeping through the roofs, stay with frinds or family, and building houses using bricks to deal with flood impacts. These are coping mechanisms in response to the flood shocks. In Accra, when it floods people climb on the roofs for refuge and place their belongings on top of wardrobes (Douglas *et al*., 2008). These responses are reactive; and coping mechanisms because they do not build capacity to anticipate and withstand similar shocks in future. Thus, people in Setswetla do what they can to withstand shocks for a particular moment but not for the future (Chapter 4).

To alleviate vulnerability, the actions employed need to deal with the root causes of vulnerability such as building resilient dwelling structures away from the path of a hazard. It is suggested that proactive measures that can anticipate hazards, build local capacity and have a longer life span are desirable for alleviating vulnerability. Proactive measures can be possible where urban authorities collaborate with local residents and leadership to cocreate solutions for dealing with communal concerns as was the case in Greenpark informal settlement, Cape Town (Chapter 2).

In Mafala settlement, Maputo, there were no internal structures that dealt with with communal concerns such as floods or for organised mutual self-help actions (Douglas *et al*., 2008). Unlike Mafala, Setswetla community leaders liaise with the DMC during disasters and any other event that threatens the community. In 2016, the community leadership assisted urban authorities with counting the flood victims and securing alternative temporal accommodation. In 2017, community leaders identified a garden space and subdivided it so that flood victims could erect shacks. The availability of a local leadership structure is a starting point for the CoJ to collaborate with the community and cocreate solutions of vulnerability alleviation.

- Municipal

The municipality response to the flooding event was also reactionary. The main intervention from the municipality was humanitarian in nature, as it provided alternative temporal shelters, blankets and food. It was acknowledged by one official that responding to the flood incident in Setswetla was not coordinated and that if a similar event were to occur again in Setswetla, the settlement would suffer the same impacts. The perception that Setswetla community is a transient community possibly underpins the lack of proper planning, and the humanitarian response, that led to the failure of having a long-term solutions that will prevent similar impacts in the future. Humanitarian responses are generally once-off and reactive in nature, and do not build capacity or initiate adaptation capacity.

How communities, individuals and officials handle and respond to disastrous events is critical for future similar events (Eriksen *et al*., 2017). The successive nature of flooding and fires in Setswetla and Alexandra, has been identified as key disturbances that have significant impact on individuals and households. Such successive hazards weaken adaptive capacity as they undermine livelihoods, and they may reinforce poverty since they disturb the resource pool of households or individuals as noted in Chapter 4 (Olsson *et al*., 2014).

There is an urgent need however to encourage a systems approach to such a complex challenge such as flash flooding events. The DMC, for example, deals with the issue of flooding and fire usually in isolation without drawing any contextual links on how these events affect the capacity of the people in terms of response and coping capacity. Floods usually happen during the summer rainfall season, and shacks usually burn in winter. The impacts of these two events have significant bearing on the capacity of households to withstand shocks. Their impacts should be interrogated to allow for a more integrated and well-informed intervention, which can potentially address root causes of vulnerability in the settlement. Since, local governments have been recognised as major role players in responding to the needs of citizens (Holloway and Roomaney, 2008; IDP, 2018/19). Therefore, local government institutions should be able to respond effectively to matters of disaster and in building local capacities to reduce disaster risks and vulnerabilities.

When dealing with informal settlements, urban authorities often take the legalistic approach. Most African governments operate within the legalistic approach and are often unwilling to provide drainage systems and basic services to informal settlements because such settlements are seen as being outside the accepted urban regulations and planning (Adelekan *et al*., 2015). Municipalities have a tendency to focus more on the formally developed areas of the city in building climate resilience, and this results in the exclusion of the most vulnerable urban societies found in informal settlements (Taylor and Peter, 2014). This legalistic approach reinforces exclusion and perpetuates inequalities.

With the lack of proper official interventions and response to alleviate risks, the communities like Setswetla become vulnerable to everyday social and environmental risks. Everyday risks and hazards are usually too small or insignificant to be classified as disasters, and yet if unaddressed they can contribute to flood and climate vulnerability since they disturb accrued household resources and livelihoods (Adelekan *et al*., 2015). Local governments such as the CoJ are aware of the everyday risks, such as violence and fires on informal settlements, because they record them on their incidents register, but little to nothing is done to reduce such vulnerability.

Lastly, communications of early warning systems by disaster management and officials from the weather services were identified as critical components to save lives and assets. The DMC

has acknowledged that it has the responsibility to issue a warning about an anticipated weather event as soon as it receives it from SAWS. The DMC issued a warning through a WhatsApp group to all relevant stakeholders. But, the residents contend that they did not receive any warnings. The community leadership confused early warnings with previous DMC campaigns; one of the community leaders provided that the DMC and SAWS came to survey Setswetla and recommended that sirens be installed to warn people when the Jukskei River is going to burst its banks. This was not a warning, but a suggestion made at one of the community awareness campaigns, because it was never followed through and therefore, failed to Early warn (Chapter 4).

A direct way to communicate an anticipated weather event in Setswetla, it is through the community leadership, local newspapers and radio (Dent, 2016). But the nature of the high intensity Highveld storms require particularly quick action by the DMC and effective means of communication for early warning system to be successful. The participants highlighted that the use of a loud hailer, was more feasible because the community leaders use the loud hailer to convene meetings and, to communicate issues of urgency and communal interest. This concurs with findings from Dent (2016) who listed community leadership as one of the most effective ways of communicating early warnings in Setswetla.

5.3.Recommendations

Projected climate change will act as a risk multiplier for many cities around the world, including African cities that are urbanising at a rapid rate (Douglas *et al*., 2008; Beall and Fox, 2009; Eriksen *et al*., 2017). However, for many underdeveloped cities, this can present an opportunity for the cities to move towards a more urban pro-poor development paradigm and transform the urban systems to be more inclusive and just. This development paradigm can result in the desired outcomes such as equality and the creation of a just and resilient society by (Douglas *et al*., 2008:201):

- ‘Providing basic services such as sanitation, housing and drainage systems to informal settlements.
- Including informal settlements in the city’s regular waste collection and management programmes.
- Planning to ensure the sustenance of informal settlement livelihoods.

- Developing key infrastructure such as roads and bridges to enable access to the settlement.
- Enforcing just and systematic relocations for the most vulnerable.'

These actions can be construed as transformational as they seek to change the processes and structures that drive vulnerability, because they are more explicit, inclusive and transparent (Zievogel *et al*., 2017). Transformational development will also mean that informal settlements are not recognised as separate from other urban settlements, but an integral part of the urban fabric. Such recognition will allow for the provision of sufficient basic services, which can stimulate adaptation. Moving towards more inclusive urban spaces can assist in reducing vulnerability in such spaces.

Therefore, this calls for an urban paradigm shift and the creation of a new urban framework that will recognise urban informal settlements as part of the urban social fabric, because the old framework does little to alleviate social and environmental injustices (Kaika, 2017).The old urban paradigm is characterised by global socio-environmental inequality and degradation, and at the same time challenges the idea that resilience building and the creation of smart cities will not really address the root causes of vulnerability but may rather perpetuate injustices (Kaika, 2017). Kaika (2017), for example, argues that communities do not want to be resilient, but want to change the things that are making them vulnerable in the first place.

5.4 Contribution to the vulnerability body of research

Vulnerability of informal settlements is a topical issue in the context of global climate change. This study has provided some sense of what drives vulnerability in the small but vulnerable settlement of Setswetla. The findings from this study highlight that vulnerability is a context-based concept and a condition that is driven by multiple factors which can be classified as physical and social. The physical risk factors mainly emanated from the physical environment, such as the geographical location of the community. The social factors included livelihoods, citizenship, presence and or absence of basic services.

Setswetla is no different to the cited cases of Dar es Salaam, Port Elizabeth, Accra, Maputo and Cape Town. All these case studies show that informal urban settlements are vulnerable to

flood impacts, as was found in Setswetla. They all highlighted that flooding impacts come with significant economic implications for municipalities and more especially residents of such settlements. They also show that population growth and rapid urbanisation brings about significant challenges for urban flood management as people settle on underserviced locations or environments that are not suitable for human settlements.

These settlements are projected to grow since more people are expected to move into urban areas. Therefore, there will be a need for studies, similar to this one, to be carried out on different informal locations with the aim of informing local citizens and all actors including local government on what conditions exist in the community that influence vulnerability, networks and opportunities that exist within the community that can drive collective efforts to reduce vulnerability.

5.5.Personal reflection

Vulnerability is constantly changing especially in informal settlements. While conducting the study and engaging with municipal officers, I did not get a sense that officials fully appreciate the changing nature of vulnerability in Setswetla. This was apparent because there was no clear plan for the Setswetla settlement except that there was a DMC advisory committee that met on a regular basis to prepare for disaster incidents. From the several meetings that I attended, Setswetla was only a topic meriting some concern because of the 2016 flood. With the changing conditions and new people coming into the settlement the next flood might result in further impacts and possible casualties. When dealing with Setswetla, the city seems to only take a reactionary approach and this might undermine the potential of building risk reduction capacity in Setswetla.

Lastly, it is imperative to emphasise that vulnerability is a context-based and constantly changing condition that is created by multiple socioeconomic and environmental factors. Credible and reliable data for informing decisions and interventions are fundamental for the alleviation of vulnerability. The CoJ as a local government institution should urgently make plans to systemically record data in a format that is standardised for all departments with regards to informal settlements disasters and incidents. Such data will enable stakeholders to have an idea of what are the current conditions in a given settlement, how many people reside at an informal settlement, at a given point in time and what are the prominent hazard affecting

the settlement. Sub-Sahara African cities are said to be lacking critical data on everyday hazards and disasters of all scales (Adelekan, 2018). This lack of data can undermine the goals of the Sendai framework of "building back better" and the SDGs of "leaving no one behind" after a disaster, and this can hinder effective and systematic planning for vulnerability reduction (Adelekan, 2018).

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7. Appendix 1: Participant information sheets and questions

Information Sheet for the community

Hello,

My name is **Paulose Mvulane (student no. 570371)**, registered for Masters in Science (MSc) by Dissertation at the University of the Witwatersrand, School of animal Plant and Environmental Sciences.

As part of my Masters programme I have to do research on an approved topic. My research topic is **Settling on Water Pathways: A case study of Setswetla vulnerability to flash floods**. The aim of this study is to understand why Setswetla is threatened by flash floods, using the 2016 November flash flood event as a case study. Specifically, I will explore causes of some of the impacts of the 2016 flash floods in Setswetla, investigate the destruction caused by the flash floods, explore what the community and individuals did to adapt to the flash flood event and, to investigate the response of the authorities and analyse whether they were prepared for such an event. With your permission, I would like to interview you. Your participation will take about an hour of your time. With your consent I would like to interview you at your home, or we may walk to a place that you may know which was severely affected by the 2016 flash floods. The interview questions will cover, background personal information, what you do for a living, estimated loss and damages suffered by you and the community during the flash floods and, what you and/or community did during the flash flood to avoid loss, and how effective were those actions in minimising or avoiding loss. Furthermore, with your permission, I would like to audio or video record the interview to ensure that I thoroughly capture your response.

Please Note: You will not be advantaged or disadvantaged in any way by participating in the study. Your participation is voluntary, so you can withdraw your permission at any time during this research or you may choose not to answer some or all of the questions without any penalty. There are no foreseeable risks in participating and you will not be paid for participating. Furthermore, the copy of this research will be available to you upon request

I will maintain anonymity and confidentiality of the interview as far as I can during and after the interview, by removing all identifying factors such as names, location of the interview or addresses on the interview. Furthermore, should your participation evoke emotions due to the loss or damaged caused by the floods? The Wits Emthonjeni Centre is willing to offer counselling to anyone participating in this study. They can be contacted at 011 717 4513 or email emthonjenicentre.SHCH@wits.a.cza

Thank you very much for your help.

Please let me know if you require any further information or feel free to contact me or my supervisor for any concerns.

Yours sincerely,

Paulose Mvulane (Student)
570371@students.wits.ac.za
073 233 9469

Prof Coleen Vogel (supervisor)
Coleen.Vogel@wits.ac.za
0117176603

Paulose Mvulane

Information Sheet for City officials

Hello,

My name is **Paulose Mvulane (student no. 570371)**, registered for Masters in Science (MSc) by Dissertation at the University of the Witwatersrand, School of animal Plant and Environmental Sciences.

As part of my Masters programme I have to do research on an approved topic. My research topic is **Settling on Water Pathways: A case study of Setswetla vulnerability to flash floods**. The aim of this study is to understand why Sestwetla is threatened by flash floods, using the 2016 November flash flood event as a case study. Specifically, I will explore causes of some of the impacts of the 2016 flash floods in Sestwetla, investigate the destruction caused by the flash floods, explore what the community and individuals adapt to the flash flood event and, to investigate the response of the authorities and analyse whether they were prepared for such an event.

With your permission, I would like to interview you. Your participation will take about an hour of your time. The interview questions will based on the work that you do for the City of Johannesburg Disaster Management Centre, including the dissemination of early warnings to communities, the ability to provide basic services after the flash floods and the relationship between CoJ Disaster Management and informal settlement, with reference to Setswetla.

Please Note: You will not be advantaged or disadvantaged in any way by participating in the study. Your participation is voluntary, so you can withdraw your permission at any time during this research or you may choose not to answer some or all of the questions without any penalty. There are no foreseeable risks in participating and you will not be paid for participating. Furthermore, the copy of this research will be available to you upon request.

I will maintain anonymity and confidentiality of the interview by removing all identifying factors such as names, location of the interview or addresses on the interview. Please note that confidentiality and anonymity cannot be guaranteed by virtue of the position you may be holding in the department. Furthermore, the copy of this research will be available to you upon request

Thank you very much for your help.

Please let me know if you require any further information or feel free to contact me or my supervisor for any concerns.

Yours sincerely

Paulose Mvulane (Student)
570371@students.wits.ac.za
073 233 9469

Prof Coleen Vogel (supervisor)
Coleen.Vogel@wits.ac.za
0117176603

Settling on Water Pathways: A case study of Setswetla vulnerability to flash floods

By: Paulose Mvulane

Participant Consent Form

I …….. agree to participate in this research project. The research has been explained to me and I understand what my participation will involve.

I agree that my participation will remain anonymous	YES	NO	(please circle)
I agree that the researcher may use anonymous quotes in his research report	YES	NO	
I agree that the interview may be audio recorded	YES	NO	
I agree that the researcher may take photos of me (But not of my face)	YES	NO	
I agree that the information I provide may be used anonymously by other researchers following this study	YES	NO	
Will you require the final report of the Research (NB: The final report will be in English)	YES	NO	

…… (Signature)

…… (Name of participant)

…… (Date)

Paulose Mvulane

Invasive waters: A case study of Setswetla vulnerability to the November 2016 flash floods.

Questions for the Community

1. **Personal basic info**

a) Name_____

b) Gender (please mark with "X")

Female	
Male	

c) What kind of work do you do for a living?

---

d) Do you have children or family who depend on you? How many? please mark with "X"

Yes	
No	

Male dependants	Number of dependants
0-20 years	
20-40 years	
40-60 years	
>60 year	

Female dependants	Number of dependants
0-20 years	
20-40 years	
40-60 years	

>60 years	

e) How long have you been in Setswetla? Please circle

0 to 10 years	10-20 years	More than 20 year

f) What do you like and dislike most about living in the Setswetla settlement?

---

g) Do you have formal schooling?

Yes	
No	

What level?

---

h) Do you have some understanding of the weather[13] patterns and weather events?

Yes	
No	

i) How do weather patterns and events affect your daily living in the settlement?

---

j) If the weather changes randomly or events such as the 2016 November flood occurs, does it bother you? Why?

---

[13] Day to day temperatures, rain, wind and etc.

---

k) Please list some of the main daily living challenges in the Setswetla community

---

---

2. Identify the extent of the 2016 Johannesburg flash floods and explore their general impacts on informal settlements

What factors enhance vulnerability[14] to flash floods in the settlement, and how do these vary spatially or by household?

a) Do you know what are flash floods or floods?

Yes	
No	

b) What causes floods or flash floods?

---

c) Which factors[15] do you think makes Setswetla to be more vulnerable to flash floods/flooding? Why?

---

[14] Vulnerability here means factors or conditions that exits within the community that can increase the impact of a hazard and/or a dangerous situation

[15] Factors will be explained as follows. Participants may choose one or more

Environmental factors	**Social factors**	**Economic factors**
Natural features of the location	The perceptions, knowledge and believes of local people	Economic status of the local people

---

---

d) Does the Setswetla community have any basic services[16]?

Yes	
No	

e) Which basic services are available in the community (please mark with "X")

Tap water		Police station/mobile	
Electricity		Emergency services	
Basic health facilities			
Waste removal			
Flushing toilets			
Bucket toilet			
Dustbins			
Education facilities			

f) How does access to these services affect the protection of property[17] or personal wellbeing[18] during the events like the 2016 flash flood?

---

g) How did the November 2016 affect you personally?

---

[16] Basic services are those necessary things that people need to have a quality life

[17] Property here refers to movable and immovable property, and individual and communal property. That may have economic value or any other value that cannot be translated in economic terms

[18] Wellbeing refers to a state of being healthy, personal and communal security or conditions which enable individuals and communities to flourish.

h) Within the community, who was more affected by the 2016 flash flood? Why?

---

3. **Investigate the damage and losses (both direct and indirect) suffered by the Setswetla community as a result of the 2016 flash floods**,

What losses were experienced (direct and indirect) by individuals and the community as a result of the flash flood?

a) How did the 2016 flash floods affect your day-to-day routine?

---

b) Did your routine change? Please mark with "X"

Yes	
No	

If yes, what adjustments did you have to do?

---

i) Do you still live in the same area that you lived in before the flash flood? Please mark with "X"

I still live in the same area	
I had to move to another area	

j) Which items of value got damaged or lost as result of the flash floods? Please list

---

---

k) Did you need to rebuild your house after the flash floods?

Yes	
No	

l) If yes, what material did you use? Please mark with "X"

Wood	
Corrugated iron	
Bricks	
Boxes	
Plastics	
Cement	
Mud	
Other specify	

---

m) How much did it cost to rebuild? Please mark with "X"

R0-R1000	
R1000-R1000	
>R10000	

n) Did you miss work after the flash flood event? Please mark with "X"

Yes	
No	

o) What was your reaction[19] to the 2016 Flash floods?

---

[19] Negative or positive reaction

---

p) Do you think something could have been done to minimize the impacts of the flash floods or the floods and impacts were beyond everyone's power? Please explain

---

---

q) Did your children or any other child that you may know miss school as result of the floods? Please mark with "X"

Yes	
No	

r) How long did your child and/or the child you may know miss school after the floods? Please mark with "X"

1-10 days	
20-30 days	
>30 days	

s) Did any of your family members become ill after the flash flood? Please mark with "X"

Yes	
No	

If yes, what kind of illness (Cholera, colds and flu etc)?

---

t) How do you feel about the impacts of the 2016 flash floods?

---

4. Explore and analyze how effective communal and individual coping strategies are in minimizing the effect of flash floods.

How did individuals or community respond to the impact of the flash flood?

a) Did the community receive any warning regarding the weather condition that will cause flash flooding? Please mark with "X"

Yes	
No	

b) What was or could have been the mode of communication used to issue a warning about an upcoming extreme weather event? Please mark with "X"

Television	
Radio	
Local Newspaper	
SMS	
Other specify	

c) Does the community have a communal process (i.e a group or forum) that deals with extreme weather event awareness and preparedness? Please mark with "X"

Yes	
No	

d) Does the community have measures in place to minimize the impacts and vulnerability to flash floods? Please mark with "X"

Yes	
No	

If yes, please describe the activities, and
Who uses them?

---

e) If the community does not have any measures in place, what can be done to ensure that impacts are kept at a minimum if similar events occur?

---

f) During the 2016 flash flood, did members of the community help each other? Please mark with "X"

Yes	
No	

If yes, how?

---

g) Are there any observed communal measures that are used to minimize the impact of flash flooding? Please mark with "X"

Yes	
No	

If yes, what are they?

---

h) How effective were these measures in the November 2016 flash flood? Please mark with "X"

Not effective	
Effective	
Not sure	

Please motivate

Individual

i) When the November 2016 floods occurred, were you at home? Please mark with "X"

Yes	
No	

j) What measures did you take to avoid or minimize the impact of the flash flood?

---

k) How effective was your action? Please mark with "X"

Not effective	
Effective	
Not sure	

Please explain your response

---

l) In your household do your dependents need to take particular measures by virtue of their age or gender[20] to avoid harm? Please mark with "X"

Yes	
No	

If yes, please explain

---

5. Investigate and analyze the preparedness and response of the disaster management authorities to the November flash floods.

How prepared and effective was the City of Johannesburg disaster officials in responding to the November flash flood?

[20] This question explores gender roles in a household at the face of a hazard or disaster. If it is unclear it will be simplified for participants

Paulose Mvulane

City of Johannesburg Disaster officials

a) What is your job title?

---

b) What does your job entail on a day-to-day basis?

---

c) How long have you been working for the City of Johannesburg Disaster Management office? Please mark with "X"

0-10 years	
10-20 years	
>20 year	

d) Are you aware of the November 2016 Flash Flood? Please mark with "X"

Yes	
No	

e) Was the flash flood predicted and/or expected? Please mark with "X"

Yes	
No	

f) How was the information regarding the floods disseminated to communities? Please mark with "X"

Television	
Radio	
Local Newspaper	
SMS	
Local leadership	
Other specify	

---

g) Did the nature of the event allow for timeous dissemination of the warnings issued by Disaster Management? Please mark with "X"

Yes	
No	

Please explain

---

h) Do you know of any communities which were severely impacted by the November 2016 flash flood? Please mark with "X"

Yes	
No	

If yes, please list them

---

i) What factors contributed to community vulnerability to flash floods?

---

j) Do you think the severely impacted communities had access to the modes of communication used to issue warnings about expected extreme weather events? Please mark with "X"

Yes	
No	

Please explain

---

k) What are the key factors that exist in the department that have affected or enhanced the preparedness and response of the department in the case of Setswetla? Please mark with "X"

Human resource	
Skills	
Communications	
Required technology	
Accessibility of affected areas	
Relationship with local leadership of affected areas	
Infrastructure of the department or the affected area	
Other, please specify	

l) Does the department have a relationship with Setswetla community leadership? Please mark with "X"

Yes	
No	

m) Does the relationship allow for meaningful engagement in aspects of disaster management and response? Please mark with "X"

Yes	
No	

Please motivate

---

n) Was the city able to provide key basic services to the Setswetla community after the flash flood? Please mark with "X"

Yes	

No	

Please motivate

---

o) Do you think Setswetla community is vulnerable to flash floods? Please mark with "X"

Yes	
No	

p) If yes, which factors influence Setswetla vulnerability (social, economic and/or environmental factors)? How?

---

q) Does the department have any monitoring methods for interventions (Pre and post evaluations)? Please mark with "X"

Yes	
No	

r) How effective was Disaster Management response to the 2016 flash flood?

Not effective	
Effective	
Not sure	

Please explain

---

s) What lessons came out the 2016 flash flood?

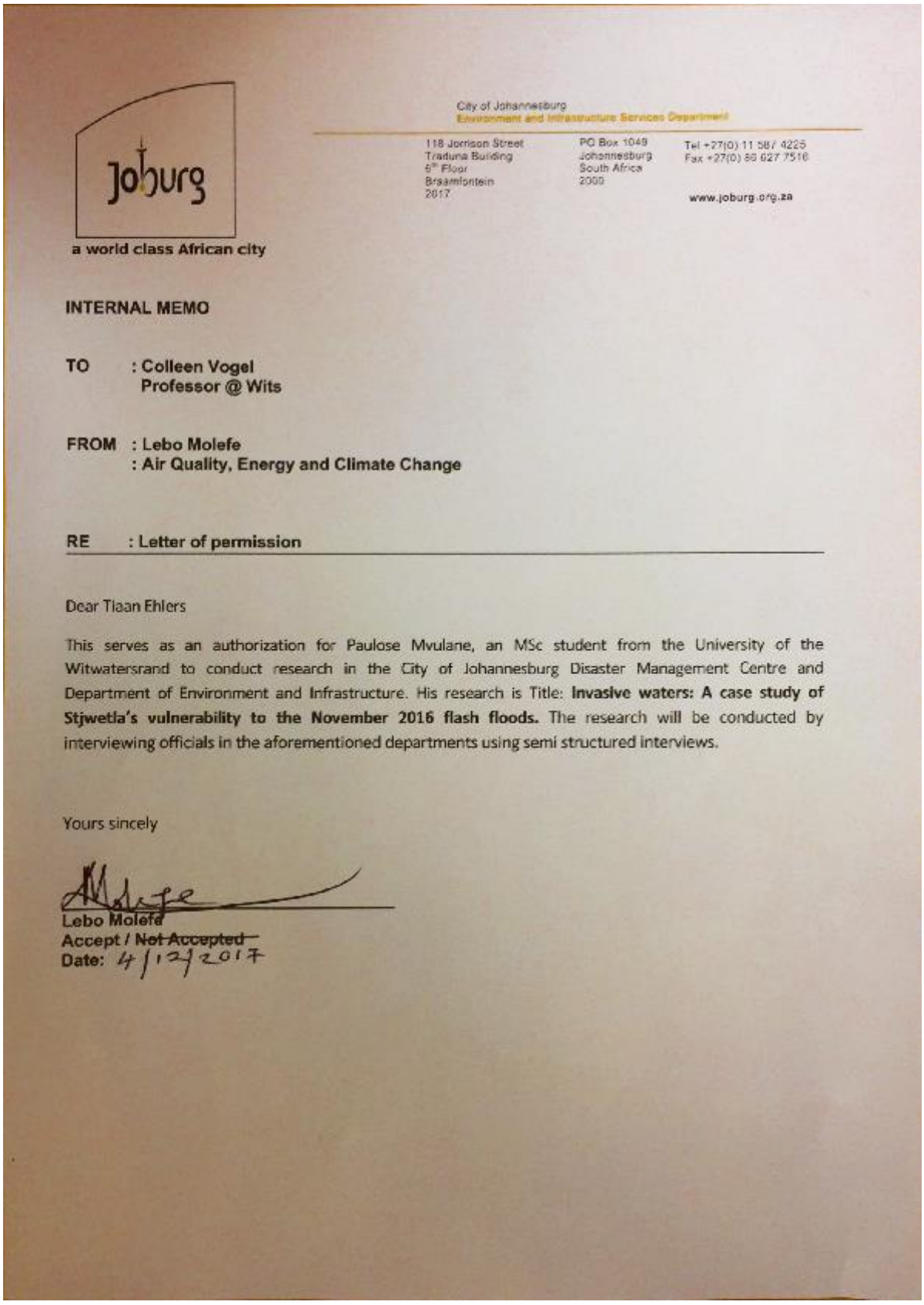
---

t) Does the department have a plan to deal effectively with similar events in future?

Yes	
No	

Please explain

8. Appendix 2: Letter of authorisation – CoJ



City of Johannesburg
Environment and Infrastructure Services Department

118 Jorrison Street
Traduna Building
5th Floor
Braamfontein
2017

PO Box 1049
Johannesburg
South Africa
2000

Tel +27(0) 11 587 4225
Fax +27(0) 86 027 7516

www.joburg.org.za

a world class African city

INTERNAL MEMO

TO : **Colleen Vogel**
Professor @ Wits

FROM : **Lebo Molefe**
: **Air Quality, Energy and Climate Change**

RE : **Letter of permission**

Dear Tiaan Ehlers

This serves as an authorization for Paulose Mvulane, an MSc student from the University of the Witwatersrand to conduct research in the City of Johannesburg Disaster Management Centre and Department of Environment and Infrastructure. His research is Title: **Invasive waters: A case study of Stjwetla's vulnerability to the November 2016 flash floods.** The research will be conducted by interviewing officials in the aforementioned departments using semi structured interviews.

Yours sincely

Lebo Molefe
Accept / ~~Not Accepted~~
Date: 4/12/2017

9. Appendix 3: Letter of authorisation – DMC

City of Johannesburg
Public Safety
Disaster Management

Disaster Management Centre
Preparedness and Planning
Portfolio: Marketing, PR and Events

Tel +27(0) 11 222 8093
Cell +27(0) 83 771 9928
Email: nielr@joburg.org.za

140 Linden Drive Sandton

P O Box 1049 - Johannesburg 2000

Tel: + 27(0) 222 8293
Email: coidmc@joburg.org.za

01 March 2018

To whom it may concern

This serves as an authorization for **Mr. Paulose Mvulane**, an MSc student from the University of the Witwatersrand to conduct research in the City of Johannesburg Disaster Management Centre and Department of Environment and Infrastructure. His research is Title: Invasive waters.

A case study of Setjwetla's vulnerability to the November 2016 flash floods. The research will be conducted by interviewing officials in the aforementioned departments using semi structured interviews.

Your consideration in this matter is appreciated.

Kind Regards,

.....

Mr Tshepo Motlhale
City of Johannesburg
Public Safety: Disaster Management
Divisional Chief

082 460 0381

Page 1 of 1

10. Appendix 4: Counselling services

EMTHONJENI CENTRE
THE SCHOOL OF HUMAN AND COMMUNITY DEVELOPMENT (SHCD)

Private Bag 3, Wits, 2050 · Tel: 011 717 4513 · Fax: 011 717 4559 · E-mail: emthonjenicentre.SHCD@wits.ac.za
E-mail: Umthombo.SHCD@wits.ac.za

27 October 2017

Dear Wits Research Office Ethics Committee,

This letter serves as a confirmation that the Emthonjeni Centre is willing to offer counselling services to the participants of Paulose Mvulane (570371) MSc research titled; Invasive waters: A case study of Stjwetla's vulnerability to the November 2016 flash floods. The participants of the research may be charged a nominal fee for such services. Please note that the offer of counselling is dependent on our capacity at the time.

Yours sincerely,

Karen Milner
Associate Professor
Director: Emthonjeni Centre

11. Appendix 5: Participants characteristic information table

Name	Gender	Home language	Occupation	Dependents	Level of Schooling
Official 1	Male		CoJ	N/A	N/A
Official 2	Female		DMC CoJ	N/A	N/A
Official 3	Male		DMC CoJ	N/A	N/A
Bricklayer	Male	Tsonga	Piece jobs/now not working	3 Children	Grade 12 (2008)
Esihle	Female	Pedi	Not working Partner not working	2 Children	Grade 11(2014)
Bigshack	Female	Tsonga	Not working	Not provided	Not provided
Chicken	Female	Tsonga	Nurse	3 Children	Nursing college
Peace	Male	Pedi	Security	1 Child	Grade 11
Mfundisi	Male	Pedi	Security	2 Children	Grade 12
P Man	Male	Xhosa	Hospital laundry	1 Child	Grade 12
Mpofu	Female	Tsonga	Not Working		Grade 12
Ma	Female	Tsonga	Not Working	4 Children	Not provided
Pa	Male	Tsonga	Piece jobs		Not provided
Ma 20	Female	Zulu	Not Working Partner working	2 Children	Grade 12
Sub Station	Male	Tsonga	Piece Jobs	2 Children	Grade 11
Nyiko	Male	Tsonga	Business	Not provided	UNISA

Slender	Female	Tsonga	Not working Partner is working	1 child	Not provided
Beauty	Female	Zulu	Business	Not provided	Not provided
Jabu	Male	Pedi	Not working	2 children	Grade 10
D'bongz	Female	Tsonga	Studying in a local college	1 child	Grade 12
Mbali	Female	Xhosa	Not working	4 children	Grade 11
Papalaza	Male	Tsonga	Not working	1 child	Not provided
Low voice	Female	Tsonga	CWP worker	2 children	Grade 11
Esther	Female	Pedi	Not working	3 children	Form 2
Mabunda	Male	Tsonga	Taxi driver	2 children	Grade 12
Lady B	Female	Pedi	Not provided	None	Not provided
Mama Z	Female	Zulu	CWP worker	1 child	Not provided
X lady	Female	Xhosa	Not working	2 children	Grade 10
Ta X	Male	Xhosa	Not working	Not provided	Not provided
Vha Vhenda	Male	Vhenda	Piece jobs	Not provided	Not provided
Pamela	Female	Pedi	Not working	Not provided	Not provided
Witness	Male	Tsonga	Business	Not provided	Not provided
Chubby	Male	Pedi	Working at Bidvest warehouse	1 child	Not provided
Actor	Male	Tsonga	Piece jobs	2 children	Grade 11
Business lady	Female	Tsonga	Business	1 child	Not provided

Baba H	Male	Tsonga	Not working	12 children	Not provided
Nkosana	Male	Ndebele	Fence designer	2 children	Not provided
Mme T	Female	Zulu	Not provided	Not provided	Not provided
Mam'Nongena	Female	Xhosa	Not provided	Not provided	Not provided
Alpha	Male	Pedi	Not provided	Not provide	Not provided
Member	Male	Tsonga	Not provided	Not provided	Not provided
Bra J	Male	Pedi	Not provided	Not provided	Not provided

12. Appendix 6: Ethics clearance certificate

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Mvulane

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H17/07/20**
PROJECT TITLE	Invasive waters: A case study of Stjwetla's vulnerability to the November 2016 flash floods
INVESTIGATOR(S)	Mr P Mvulane
SCHOOL/DEPARTMENT	Animal, Plant and Environmental Sciences/
DATE CONSIDERED	21 July 2017
DECISION OF THE COMMITTEE	Approved Permission letters are required before data collection can commence
EXPIRY DATE	27 September 2020

DATE 28 September 2017 **CHAIRPERSON** pp (Professor J Knight)

cc: Supervisor : Professor C Vogel

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

_____ _____/_____/_____
Signature **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES