Flood risk and sanitation service delivery in informal settlements under climate change: a case study of Cape Town, South Africa

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Informal settlements are home to 32 per cent of urban dwellers worldwide. Access to sanitation in these spaces is amongst the most pressing needs and contentious issues in cities in developing countries. Residents of informal settlements, or shack dwellers, regularly cope with flooding that reduces their access to basic services. Yet the impact of environmental risks, such as flooding and climate change, on urban service delivery is understudied. Using a case study approach, key informant interviews were conducted in Cape Town, South Africa with municipal staff, civil-society organizations, and local researchers. Opportunities for climate change adaptation in informal settlements were located within municipal service delivery and flood mitigation strategies. Six major themes emerged: the need for an integrated approach to urban service delivery; the social and human factors which undermine technical interventions; the reality of trade-offs in complex environments such as informal settlements; the role of experimentation and collaboration in creating opportunities for building trust between stakeholders and bridging knowledge gaps; the limitations of formal planning tools in informal spaces; and the need to theorize cities from the reality of urban spaces in the global South.

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Preface

I arrived in South Africa a few months after the country celebrated the 20th anniversary of the end of apartheid on April 27th, 1994. Though apartheid now seems long past to the rest of the world, its legacy is felt everywhere you go in South Africa. This was clear in the love for Nelson Mandela, celebrated almost unanimously, and the legacy of freedom fighters, particularly in the still-poor townships. The debris of apartheid-era planning and continued contradictions lingered in my mind throughout my field work.

An impressive highway system cuts through kilometres of shacks which transition into subsidized housing subdivisions arranged neatly in rows before you enter the developed core of Cape Town, mimicking apartheid planning goals of racial and class segregation. Individuals I met asked if I would be studying flooding 'in the country', as if the Cape Flats were entirely separated from the proper city of Cape Town. People spoke of places like Kosovo, Barcelona, and Europe, informal settlements, named, perhaps ironically, after the global events at the time of their origin. In the Central Business District (CBD), sophisticated rapid transit has been built with an extensive network of terminals and dedicated bus lanes. On the way to Camps Bay, an affluent beach-side neighbourhood, the metal and concrete skeleton of an elevated freeway breaches the skyline, its construction incomplete after being abruptly halted twenty years previously during the political transition.

Suffice to say, I was completely out of my element and spent the better part of my field work asking who I was to come here and pretend I could offer anything. Conversations with people who lived or worked in Khayelitsha continuously challenged how I approached my research questions, pushing me out my comfort zone and confronting what I knew, or thought I knew, about development. The reality I found was that, like everywhere, people make trade-offs for the sake of opportunity, family, and survival. People live, struggle, and fight for their claim to the city. The fight for basic rights does not express the battle waging between residents and the structures of market and government.

As my field work was conducted during the winter season, reports of flooding were regular. I witnessed the intense rainfall of Cape Town that clears the streets in a matter of seconds. Shacks stand precariously placed in the most unlikely locations. I wondered how they could be so sturdy while seeming so fragile. It was easy to see how water affected residents. I wondered how people got to work or how children and young people studied when their roofs barely kept the water out. In Cape Town, flooding is not catastrophic in the sense of tsunamis and typhoons, but it is catastrophic in the sense that residents are continually held back from flourishing, whose unique aspirations and desires are regularly interrupted by managing floodwaters, avoiding or suffering waterborne illnesses, and

taking risks associated with traveling far distances, often alone and often in darkness, to access clean water and sanitation services.

We often think about the provision of toilets, the risk of flooding, and the possibility of climate change as if they are separate. However, planning must seek some greater ideal. Planning problems do not exist in a vacuum and solutions are not implemented as if the city were disentangled from its environment and its inhabitants. We, as planners, must consider the often conflicting needs and desires of residents and how they relate to their community, their city, and their wider physical environment. We must also understand the capacities and limitations of the city, both as an ideal, and in reality. We, as planners and as city dwellers. are entangled with not only the physical form of the city, but the natural environment on which it depends and the intricate social dynamics that shape our daily lives. With this notion of entanglement in mind, I approach this thesis seeking to understand how cities might better approach planning for those economically and socially excluded from the planning process, those who with little more than scrap metal, reclaimed wood, and lifted electrical wire, self-actualize, raise families, gather in community, and claim their space within cities that are unwelcoming and even hostile to their existence.

Chapter 1 Introduction

1.1 Background and research problem

Global urbanization has been accompanied by the growth of informal settlements, now home to more than 32% of the world's population (UN-Habitat, 2009a). Basic services, particularly sanitation, have been the locus of local and international campaigns to improve quality of life in informal areas. However, informal settlements across geographies are sites of regular flooding due to both natural and man-made causes (de Risi et al., 2013; Jiusto & Kenney, 2015). Flooding impacts service delivery and urban infrastructure, and erodes the assets[1] of informal settlement residents, or shack dwellers (Few, 2003; Heltberg, Siegel, & Jorgensen, 2009). Climate change is expected to impact poor countries disproportionately and experts fear that climate change will set back development gains (Douglas et al., 2008; IPCC, 2014b). As such, climate change adaptation is intricately connected to mitigating flood risk and improving quality of life for informal settlement dwellers. However, integrating flood mitigation with social and economic development continues to be an elusive goal and research agendas are often disconnected (Pharoah, 2014). This thesis explores how sanitation service delivery and long term development in informal settlements are impacted by flooding, and how these impacts will increase with climate change.

Anthropogenic climate change impacts have already been reported on all continents, with some locations significantly more at risk than others due to physical exposure and underlying vulnerability (IPCC, 2014e). Cities are home to more than half the world's population and, as such, are particular areas of concern for adaptation (IPCC, 2014b). Cities are also areas of concentrated capital, resources, institutions, and innovation (IPCC, 2014f). Urban climate change adaptation has emerged as an important area of research and policy-making (Carmin, Anguelovski, & Roberts, 2012).

Vulnerability to climate change derives from both social and physical processes (IPCC, 2014e). In low- and middle-income countries, vulnerability is higher where rapid urbanization has been accompanied by growth in informal settlements (ActionAid, 2006; IPCC, 2014f; UN-Habitat, 2009a). These settlements are often locations of poverty, poor or no infrastructure, and social challenges. Existing quality of life deficits increase the harm of both climate variability and projected climate change (Few, 2003). Flooding is a risk factor in informal settlements across geographies due to

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[1] Productive (human, natural, physical, financial), social and political (networks), and locational (proximity to agricultural land, markets, or transportation); see Heltberg et al., 2009; also Moser, 1998.

common characteristics: settlement on poor quality land, housing materials and construction practices, extremely high densities, and lack of drainage (Ibid).

Access to water, sanitation, and better housing are a primary struggle for residents in informal settlements who face frequent environmental hazards such as flooding. Internationally, efforts such as the Millennium Development Goals have raised awareness of these issues; locally, residents and activists have called for rights and services through protest action (Nyar & Wray, 2014; United Nations, 2014). The long-term sustainability of development gains is compromised when climate change and environmental factors are not considered hand-in-hand with development action and infrastructure investment (Chuku, 2010; Ireland, 2010; Klein et al., 2007; Sharma & Tomar, 2010; Wekesa, Steyn, & Otieno, 2011). Cities in developing countries struggle to bring housing and infrastructure to an acceptable level against existing weather patterns. However, research on adapting urban services and infrastructure to climate change is more common for developed countries which, unsurprisingly, possess the resources and capacity to embark on such projects (Berrang-Ford, Ford, & Paterson, 2011). More research is needed on how cities in developing regions can adapt to climate change in conjunction with promoting a better quality of life for urban informal settlement dwellers.

Recognizing the critical nature of urbanization and informality under climate change, this thesis explores the impact of flooding and climate change on sanitation services in informal settlements, and the role of adaptation within this. The City of Cape Town serves as a case study to examine flood impacts on sanitation delivery in informal settlements, and the actions and opportunities available for incorporating adaptation in municipal interventions. Using a holistic risk framework (introduced in Chapter 2), I examine the multiple and interrelated sources of risk that contribute to flooding and reduce the effectiveness of development interventions, and argue that climate change adaptation cannot ignore underlying risk factors in informal settlements.

The following terms will be used throughout this thesis:

Sanitation service delivery: Urban service delivery encompasses the provision of infrastructure and services required to maintain the function of human settlements including: roads, water, sanitation, waste, and electricity. This thesis focuses on the provision of sanitation infrastructure such as underground sewer lines and toilet facilities, and sanitation services, such as maintenance and cleaning of communal sanitation facilities. The provision of one type of service is often contingent on others: e.g. providing sanitation services often requires road access and water connections.

Flood mitigation: Flood mitigation describes efforts to prevent or reduce the impact of flooding, or to respond to a flood event (Vojinovic & Abbott, 2012). Mitigation is used in hazards literature to mean the management of flood waters. In climate change literature, the word *adaptation* would refer to efforts to manage flooding due to climate change.

Climate change adaptation: Efforts by households, communities, or societies to adjust to potential impacts of climate change, through changes to practices, infrastructure, and policies (IPCC, 2014a). Generally, climate change adaptation seeks to maintain the ability to pursue livelihoods within an area under a changing climate.

1.2 Case study: City of Cape Town, South Africa

In Cape Town, South Africa, 13.5 – 15% of residents live in informal settlements, approximately half a million people[23] (City of Cape Town, 2012b; Ziervogel & Smit, 2009). Though there are a variety of forms of informal settlement in Cape Town (see Chapter 4), this thesis focuses on large informal settlements that have developed on the periphery of poor, formal areas in the Cape Flats, a low-lying and flood prone area of the city (Figure 1)[4]. Major flooding between 2007 and 2009 displaced between 32,000 and 34,400 informal settlement residents each year (Ibid). Such numbers do not account for daily damp conditions that impact the health and safety of residents. Though the type of flooding experienced in Cape Town rarely results in loss of life, it significantly impacts people's homes, local infrastructure, and road access (Pharoah, 2014)

The City of Cape Town, in the Western Cape Province, anticipates an increase in the frequency and severity of extreme rainfall and weather events (Tadross & Johnston, 2012). Though the region is expected to be drier overall, potentially provoking future water crises, extreme weather events and changes to rainfall patterns may heighten flood risk in areas that already face frequent disruptions due to flooding and associated health and safety consequences (Ziervogel, Waddell, Smit, & Taylor, 2014). In addition to environmental hazards such as flooding, informal settlements in Cape Town face a myriad of issues around water and sanitation service delivery, as well as housing (Govender, Barnes, & Pieper, 2011).These range from insufficient provision of sanitation facilities in some areas to frequent servicing issues in others. Sanitation services are some of the most contentious issues in South Africa, with frequent protests over services indicative of the socially and politically

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[2] 13.5 % was reported in the 2011 census, 15% was reported in the literature.
[3] An addition 7% of households live in backyard dwellings – shacks built on formal properties, normally paying rent to the landowner.
[4] Note that the Hout Bay area, another area with informal settlements facing service delivery challenges, is also marked in Figure 1 for reference.

explosive consequences of inadequate services for hundreds of thousands of informal settlement dwellers (Nyar & Wray, 2014). A publication by the Western Cape Government noted that service delivery in the region was already affected by climate variability (Midgley et al., 2005).

Though large informal settlements exist within Cape Town, the municipality possesses higher levels of human and financial capacity than other cities in South Africa (Chitiga-Mabugu & Monkam, 2013). As an early adopter of climate change adaptation policy, the City of Cape Town has been at the forefront of climate change policy and was chosen for this study to gain insight into the process of integrating climate change adaptation into flood mitigation and urban service delivery. A qualitative study was conducted using key informant interviews with staff at the City of Cape Town, civil society organizations, and local researchers. This thesis focuses on the role of the municipality as the locus of sanitation and flood intervention in informal settlements. Though non-governmental organizations have been involved in development projects, including alternate housing provision, and private sector actors are often used as contractors in the servicing of toilet facilities, the municipality is a key point of coordination and initiative. Furthermore, South Africa has legislated basic services such as water and sanitation provision as a human right to be provided by government. As such it is the local government where most demands are made, and which is the focus of this study.

Figure 1 - Location of Cape Flats and Hout Bay in Cape Town

Source: City of Cape Town, 2013a

1.3 Research questions

1. How does climate change impact the way that the City of Cape Town will need to plan municipal services for informal settlements?
    a. How does the city currently respond to sanitation issues caused by flooding?
    b. How does flooding impact the provision of sanitation services in informal settlements?
2. What sanitation options are available to cope with increased flood events and changes in rainfall patterns due to climate change?
    a. What long-term sanitation infrastructure is needed to promote resilience to flooding under climate change?
3. How can the City of Cape Town define and measure successful flood and/or climate change adaptation in the context of informal settlements?

1.4 Organization

This thesis is organized into six chapters:

Chapter 1 provides background to the thesis topic, contextualizes the case study, and introduces the research questions.

Chapter 2 reviews the current state of literature on flood mitigation, climate change adaptation, and urban service delivery in the context of informal settlements.

Chapter 3 outlines the research methods used.

Chapter 4 provides an overview of Cape Town including a profile of demographics, flooding context, and climate change projections. This chapter also summarizes the research results on existing flood risk in Cape Town.

Chapter 5 summarizes the key research findings resulting from the qualitative research conducted.

Chapter 6 discusses the findings in light of the literature, summarizes conclusions, and identifies opportunities and recommendations for practice and further research.

Chapter 2 Literature Review

Researchers agree that poor households living in informal settlements are among the most vulnerable to the impacts of climate change and that climate change threatens social and economic development (Friend & Moench, 2013; Heath, Parker, & Weatherhead, 2012; Hughes, 2013; IPCC, 2014f; Laukkonen et al., 2009). However, vulnerability to climate change derives from a complex overlay of risk factors that contribute to flooding in many informal settlements. This literature review examines the intersection of urban service delivery, flood risk, and climate change, demonstrating the complexity of decision-making in an informal environment. It draws from literature across a diverse set of disciplines including climate change adaptation, development, environmental planning, urban planning, urban service delivery, and disaster risk reduction. This thesis seeks to demonstrate the importance of considering underlying risk factors, in addition to climate change, in formulating adaptation strategies.

2.1 Conceptual framework

Shacks are homes built without reference to regulations. Informal settlements range from a cluster of shacks, to a neighbourhood, to a size comparable to many cities. They may occupy publicly or privately held land. Regardless of their size, informal settlement patterns are unguided by city planners, engineers, or developers. Because shacks and settlements are built outside of formal building and planning rules, flood events are common and it is well established that climate change will strongly impact shack dwellers due to the nature of shack construction, the quality of land occupied, as well as the socio-economic realities poor urban residents face (Few, 2003; Heath et al., 2012).

Conventional approaches to flooding tend to focus on natural and technical factors: for example, an extreme weather event, the failure of a dam, or drainage problems (Vojinovic & Abbott, 2012). However, informal settlements are locations of extensive social, political, and economic pressures that contribute to flooding but are not captured by conventional approaches. Furthermore, climate change impacts occurs in addition to numerous underlying factors that contribute to flooding and increase overall risk (Douglas et al., 2008; Ziervogel & Smit, 2009)

This thesis uses a holistic risk approach adapted from Vojinovic and Abbott (2012) (Figure 2) to contextualize informal settlement flood risk, and to frame flood mitigation and climate change adaptation strategies. This approach uncovers the complexity of flooding by integrating natural, technical, social, and human factors that contribute to flooding and influence the way responses are

conceptualized. This holistic risk framework serves as the structure for this thesis to engage the concepts and theories of flood mitigation and climate change adaptation. Flood risk in informal settlements, aggravated by climate change, is the product of numerous phenomena that occur both independently and dependently.

Figure 2 - Holistic risk approach

Factor	Description
Human	The thoughts, beliefs, and values associated with certain processes and outcomes that bias our approach to problem-solving.
Social	Underlying social realities, political divisions, and/or economic pressures that motivate settlement in areas exposed to hazards or prevent sustainable and equitable interventions
Technical	Failure of engineering interventions due to poor design, lack of capacity, or lack of maintenance.
Natural	Exposure to hazard from natural processes such as rainfall, riverine overflow, tidal surges, etc.

Source: Adapted from Vojinovic & Abbott, 2012

2.1.1 Urban flood risk and informal settlements

Natural factors of flooding are processes such as "heavy rainfall, increasing groundwater levels, river-related issues, tidal surges, and their combinations" (Vojinovic & Abbott, 2012, p. 17). Rainfall often plays an important role in triggering flood events. In urban areas, unmanaged runoff from rainfall can contribute to flooding. Runoff is water from rainfall or snow that is unable to infiltrate due to surface impermeability which may be due to existing saturation, because the ground is paved over, or because the ground has hardened (Vojinovic & Abbott, 2012) (Figure 3). In cases where rainfall is prolonged, groundwater levels may rise to the surface. Unlike flooding due to surface runoff, which is normally short-lived, flooding from high groundwater levels may persist for weeks (Few, 2003; Vojinovic & Abbott, 2012). Combined with poor drainage, water logging may result and produce flooding with even small amounts of rain (Few, 2003). River-related flooding, similarly, may be triggered by high levels of rainfall. Other forms of flooding such as storm surges, tsunamis, and cyclones pose risks for settlements near coastlines.

Figure 3 - Infiltration & impermeability
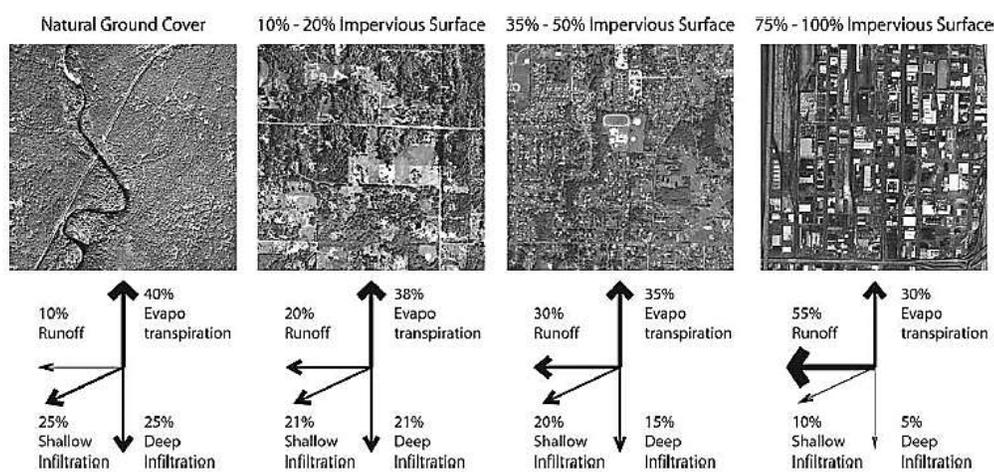
The impacts of frequent, low-magnitude flooding—common in informal areas—is wide-ranging, from disrupting the function of key infrastructure, interrupting regular services such as waste disposal, and impacting health through the spread of water-borne disease (Few, 2003). Globally, informal settlements are often located on land that is naturally prone to flooding because poor residents are excluded from accessing better land and housing for social and economic reasons (Durand-Lasserve & Clerc, 1996; UN-Habitat, 2009a; Watson, 2009b). For example, in South Africa, a history of apartheid-era urban planning resulted in the exclusion of people of colour from many parts of the city and forced large numbers into low-quality peripheral land (Massey, 2013). Today, settlement patterns based on poverty and lack of affordable formal housing mimic apartheid-era planning.

Technical factors of flooding are associated with engineering or technological interventions. Flooding may occur when these interventions fail or are inadequate such as "poor drainage systems (e.g. lack of the system's capacity, poor design, bad construction practice, lack of operation and maintenance, etc.), inadequate flood defense structures and local obstructions across overland flowpaths" (Vojinovic & Abbott, 2012, p. 18). Urban stormwater management systems, by redirecting water to the sea or other bodies of water, are the main form of runoff management and flood prevention in cities. These systems include a configuration of: "pipes, channels, culverts, manholes, catchpits, outfalls, pumping stations, bifurcations, treatment and other ancillary structures, detention/retention/infiltration basins, watercourses, dams, etc." (Ibid, p. 18). In Cape Town,

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stormwater is directed into the ocean (Armitage & Rooseboom, 2000). Cities with stormwater management systems are not immune to flooding if systems are inadequate for the size of the population, poorly designed, and/or poorly maintained. Inappropriately constructed sewer lines and toilet facilities are also prone to failure under flooding (Jiusto & Kenney, 2015); for example, heavy storms and extreme rainfall may quickly overwhelm these systems.

Built-up areas, impermeable surfaces, and high densities reduce the amount of water naturally absorbed and redirect natural flows, often in undesirable ways. Management of runoff and flooding has long been a responsibility of urban and environmental planning, and related fields such as engineering. There are numerous strategies, both hard infrastructure and ecosystem-based, which have been employed across cities around the world. However, in cities with informal settlements, the issue of managing runoff is exponentially more complex because the formal processes and high quality infrastructure used to manage runoff are either completely lacking or severely deficient (Armitage, 2011).

Robust drainage systems are integral to urban life. The health and safety impacts of flooding are wide-ranging: preventing residents from safely moving around their homes and neighbourhoods, increasing the spread of water-borne illness, and destroying property and belongings. Armitage (2011), writing on the challenge of sustainable urban drainage systems, laments that drainage is not among the Millennium Development Goals (MDGs). Lack of drainage is a widespread problem in poor and marginalized communities, directly impacting the health of residents and the sustainability of other forms of development interventions.

Without stormwater systems and appropriate drainage for waste water, flooding inevitability occurs in built-up places. The combination of urban waste and flooding may result in "extremely polluted environments with a toxic cocktail of stormwater mixed with greywater, urban refuse and even faecal matter surrounding, and at times inundating, the crudely constructed dwellings (shacks)" (Ashipala & Armitage, 2011, p. 1781). Figure 3 demonstrates how runoff, evapotranspiration, and infiltration rates change as impervious surfaces expand. Because of high densities and building materials, such as zinc sheets and other metals, the amount of space for infiltration in informal settlements is very low. Urbanization without accompanying drainage solutions invariably increases the possibility of flooding.

Informal settlements are normally locations of inadequate, or complete lack of, urban drainage systems (Armitage, 2011). They also face solid waste disposal challenges that result in accumulated solid waste and silt that block drainage and prevent water from leaving an area

following heavy rains (Armitage & Rooseboom, 2000; Douglas et al., 2008). Without adequate drainage, accessing basic services, such as water and sanitation, can increase the risks associated with flooding. Pooling may occur with even small amounts of water used by households for cleaning when there are no appropriate places to dispose of it. Inappropriate or inadequate disposal of human waste can become a health crisis during flooding.

Social factors of flooding are diverse. One of the strengths of this framework is recognition of the importance of social and political history in present flood risk. For example, many former colonial cities in developing countries were strategically located to suit colonial needs, rather than consider the sustainability of the environment. This put cities at risk for storm surges, tsunamis, and other coastal flood hazards (Vojinovic & Abbott, 2012). Similarly, urbanization is a social and political process that changes the environment where it takes place. Informal settlements are often located in high-risk areas due to their political, social, or economic exclusion from formal parts of the city due to formal exclusionary policies, such as apartheid, or economic systems that produce inequality. Continued migration into urban areas puts pressure on land where high densities combined with inadequate urban drainage systems interact to increase flood risk (Few, 2003).

As social processes contribute to flooding, so can social processes prevent or reduce the opportunities available to respond to it. Improving stormwater management in informal settlements often take place within tense state-civil society relations. Furthermore, in many cities, informal settlements develop on ecologically sensitive land, such as natural wetlands and flood plains, which under other circumstances would be used to redirect water away from the formal areas of the city. The packed nature of informal settlements makes installing stormwater systems a major challenge requiring temporary or permanent resettlement of many residents. Because of this, management of stormwater is often a component of other strategies for urban service delivery in informal settlements. Flood intervention must account for the ecological nature of the land where it takes place, the limitations to technical interventions, and the social processes that contribute to marginality in the first place.

Informal settlement dwellers have historically been affected by flooding issues, and may consider flooding as a trade-off for living in cities and accessing economic opportunities (Cairncross & Ouano, 1990; Few, 2003). Climate change may alter the risk trade-off equation, or it may make such trade-offs more dangerous. The role that economic opportunities play in determining where poor households settle is indicative of the important role social processes play in producing flood risk.

Finally, by examining **human** factors of flooding, this framework incorporates a novel component perspective on flood mitigation and climate change adaptation, particularly in an urban

context, which has not been addressed in detail in other literature. Human root causes are related to the way that we think, believe, and value certain processes and outcomes over others (Vojinovic & Abbott, 2012). Vojinovic and Abbott look specifically at how a capitalist system focused on cost-recovery, asset accumulation, and socio-economic control through access to debt dominates the current approach to problem-solving. I argue that a neoliberal economic system restricts our capacity to imagine interventions to wicked urban problems such as flooding in informal settlements and climate change mitigation and adaptation. Interventions with low return-on-investment and high levels of uncertainty fall outside the scope of market interventions. Governments are increasingly taking a business-oriented approach to service provision that limits interventions to those where costs can be recovered and decisions are made based on cost-benefit analysis rather than social justice. Furthermore, the World Bank actively requires cost-recovery on the basis that it promotes community ownership (P. Bond & Dugard, 2008; Rydin et al., 2012). Such approaches limit interventions to established methods with known costs. However, many urban problems appear to be intractable or overwhelming to experts and practitioners and require imagining alternative approaches that overcome historical barriers. As such, integrating urban service delivery, flood mitigation, and climate change adaptation requires new forms of problem-solving that go beyond conventional approaches.

I will return to the four root causes of flooding—natural, technical, social, and human—throughout this thesis. This framework provides the structure to incorporate the diversity of factors that make informal settlements places of flood risk. In the next section, the literature on climate change adaptation is introduced and examined in relation to development.

2.2 Climate change adaptation

Anthropogenic climate change is driven largely by human activity, resulting from the emission of the highest historical levels of greenhouse gases into the atmosphere (IPCC, 2014c). Climate change impacts have been recorded globally (IPCC, 2014e) and each successive IPCC publication strengthens the evidence for action (Parnell, Simon, & Vogel, 2007). Human vulnerability to climate risk is already evident as disasters such as the Indian Heat Wave in 2015, Hurricane Katrina in 2005, and Western Canada's European Pine Beetle Infestation from the 1990's to 2000's demonstrate (Ford et al., 2010; Natural Resources Canada, 2015; Thompson & Climate Central, 2015). Overall, however, Few (2003) emphasizes that flood hazard is expected to increase globally and that an increase in the frequency of extreme events poses a greater threat to human settlement than other climatic changes with longer lead times. Climate change poses a threat to informal settlements residents through their exposure to hazards and pre-existing vulnerability, and undermines development efforts, which seek to improve

access to water and sanitation, housing, education, and other quality of life priorities. This section contextualizes urban service delivery within climate change adaptation research through a discussion of major themes, the conceptualization of climate risk, and how adaptation research has been approached thus far.

Climate change adaptation is defined most consistently as the "process of adjustment to actual or expected climate and its effects… [seeking to] moderate or avoid harm or exploit beneficial opportunities" (Ford et al., 2010; IPCC, 2014a, p. 1758). Adaptation aims to 1) increase the resilience of a household, community, city, country, or other system, which means increasing its ability to withstand shocks, or increase the speed through which such a system can recover from shocks; and/or 2) decrease vulnerability to climate impacts (da Silva, Kernaghan, & Luque, 2012). Humans have been adapting to climate for millennia (Pope & Terrell, 2008).

Though researchers have studied adaptation to anthropogenic climate change for decades, it is only recently that the discipline has experienced a surge in academic interest (Mustelin et al., 2013). A significant amount of research has focused on defining and operationalizing the slippery and interdisciplinary language and concepts used within adaptation research (Adger, 2000, 2006; Kelly & Adger, 2000; O'Brien, Eriksen, Nygaard, & Schjolden, 2007; O'Brien, Eriksen, Schjolden, & Nygaard, 2004). Many of the concepts used research are rooted in other disciplines, particularly ecology, development, and environmental science (Heltberg et al., 2009).

2.2.1 Climate change risk

Climate change risk is the interaction of hazards, exposure, and vulnerability (Figure 4). The total flood risk facing a community, however, is the interaction of climate change with underlying risk factors. Reducing risk, and promoting resilience, requires identifying the locus of risk where action must take place. Table 1 summarizes the literature on hazards, exposure, and vulnerability, connecting these concepts with the presence of flood risk in informal settlements.

Figure 4 - Risk = vulnerability + hazard + exposure
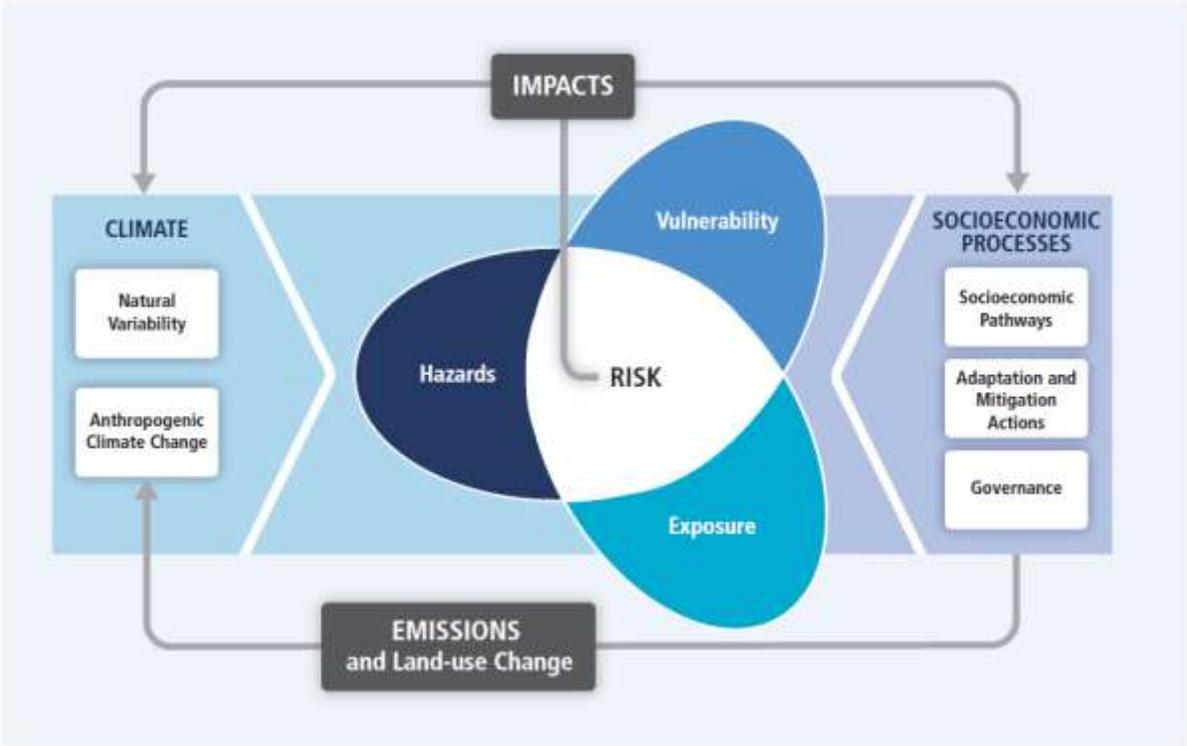
Source: IPCC, 2014e

Table 1 - Summary of climate change risk framework

Concept	Definition	Flood risk
Hazard	"potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources" (IPCC, 2014a, p. 1766). "dangerous phenomenon" that leads to injury, loss of life, or damage (UNISDR, 2009, p. 17) - Natural hazards are considered unavoidable conditions due to processes such as extreme weather events (The World Bank, 2010)	- Flooding is the most common natural hazard globally and appears to be increasing in frequency (Wilby & Keenan, 2012) - Climate change increases the *potential* for flood hazard because of the impact of global warming on the water cycle and global temperatures, e.g. increasing the frequency and intensity of extreme rainfall (IPCC, 2014d)
Exposure	- The presence of "people, livelihood, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets" in areas of hazards (IPCC, 2014a, p. 1765; UNISDR, 2009)	Informal settlements frequently develop without regard to the existence of hazards and the level of exposure (Ashley, Balmforth, Saul, & Blanskby, 2005)
Vulnerability	- Derives from the social forces that contribute to an individual, household, or community's inability to withstand the impact of a hazard (Bankoff, Frerks, & Hilhorst, 2004) - Outcome vulnerability is defined as residual consequences following adaptation (IPCC, 2014a; Kelly & Adger, 2000; O'Brien et al., 2007) - Contextual vulnerability, on the other hand, is defined as "a present inability to cope with external pressures or changes… characteristic of social and ecological systems generated by multiple factors and processes" (IPCC, 2014a, p. 1762; O'Brien et al., 2007)	- Vulnerability in informal settlements derives from (e.g.): - Settlement in areas exposed to hazard due to exclusion from safer areas due to economic barriers or social exclusion mechanisms (e.g. apartheid era planning) - Inability to protect oneself from flooding because of lack of means/social capital - The erosion of assets due to frequent exposure to hazards.

Further considerations of vulnerability: Within climate change adaptation literature, there has been a concentrated effort to operationalize vulnerability and its role in managing climate change risk (Notably: Adger & Kelly, 1999; Adger, 2006; Kelly & Adger, 2000; O'Brien, Eriksen, Nygaard, & Schjolden, 2007). The concept of vulnerability is of particular importance in informal settlements where risk is comprised of significantly more than hazard and exposure. The Latin root of vulnerability, vulnerā bilis, describes a wounded soldier (Kelly & Adger, 2000). Through this lens, vulnerability is based on the damage already experienced, rather than solely the potential for future damage, as climate change adaptation is usually framed with vulnerability describing the outcome state following adaptation (Ibid). Vulnerability is conceptualized in this thesis as an existing state and is also referred to as contextual, or starting-point, vulnerability. A contextual vulnerability lens is appropriate in the context of informal settlements because of the underlying conditions that contribute to vulnerability, and the factors that lead to settlement in areas exposed to hazards.

The vulnerability of poor households to climate change impacts has emerged as a major area of research. Vulnerability and poverty are often equated; however, this conflation is problematic (Adger, 2006; Béné, Wood, Newsham, & Davies, 2012). Heltberg et al. (2009) have clarified by distinguishing between vulnerability and poverty, and by redefining each term in relation to the other. First, they argue that climate impacts may increase poverty by eroding household assets, pushing them into poverty, or by trapping poor households in a cycle of poverty whereby climate shocks erode any asset gains made over time (Ibid). Second, they define vulnerability as the possibility of falling below a standard of living following the occurrence of a climatic event (Ibid); in other words, vulnerability is the potential to become poor should a shock occur.

Adger and Kelly (Adger & Kelly, 1999) argue that poverty is a contributing factor to vulnerability to climate change. Though these definitions seem contradictory, I would argue that they represent the ways that contextual and outcome vulnerability are used in literature without clarification. Adger describes the use of vulnerability as "a powerful analytic tool for describing states of susceptibility to harm, powerlessness, and marginality of both physical and social systems" (2006, p. 268) and describes the evolution of vulnerability research and its convergence with resilience.

The use of a holistic risk framework in this thesis seeks to reduce the confusion of terms by being both restrictive and inclusionary. While defining the use of terms such as vulnerability is important to place this research within climate change adaptation literature, the holistic risk approach incorporates the variety of factors included in risk such as hazard, exposure, and vulnerability, but more inclusively, the natural, technical, social, and human factors of risk, specifically flood risk.

Resilience

Like vulnerability, resilience has emerged as a dominant framework in climate change adaptation research (Friend & Moench, 2013). Resilience was originally used to describe the capacity of an ecosystem to experience change, specifically to withstand disruption (C. S. S. Holling, 1973; Folke, Carpenter, Walker, Scheffer, & Chapin, 2010). It has since be transplanted to a wide array of disciplines including psychology and other social sciences (Dieleman, 2013). Within climate change research, the concept of resilience is used in different ways. First, it is used to describe the amount of disturbance a system can absorb before it changes (Adger, 2000; Holling, Schindler, Walker, & Roughgarden, 1995). And second, it is used to describe how quickly a system can return to function following a shock (Adger, 2000). The use of resilience to describe different components of a system, for example social versus ecological resilience, is often normative and can be problematic. Do we locate resilience in the ecosystem a human settlement relies on, or do we locate resilience in processes and institutions that support that settlement? Or both? Though resilience in an ecological or systems theory sense does not necessary describe a positive or negative state, within climate change discourse, resilience has become an ideal to which we aspire.

Though used as an ideal state within climate change adaptation literature, the concept of resilience is also used to describe the persistence of both positive and negative systems. For example, in human settlements, dangerous conditions may stabilize and become resilient to change (Dovey, 2012). However, this use of resilience, as opposed to the more normative climate change resilience, describes the durability of sub-optimal outcomes or path dependence which we see in persistent, but negative, systems. Path dependency, in reality, can promote forms of urbanization that undermine social equity goals and long term climate change resilience (Geyer, Geyer, du Plessis, & van Eeden, 2012). Therefore, the systems of apartheid planning which continue to be felt in forms of economic or class apartheid in South Africa (Patrick Bond, 2004) are remarkably durable—and even replicated within a capitalist economy—yet interrupt or prevent more desirable and equitable urban solutions for reducing climate change risks.

Climate change resilience, on the other hand, has become a powerful image for inspiring change (Friend & Moench, 2013). However, as Friend and Moench argue, "much of the uptake of resilience is as a buzzword rather than a conceptual framework" (2013). Work is being done to develop this concept into useful application. For example, Biggs et al. (2012) identify seven principles of resilience for the sustainability of ecological services: 1) maintain diversity and redundancy, 2) manage connectivity, 3) manage slow variables and feedback, 4) foster an understanding of social-

ecological systems as complex adaptive systems, 5) encourage learning and experimentation, 6) broaden participation, and 7) promote polycentric governance systems (Ibid). The development of such principles aims to solidify concepts for practical usage. However, in the context of this thesis, such principles are more useful as guiding best practices rather than as an applicable conceptual framework. For that reason, I turn to a risk framework rooted in flood research to identify resilience through the reduction of root causes of risk and emergent risks that occur through the interaction of phenomena.

Though resilience is defined by systemic flexibility and the capacity to absorb shocks, applying resilience at a city or regional level can be problematic, particularly when the complex interaction of phenomena that results in risk is unclear. In cities, differential levels of development, resources, and power are intimately linked with vulnerability and resilience (Shefer & Antonio, 2013; Vale, 2014). Cities with informal settlements or other marginalized populations may have a high level of disparity between different neighbourhoods. Because of this, examining resilience or vulnerability, or addressing risk, cannot necessarily be done at a city level; rather, a more nuanced approach between different groups and neighbourhoods is needed.

Friend and Moench (2013) argue that climate change literature does not adequately address the roots of distributional and spatial inequality inherent in cities. Though resilience may be emotionally powerful, analytically, resilience frameworks do not necessarily address the "critical issues of power, voice and equity (Ibid, p. 98). Though climate change adaptation research is often concerned with the vulnerability of poor or marginalized populations, analytic frameworks such as vulnerability or resilience do "not easily locate social equity – resilience for whom, by what nature, or by whom – as a central consideration in the choice of approaches" (Friend & Moench, 2013, p. 104; Smith & Stirling, 2008). Friend and Moench (2013) warn that special interests easily dominate discourse and policy. Applying concepts such as vulnerability and resilience must be done with awareness of the way that different stakeholders will have different interpretations of what should be done. Differences in power and resources play an important role in determining how resources are allocated for urban infrastructure and development. These are not neutral processes, rather they are highly politicized and often result in economically and social segregated spaces (Caldeira, 1996).

Development is often imagined on a national scale. We speak of developing countries, not developing neighbourhoods. Though it is established that poor countries will be disproportionately impacted by climate change (Hustable & Yen, 2009), examining risk and vulnerability at a national scale ignores the dynamics of inequality within a nation's borders. Powerful economic forces divide

cities into places of high and low risk and the interests of poor do not always align with those of elites (Kates, 2000).Though informal settlements are often considered loci of highest risk, urban adaptation at the city scale does not necessary require prioritizing these areas. In fact, our current economic structure where high value property is prioritized over others may result in quite the opposite.

2.2.2 Gaps in climate change adaptation research

In response to the question, 'What is adaptation?', Smit et al. (2000) (Figure 5) break adaptation action into three components: *who* adapts, *what* is being adapted to*,* and *how* does adaptation happen. What results is a 'gross anatomy' of adaptation to differentiate adaptation actions (Ibid). This framework was developed to allow researchers to set boundaries around what type of actions they were studying. The *what* that is being adapted to encompasses global climate change, normal climate variability, and isolated extreme events because "these types of climatic stimuli are not separate or independent" (Ibid, p. 2310). However, differentiating climate change adaptation actions from other forms of adaptation (e.g. to existing climate variability) has been problematically taken up by climate change adaptation researchers.

Figure 5 - Gross anatomy of adaptation
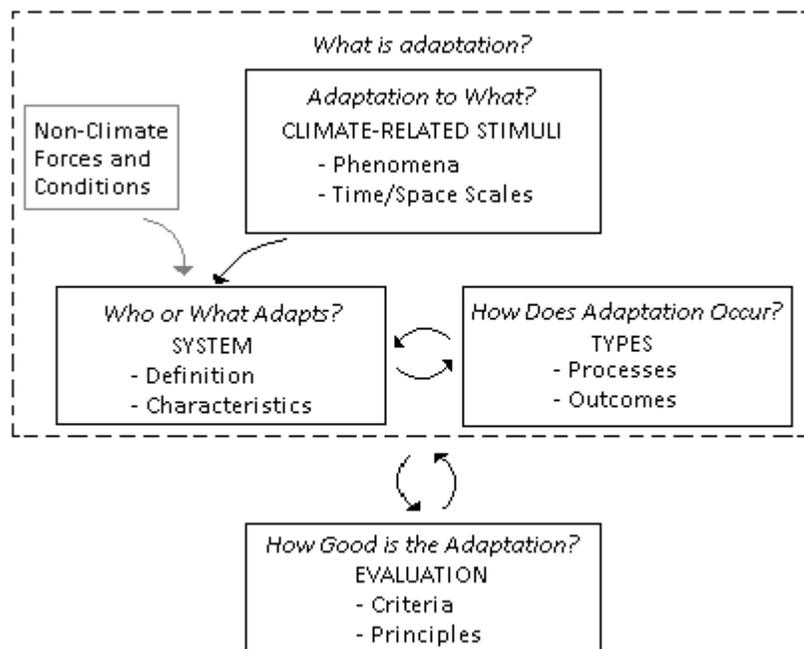
Source: Smit et al., 2000

The UNFCCC has been dominant in shaping climate change research agendas. However, its approach to climate change adaptation has been critiqued for too narrowly focusing on climate change separately from general climate variability (Schipper, 2007). This is problematic in conditions where climate variability is not well adapted for, due to, for example, deficiencies in urban infrastructure. The existence of a 'development deficit' severely constrains the effectiveness of adaptation efforts aimed only at the additional burden of climate change (Berrang-Ford et al., 2011; Kiunsi, 2013). For example, informal settlements are particularly vulnerable to climate change impacts due to precarious living conditions, low economic assets, and conflictual relations with the state (Adger & Kelly, 1999; J. Hardoy & Pandiella, 2009). Adaptation is just one of myriad challenges facing informal settlements and focusing on climate change at the expense of housing, water, and sanitation delivery would be counter-productive. For many, integrating adaptation with development is necessary for long-term sustainability (IPCC, 2014b; Taylor & Peter, 2014; Ziervogel, Shale, & Du, 2010). However, international adaptation funding normally requires proof of climate change "additionality" (Ford, Berrang-ford, Lesnikowski, Barrera, & Heymann, 2013; Füssel, 2007).

Additionality approaches stand in contrast to a significant body of work which argues that adaptation is not a separate or independent process or outcome in cities, rather it is integral to the long-term viability of cities and the sustainability of our environments (Ayers, Huq, Faisal, & Hussain, 2014; Kiunsi, 2013; Schipper, 2007; Sharma & Tomar, 2010; Uittenbroek, Janssen-Jansen, & Runhaar, 2012). This requires considering established functions of municipalities, such as urban planning, stormwater management, and urban service delivery, through the lens of a changing climate (Carter et al., 2014). In some cases, existing institutional structures may allow for the integration of adaptation into planning and day-to-day operations. In others, however, the interdisciplinary nature of climate change adaptation exposes the silo-based structure of many organizations (Carter et al., 2014), and require changes to governance structures to overcome a status quo that contributes to, rather than alleviates, climate change (Satterthwaite, 2008).

The long-term sustainability of development interventions is compromised when climate change and environmental factors are not considered hand-in-hand with development action and infrastructure investment (Chuku, 2010; Sharma & Tomar, 2010). Research on the interaction of poverty and vulnerability to climate change has drawn attention to the risks climate change poses to development gains. Climate change impacts may increase poverty as household assets are eroded through climate shocks that impact homes, livelihoods, and health (Adger & Kelly, 1999; Heltberg et al., 2009). Heltberg et al. (2009), among others, have proposed focusing on development strategies that increase household and community assets as an adaptation strategy.

Finally, considering adaptation without development (or vice versa) introduces the potential for maladaptation, or inadvertently increasing the vulnerability of a population to climate change (Barnett & O'Neill, 2010). Smit (1993) and Burton (1997) were among the earliest to use the word 'maladaptation' though it has since taken off as a major area of concern (Barnett & O'Neill, 2010). Maladaptation was expanded by Barnet and O'Neill (Ibid) into an oft-cited list of 5 typologies of maladaptation: adaptation actions that increase greenhouse gas emissions; that disproportionately burden vulnerable populations with high opportunity costs; that reduce the incentive to adapt; and/or that create path dependency. Interventions related to urban service delivery and housing, because of the permanence and environmental impact of infrastructural projects, have the potential to become maladaptive when climate change impacts are not considered.

2.2.3 Locating adaptation

One of the major stumbling blocks in the uptake of adaptation in research and practice has been the lack of knowledge of what adaptation looks like on the ground. Research on adaptation case studies has proliferated in an effort to identify effective (and ineffective) strategies (Ford et al., 2010). Adaptation competes with other priorities for investment and therefore requires empirical evidence of efficacy before risk-averse communities decide to invest. Building on work defining adaptation (e.g. Smit et al., 2000) has been research on categorizing and describing what types of actions would be considered adaptation. For example, Biagini et al. (2014), through an analysis of adaptation efforts funded by the Global Environmental Facility, describe ten categories of adaptation: capacity building, management and planning, practice and behavior, policy, information, physical infrastructure, warning or observing systems, green infrastructure, financing, and technology. These categories help to identify areas where adaptation can take place.

Cities are sources of adaptation (Agrawal, 2008; Rauken, Mydske, & Winsvold, 2014; Satterthwaite, 2008; Sharma & Tomar, 2010; Wamsler, Luederitz, & Brink, 2014). Though climate change will occur globally, the tools for adaptation are already found within local government functions from provision of energy and water, to transportation, to affordable housing, green space, and numerous other areas where adaptation can take place. Furthermore, in many countries, the responsibilities of high levels of government have been increasingly downloaded to municipalities (Sharma & Tomar, 2010).

One of the challenges of adaptation at the local level is a lack of scaled-down climate projects (Ziervogel, New, et al., 2014). In other cases, the uncertainty of scaled-down climate information or lack of such information may decrease the likelihood of adaptation action (Ibid). Even

localized rainfall is presently difficult to predict and tends to surprise residents (Douglas et al., 2008). Few (2003) argues that climate modeling is risky because of the inherent uncertainties around climate change impacts and the potential for a false sense of confidence in projections.

This thesis locates adaptation in existing trajectories of urban service delivery and housing provision in informal settlements. The next section will first engage in a discussion of informality within urban theory and urban planning literature, followed by identification of established service delivery and housing approaches.

2.3 Informality and planning theory

Hart (1973) is credited with first identifying the informal sector as a legitimate source of livelihoods ignored by studies of the formal economy. He argued that the informal economy was diverse and possessed both "legitimate" and "illegitimate" occupations (e.g. street hawkers vs. pickpockets). Dovey (2012, p. 352) defines informality as "practices that operate outside the control of the state"; however, she argues that informality is not simply the opposite of formality, "nor is it easily identified with underdevelopment, illegality or poverty". The popular conception of informality as illegitimate and requiring regulation fails to capture the complex role played by the informal sector in creating opportunities for housing and employment for (often) poor residents.

Urban settlements historically encompass both spontaneous, organic growth, what is now called informal (e.g. European human settlements in the middle ages), and formal developments guided by central authorities (e.g. Ancient Rome). Centralized planning has long been an expression of power and money, whereas informal housing and unmanaged urbanization were often the only options for the average household. Contemporary urban planning theory emerged from the rapid urbanization generated by the Industrial Revolution. Planners and theorists sought to find solutions to the slum living conditions of extremely dense, unsafe, and unsanitary tenement housing built to house the influx of workers without planning for urban form or according to safe building regulation.

Conventional spatial planning regards informal settlements as "holes" in the city fabric (Abbott, 2001, p. 267). This has framed international social policy which has primarily concerned itself with eradicating informal settlements using methods across the ethical spectrum (Huchzermeyer, 2011). In developed countries, the emergence of urban planning as a profession initiated the systematic eradication of informal settlements and other evidence of poverty through the progressive formalization of the urban environment. Though both international and local policies may be based on legitimate concerns of quality of life and safety, the practices associated with eradicating informal

settlements are based around notions of blight and the incongruence between formal economies and informal realities (Kamete, 2013). Furthermore, many of these policies conform to neoliberal aspirations of cities, where all citizens and means of productions are integrated within the formal economy.

Popular perceptions of informality fail to grasp the complex role played by informal settlements in the urbanization process. Urbanization is a series of complex processes that takes years, if not decades, to actualize. For one billion people worldwide, informal settlements represent the best coping strategy (UN-Habitat, 2009b). Informal settlement are, in many cases, outcomes of poverty and exclusion. As households gain or lose assets, they make different choices based on what is accessible to them. Informal urbanization, seen globally through almost one-third of urban residents living in informal settlements, is indicative of this reality.

Planning in the 20th century emerged as a modernist idea, imagining societies progressing linearly towards modernization. Processes of colonialization, and later globalization, facilitated the exportation of planning ideas from the global North to the global South (Healey, 2011). Healey's work on the international flow of planning ideas asks whether contemporary transference of planning ideas is little more that "a new form of colonization or hegemonic domination" (Ibid). Though planning has evolved, the idea of planners providing "guidance…to keep development 'on track'" continues to define the role of planning in the urbanization process (Healey, 2011, p. 191). Healey challenges the "universal validity" of urban planning ideas when applied to complex contexts of development. She draws attention to the way that planning ideas and innovations are dislocated and transplanted globally without thoughtful consideration for the local politics and culture that produced them.

Globally, urban informal settlements have exploded over the last half century as the "most pervasive single form of new urban development" (Dovey, 2012, p. 349; UN-Habitat, 2006) Yet, despite the history and ubiquity of informality, there is a lack of theory of how urban informality works (Dovey, 2012). It is most frequently represented as the opposite of formality and associated with illegality, as a "state of exception from the formal order of urbanization (Roy, 2005, p. 147)" . Urban planning continues to be rooted in a conceptualization of urbanization as a formal, regulated process. Roy (2005) describes this as the paradox of 21st century urbanism: while urbanization is taking place predominantly in the global South, urban theory has historically been developed in the global North. Critics argue that planning theory is no longer adequately engaged with the physical materiality of the city, focusing on meaning and power at the expense of physical realities (Harrison, 2013; Watson, 2003). Watson contends that there is a conflict between the lived experience of poor and

marginalized informal settlement residents and the "increasingly techno-managerial and marketised systems of government administration, service provision, and planning" (2009a, p. 2260).

The "fundamentally different worldviews and different value-systems" of diverse and often conflicting populations living in cities are treated superficially in planning theory (Watson, 2003, p. 396). The focus on consultation and mediation in planning, a worthy ideal, acknowledges the need to engage with residents, but does not address the inequality and material conditions that residents face (Ibid). These authors call for planning theory to be re-oriented from an inclusive and pro-poor perspective, something that has been largely absent from techno-managerial approaches to planning so commonly used within municipalities that strive for neutrality among stakeholders, failing to the grasp the desperate conditions poor households often find themselves in.

Watson (2009a) further argues that there is a 'conflict of rationalities' between the market, the state, and the survival efforts of poor urban residents. Urban planning, as a tool of government, manages space and people within defined boundaries (Watson, 2009a). However, the long-held assumption that the state, through planning, can guide the economy has largely been displaced by the forces of neoliberalism globally and self-interested economic actors locally (e.g. real estate speculation) (Ibid). Harvey (2008, p. 23) writes: "We live in an era where ideals of human rights have moved centre stage both politically and ethically… But for the most part the concepts circulating do not fundamentally challenge hegemonic liberal and neoliberal market logics, or the dominant modes of legality and state action." A market economy in cities is bounded by property rights protected by the state and standards of payment for goods and services. Contravention of these boundaries results in illegality. As such, informal settlements through "illegal" occupation of land, possess no rights within the market, justifying their eviction in favour of paying market actors (Harvey, 2008). Though these assumptions are largely upheld through conventional planning practice, the scale of informality challenges the meaning and role of urban theory and planning practice in cities of the global South. In many 21st century cities, informal settlements represent not "squats" but the only housing option for hundreds of thousands (or more) citizens. The survival efforts of the urban poor are acting against the failure of both the state and the market to respond to the need for housing and employment (Watson, 2009a).

Globally, cities are struggling with the conflicting terms of alleviating poverty and improving conditions in informal settlements within an economic system that demands payment for things such as land, housing, and water. The conceptualization of planning as an inclusive exercise seeking to benefit the poor asks, "Who has a right to the city?" and is rooted in the work of Lefebvre (1968). Harvey

(2008) has continued to build on this work, recently calling for a human right to the city in the face of the impact of global capital on poor households worldwide. Parnell and Pieterse (2010) argue that right to the city perspectives seek to 'downscale' the global human rights agenda to the city in response to the urbanization of poverty.

International rights-based approaches to poverty reduction conflict with the logic of a market economy where "rights" are earned. Therefore, the call for the right to the city demands "the right to access economic and livelihood opportunities as a basis for leading a materially sufficient and good life; this right being dependent on access to spaces where economic opportunities exist" (Hendler & Wolfson, 2013, p. 18). Access to quality of life in urban environments is increasingly a commodity, bought and sold in ever-more specialized markets (Harvey, 2008). In this space, allowing the 'unlawful' occupation of land and provision of free water and sanitation services is an anomaly rather than a legitimate sphere of government action. This has been buttressed by global actors such as the World Bank and IMF advocating for the privatization of urban services, though this has shifted in recent years to a focus on governance mechanisms (UN-Habitat, 2009a).

Critiques of neoliberalism are prominent in literature relating to housing and service delivery for poor citizens. However, Harrison (2013, p. 73) argues that focusing exclusively on neoliberalism, "ignore[s] the multiple imperatives that inform state strategy and action, and the agency of politicians and officials working with state administration". Rather, critiques often frame local government as acting solely on behalf of private capital, in direct conflict with poor residents. However, such a framing fails to capture the often restricted means available for local government actors, as well as other institutions, to challenge the status quo. In reality, the delivery of urban services and housing in cities with large informal settlements takes place in an environment of constant tension between the logic of the market, international pressure towards privatization, and the fight for rights for poor and marginalized urban citizens. In this context, service delivery and housing is often a complicated mix of protest action, subsidies, private contractors, and ad hoc coping mechanisms.

Informality is a reality of contemporary cities. Urban planning, to contribute meaningful to the fastest growing form of urbanization, must break through conventional approaches. This thesis argues that only when informal settlement residents are granted the right to exist in the city can risks such as flooding and climate change be truly managed. Social justice must be a component in the drive to alleviate flooding (Vojinovic & Abbott, 2012). As such, the holistic framework is used to help consider the different factors which contribute to flooding, particularly the human element that affects the way planners and other professionals view informal settlements.

In the following section, urban service delivery and housing approaches are identified through the literature. These approaches provide a lens for the strategies used in the case study, and a jumping off point to consider how the nature of informality, combined with environmental risks from flooding and climate change, alter the requirements of intervention.

2.3.1 Planning and urban service delivery

Responses to informal settlements have evolved (e.g. Aigbavboa & Thwala, 2010; Massey, 2013). Historically, because of the very nature of informality, residents have been systematically barred from claiming rights to the land they occupy. This legitimized evictions and slum clearance practices as informality was equated with criminality. This strategy creates far more problems than solutions and has generally fallen out of favour (UN-Habitat, 2009a). However, evictions still take place, particularly when squatted land is privately owned. Best practices, which are described below, have not resolved the conflict between private property and informality, though there are ongoing efforts to secure land ownership for residents (e.g. Payne, 2001).

International best practice has shifted towards consulted resettlement and in-situ upgrading as the existence of informal settlements is increasingly seen as a result of insufficient employment opportunities and a lack of affordable housing (UN-Habitat, 2003). This shift in perspective is accompanied by myriad programs, policies, and research projects seeking to improve the lives of shack dwellers, with a focus on improving access to water and sanitation, housing quality, health care, and education (United Nations Inter-Agency and Expert Group on MDG Indicators, 2013). However, international campaigns such as 'Cities without Slums' continue to promote a perspective that informal settlements are undesirable and need to be removed (Huchzermeyer, 2011). For example, this campaign was translated in South Africa into a call for the eradication of slums with a policy passed in 2004 promising the end of informal settlements within a decade (Ibid). Though this policy was framed as a positive development—housing was promised for displaced residents—Huchzermeyer argues that the continued effort to eradicate informal settlements demonstrates the pervasive attitude of informal settlements as blight on the urban landscape. For political leaders seeking to position their cities as 'world class' in competition for international investment, the presence of informal settlements indicates widespread poverty, whereas a city without slums projects, however misleadingly, an image of more opportunity and less social conflict.

Current approaches to informal settlements can be summarized by five main approaches (summarized from Abbott, 2002; Mukhija, 2001; Wekesa et al., 2011). First, sectoral interventions aim to provide basic services such as water taps and toilet facilities. They often take a quantitative

approach by determining an acceptable ratio of facilities per number of households. Sectoral approaches are often the first response to informality when alternative approaches are unavailable. Informal settlements remain as they are, but are provided with basic services considered necessary to maintain basic living conditions.

Second, land regularization, or the provision of tenure, either through formal property rights or long-term leases, accepts the reality of informal settlements. Tenure enshrines the rights of residents to remain where they are. This approach has been the impetus for numerous international rights campaigns. Granting tenure is considered a supportive approach to long term development. By providing security against eviction, households are thought to be better positioned to invest in their homes over time. Furthermore, land ownership allows residents the chance to leverage their property, increase their income, and—it is hoped—move out of poverty. This can be seen through residents renting their homes or properties for income, or borrowing against the value of their property to invest in their business or to move to a better neighbourhood.

Third, in situ upgrading, an approach recommended by UN-Habitat, means working with residents to provide underground infrastructure such as water mains and sewer lines, as well as reconfiguring settlements to allow road access. In situ upgrading requires extensive consultation with residents as it requires moving shacks, and may require displacing some residents to ensure the reconfigured area can accommodate the infrastructure and roads required. Land regularization and in situ upgrading have been critiqued for assuming that residents wish to remain on the land they currently occupy. In many cases, settlement is considered temporary and residents would prefer to move to an area with better access to jobs and transportation. In other cases, environmental risks underlying occupied land preclude in situ upgrading, though this has not been extensively researched as a criterion of in situ upgrading or land regularization (Mukhija, 2001).

Fourth, sites and services describes a form of greenfield development. Land is identified for the installation of basic infrastructure (sites and services) and informal residents are allowed to legally occupy plots. Housing construction is initially informal as residents are responsible for constructing their own shacks. However, by providing infrastructure and imposing regularity on the settlement, it is expected that long term development and progressive formalization is more attainable.

Fifth and finally, direct public housing is the provision of publically-subsidized housing, either as apartments—most commonly associated with project housing in the United States or council housing in the United Kingdom—or free-standing homes—the approach historically favoured in South Africa. This approach has been widely used in developed countries through the provision of social housing. In

South Africa, direct public housing emerged as a large-scale national program in an effort to respond to the legacy of urban apartheid and the growth of informal settlements. However, this approach is extremely expensive and difficult to implement on a large scale. The experience in South Africa is indicative of this: South Africa's 2009 General Household Survey indicated that 458 000 households living in shacks not in backyards[5] had at least one household member on the subsidized housing waitlist (Tissington, Munshi, Mirugi-Mukundi, & Durojaye, 2013).

Table 2 provides an overview of approaches to informal settlements. While there has been a shift in accepted best practices for providing informal settlements with housing, water, sanitation, and other services, globally, all of these approaches continue to be implemented through different forms. These approaches often do not incorporate environmental risks in a systemic way. Land regularization, in situ upgrading, and negotiated resettlement have been identified as preferable interventions to improve conditions in informal settlements by guaranteeing property rights (permanently or through leases) and by providing services in the area where settlements are located.

Mukhija (2001), writing on how physical conditions impact informal settlement resident preferences for formalization in Mumbai, argues that conventional approaches to in situ upgrading assume informal settlement locations are desirable and that lot sizes are adequate. In Mumbai, as in Cape Town, lot sizes are too small to allow future additions or household gardens and densities preclude the installment of infrastructure and services (Mukhija, 2001). Furthermore, informal settlements often occupy poor quality land that may be exposed to numerous natural and man-made hazards (UN-Habitat, 2009a) Granting tenure in such conditions is undesirable for residents and may create larger environmental problems in the future.

Much of the literature on informal settlements addresses the flood risks within these spaces (Benitez, Perez-Vazquez, Nava-Tablada, Equihua, & Alvarez-Palacios, 2012; de Risi et al., 2013; Few, 2003; Ziervogel, Waddell, et al., 2014). However, few link flood mitigation with housing and service delivery, to the detriment of long term sustainability. Pharoah (2014, p. 313) argues that disaster risk reduction and housing issues have been "divorced conceptually and practically". This continues even though UN-Habitat (2009a) reports that 40% of informal homes in developing countries are at risk of environmental disaster, produced by a combination of natural forces and human action.

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[5] In South Africa, shack dwellers are divided into two categories: informal settlements not living in backyards and backyard dwellers. The former represent squatter settlements. The latter represent households that rent backyard space from a property owner to construct a shack. Both are considered informal but are treated differently, this will be discussed further in Chapter 4.

Table 2 - Service approaches

Approach	Description	Criticisms
Sectoral interventions	Provision of specific basic service such as toilets and taps	Inadequate; does not address to root causes; inappropriately quantitative success measurement
Land regularization	Residents of informal settlement given tenure	Conforms to capitalist ideas of property; assumes property is appropriate for long-term habitation
In situ upgrading	Infrastructure Shacks upgraded within boundaries of existing settlement	Not always desired by residents; land must be suitable; small-scale; often requires displacing some residents
Sites & services	Municipality provides infrastructure while households are responsible for housing structures	Encourages sprawl; often greenfield development; expensive; need for land; often located far from CBD/places of work
Direct public housing	Residents relocated into public housing or subsidized housing	Displaces populations; extremely expensive

Source: Abbott, 2002; Mukhija, 2001; Wekesa et al., 2011

2.4 Summary

In this chapter, I have synthesized research across three major disciplines that will be addressed in this thesis: urban service delivery, flood risk and mitigation, and climate change adaptation. I introduced a holistic risk conceptual framework to provide structure in assessing what risks informal settlement residents face, and how such risks can be mitigated. I engaged planning theory on informality to set the stage for how urban service delivery, flood mitigation, and climate change adaptation can be integrated in informal settlements.

This thesis specifically addresses the lack of engagement with how flooding, a common occurrence in informal settlements globally, impacts the provision of services and housing. Responding to what Pharoah (2014) describes as the conceptual divorce between disaster risk reduction and urban service delivery, this thesis engages in an area that will become even more critical within a changing climate system that in many areas is expected to increase the frequency of extreme weather events and change rainfall patterns. I propose that integrating service delivery, flood mitigation, and climate change adaptation is necessary for increasing the so-called resilience of informal settlement residents: resilience defined not only as the capacity to withstand shocks, but rather resilience as the freedom to pursue community, education, and livelihoods—the stuff of life—despite the presence of

natural hazards.

This review identified the four literature gaps which I seek to help fill through this thesis:

1. By focusing on the additionality of climate change, much of adaptation literature avoids engaging with the interaction of risk in more than a cursory way. This thesis explicitly seeks to understand how climate change interacts with existing flood risks and social and economic vulnerability.

2. Extensive research on urban flooding already exists, and could be more meaningfully integrated with climate change adaptation research. However, much of this work has focused on natural and technical root causes of flooding, at the expense of social processes that contribute to flood risk, and without consideration to the human factors that impact the way practitioners imagine solutions to flooding.

3. Research on development in informal settlements has a long history. The trend for urban service delivery has moved toward a more compassionate approach to informal settlement that seeks to improve conditions without displacing residents. However, calls for in situ upgrading and tenure of informal settlement residents do not necessarily acknowledge the suitability of already settled land and the environmental risks inherent in staying in the same place. Similarly, provision of basic services has focused on meeting basic rights to the exclusion of the quality of service within the environmental constraints that exist.

4. Finally, this thesis takes a broad theoretical view that reducing flood risk and promoting urban service delivery in informal settlements requires accepting the right residents have to live within the city boundaries. However, planning theory has not yet caught up to the reality of informality and provides little direction for engaging informality through planning practice.

Chapter 3 Research Methods

This Chapter outlines the research methods used in answering the following research questions:

1. How does climate change impact the way that the City of Cape Town approaches service delivery and upgrading in informal settlements?
   a. How does the city currently respond to flooding?
   b. How does flooding impact the provision of sanitation services in informal settlements?
2. What options are available to improve service delivery in informal settlements and reduce flooding in the long term?
   a. What are the long-term sanitation infrastructure needs for promoting resilience to flooding under climate change?
3. How can the City of Cape Town define and measure successful flood and/or climate change adaptation in informal settlements?

The prevalence of informal settlements in cities around the world and the increasing concerns regarding the impact of climate change on marginalized communities appeared to me a major challenge and task for urban planning scholarship. This project was motivated by my desire to understand what could be done to alleviate some of the risks facing people in informal settlements who are already coping with myriad environmental hazards. I wanted to understand how professionals working in an urban environment and providing services to residents within that environment understood their role in flood mitigation and climate change adaptation, as well what strategies were available to them. This thesis asks about possibility: *how* can municipalities, and the individuals who work for them, grapple with the challenges posed by urban service delivery, flooding, and climate change and *what* tools do they have at their disposal.

3.1 Qualitative approach

This thesis is a qualitative inquiry into the processes of municipal intervention in informal settlements. Qualitative research falls into two streams of thought: 1) qualitative research as a "blanket designation for all forms of social inquiry that rely primarily on qualitative data (i.e., data in the form of words) including ethnography, case study research, naturalistic inquiry, ethnomethodology, life-history methodology, and narrative inquiry"; or 2) qualitative research as research that "aims at understanding the meaning of human action" (Schwandt, 2007, pp. 247–248). This thesis fits into both

categories through the use of qualitative data and the goal of understanding human action through government policy and practice.

A qualitative approach may be chosen for a number of reasons: from the desire to study human subjects in-depth in a real world setting to the limited capacity of applying quantitative research methods to the chosen topic of study. Qualitative research allows in-depth inquiry into subjects that may be difficult or impossible to study through the use of experimental design or quantitative measurement (Yin, 2011). This thesis seeks to represent the views and perspectives of professionals working in the subject field in Cape Town, capturing "meanings given to real-life events by people who live them, not the values, preconceptions, or meanings held by researchers" (Yin, 2011, p. 9). Furthermore, this thesis seeks to understand the contextual conditions (social, institutional, political, economic, and environmental) within which participants live—or in this case, work. Both of the goals are difficult to address through other research methods (Ibid).

In seeking to represent the views of participants, the study results are presented through the form of qualitative description as described by Sandelowski (2000). The researcher does not move far from the data and does not render the data abstract (Ibid). However, no form of description is free from interpretation; the goal of qualitative description, however, is to be as low-interference as possible. Sandelowski argues:

> "Qualitative description is especially amenable to obtaining straight and largely unadorned (i.e., minimally theorized or otherwise transformed or spun) answers to questions of special relevance to practitioners and policy makers." (2000, p. 337)

Though Sandelowski argues that qualitative description is independent of other qualitative approaches such as phenomenological, ethnographic, or grounded theory, she concedes that many qualitative studies take on "hues" of other approaches. As such, this thesis approaches the findings through a qualitative description of the primary data—representing the answers as close as possible to the way that participants described them—while the conceptual framework introduced in Chapter 2 emerged through the data—more in line with a grounded theory approach.

3.1.1 Case study

Cities around the world face challenges around the intersection of urban service delivery, flooding, and climate change in informal settlements. The research questions this thesis seeks to answer are not unique to Cape Town. However, there are numerous challenges to researching climate change adaptation in cities. Differences in local contexts such as culture, language, and history, may make it difficult to address these challenges in a comparative way. Case studies have been used in natural

hazards research since the 1970s and more recently in research on the human dimensions of climate change (Ford et al., 2010). The use of case studies has emerged as a highly appropriate method of inquiry into climate change adaptation (Matthews, 2014). Ford et al. argue that

> "…case studies and analogues are particularly useful for identifying opportunities for adaptation in light of future conditions, developing an understanding of how human-environment systems experience and respond to changing conditions including those associated with climate change." (2010, p. 375).

Case studies ask 'how' and 'why' (Flyvbjerg, 2006). They are used to "illuminate a decision or set of decisions: why they were taken, how they were implemented and with what result" (Yin, 2009). This methodology is appropriate because it allows for a detailed examination of the specific context where actions are taking place. Furthermore, while the results of a case study may not be generalizable in predicting what may occur in other cities, this method aims to identify propositions or theories that can be tested in other environments (Watson, 2003; Yin, 1994).

This method allowed me, as a researcher, to answer the research questions by studying an environment where the challenges introduced by this thesis are taking place. Cape Town was chosen for the following reasons: the municipality's leadership in climate change planning and policy, the presence of large informal settlements in a city known for its relative prosperity in the region, regular flooding events, and the critical role of service delivery in shaping the state-civil society relations within the city. As a graduate student, the scope of this inquiry was also focused on a single city to gain an in-depth understanding of the local environment that led to certain strategies, to keep the scope within the timeframe of a master's thesis, and to answer the research questions within the constraints of time and resources.

Criticism of the case study approach in adaptation research has asked whether focusing on specific cases and compiling lists of adaptation options is truly useful for understanding adaptation or motivating action (Wandel, Cowing, & Springer, 2015). However, as a policy and practice, adaptation is a newer field filled with uncertainty. Trial-and-error, experimentation, and follow-up studies are key to establishing criteria and guidelines for "good" adaptation. Approaching the question of adaptation through cases studies allows researchers to identify local factors that may influence results that may be missed through high-level quantitative analysis. Understanding *why* things happen in a local context may help in identifying why certain policies or practices may or may not be transferable to other settings. Palys and Atchison (2014), in their discussion of case studies, note that even the harshest critics of this method acknowledge that it presents an opportunity for the researcher

to be surprised and develop connections they may not find otherwise. It is for this reason that the case study was identified as the most effective approach for this project.

3.2 Data collection

This thesis intentionally focuses on the role of the municipality as the primary source of intervention. As such, data was primarily focused on examining government publications such as policies and plans, and interviewing key informants, primarily at the City of Cape Town. Interviews with civil society organizations and university-based experts were conducted to corroborate and/or balance the feedback received from interviews with staff at the City of Cape Town. While the municipality is by no means the *only* source of intervention, it is a critically important one. Legally, South Africa employs a rights-based approach to basic services and access to water and sanitation is enshrined in the constitution. The state, through local government, is primarily responsible for services such as sanitation, housing, and flood response. Therefore, the different levels of government in South Africa—municipal, provincial, and national—are legally responsible for providing the services that are at the heart of this thesis.

The first component of this thesis required the use of **archival methods.** Desk research was conducted prior to field work. This included preparation of a literature review, compilation of key policy and planning documents, as well as research into identifying key stakeholders and potential informants. Public documents from all levels of government pertaining to climate change adaptation, flood mitigation, and/or urban service delivery in informal settlements were reviewed for context prior to field work, and following field work as supportive documentation for the research findings. Research of this nature continued throughout the thesis writing process to maintain relevance. Government documents were collected based on public availability online and through recommendations by informants. Throughout the research process, informants emphasized the public availability of all relevant publications for projects, plans, policies, rules, and laws that might apply. However, a few key documents such as the Winter Readiness Programme (also known as the Winter Preparedness Strategy), a key component of the City of Cape Town's flood mitigation efforts, are not available online. A research contact at the University of Cape Town provided me with the 2009 version of this document, confirming that it was difficult to obtain the most current version. Efforts seeking this document directly from the Disaster Risk Management Centre were declined.

Three types of planning documents are of particular importance within this study. First, the Climate Adaptation Plan of Action (CAPA), which represents the municipal-level climate change adaptation policy. Cities around the world are beginning to publish such documents to guide urban

planning. In Cape Town, this document is represented by the Framework for Adaptation to Climate Change in the City of Cape Town, as well as the Water and Sanitation Sector-Based Climate Adaptation Plan of Action. Second, South African cities are required to create and regularly update an Integrated Development Plan (IDP), the official planning document for the city. This document expresses the long-term vision for the municipality and contains key indicators used to monitor the success of departmental goals. Third, the Spatial Development Framework (SDF) is Cape Town's land use planning guide. This document guides formal development decisions. Table 3 summarizes the data used to answer each research question.

Table 3 - Summary of data sources

Research question	Data source

1. How does climate change impact the way that the City of Cape Town approaches service delivery and upgrading in informal settlements?
  a. How does the city currently respond to flooding?
  b. How does flooding impact the provision of sanitation services in informal settlements?
	Key informant interviews supplemented by policy documents:
	• Spatial Development Framework (City of Cape Town, 2012d)
	• Integrated Development Plan (City of Cape Town, 2014b)
	• Framework for Adaptation to Climate Change in the City of Cape Town (Mukheibir & Ziervogel, 2006)
	• Moving Mountains: Cape Town's Action Plan for Energy and Climate Change (City of Cape Town, 2011b)
	• Water and Sanitation Sector-Based Climate Adaptation Plan of Action (CAPA) (City of Cape Town, 2012a)
	• Winter Preparedness Strategy (2009 and 2014 Media Release) (City of Cape Town, 2009, 2014d)

2. What options are available to improve service delivery in informal settlements and reduce flooding in the long term? a. What are the long-term sanitation infrastructure needs for promoting resilience to flooding under climate change?	Key informant interviews
3. How can the City of Cape Town define and measure successful flood and/or climate change adaptation in informal settlements?	Key informant interviews supplemented by policy documents • Integrated Development Plan 2012-2017(City of Cape Town, 2014b)

The primary data collection consisted of **in-depth semi-structured key informant interviews[6]**—the interview guide may be found in Appendix A. Individual and multiple-person interviews were used as appropriate for each department interviewed (Beitin, 2012). A semi-structured interview format was followed. Because of the nature of the work being done by each of the individuals who were interviewed, the questions asked followed a similar progression but may include all or only some of the questions in the original list. For example, the department of Roads and Stormwater and the department of Water and Sanitation may collaborate or have responsibilities that overlap, however, each answered questions in relation to their particular area of expertise. Therefore, the questions were targeted towards the informant.

Purposive sampling was used during the preparatory stage. A list of 45 potential individuals or departments was created and this list was reviewed by a local researcher with direct experience in the area of study. From this review process, relevant informants were identified and systematically contacted. An introductory e-mail was first sent outlining the research goals and reasons for the interview request. Informants who did not reply by e-mail were called the following week. In most cases, an interview was schedule or the contacted party suggested a more relevant informant to interview. In some cases, interviews were declined, primarily because the informant was unavailable or did not consider their current work immediately relevant. One department, Environmental Health, who was considered a key stakeholder for their role in public education and awareness of flood and health risks, declined to be interviewed. Snowball sampling was also utilized. When snowball sampling was used, interviews were normally requested after multiple referrals.

This thesis aimed to interview between 20 and 25 individuals. The number was determined by inquiring into research projects with a similar scope, expectation of saturation, as well as the number of identifiable key informants. Thirteen informants were staff at the City of Cape Town, four were staff at a non-governmental and/or community-based organization, two were academic researchers, one was a provincial staff member, and one was a university researcher embedded with the City of Cape Town. Appendix B provides informant details.

1. *Government:* City of Cape Town staff were primarily interviewed due to the nature of the research questions. They were identified through their role in providing sanitation services to

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[6] Note about language: For many informants, Afrikaans or Xhosa may be their first language and English their second. In some quotations, incorrect English syntax may appear, which in Afrikaans would be correct. For example, the verb 'to be' is the same in singular and plural. However, I made an effort to preserve how things were said as much as possible. Cape Town, like the rest of South Africa, is incredible diverse and multi-lingual. Flexibility in language is necessary in this context.

informal settlements in the Cape Flats, their role preventing and/or responding to flood events, their involvement in climate change adaptation efforts, and/or their role in long-term planning in relation to the Cape Flats. One informant from the Province of the Western Cape was interviewed for their specialized knowledge of South African climate change policy and actions.

2. *Civil society organizations (CSO):* Interviews were conducted with civil society actors who were prominent in the areas of informal settlement development and included both advocacy organizations and non-governmental organizations that implemented development projects. Organizations were chosen based on their expertise in informal settlements and involvement in urban service delivery issues.

3. *University researchers:* Interviews were conducted with a small number of university researchers to provide context for municipal policy and practices, as well as to corroborate or balance statements from other informants. In addition to those interviewed, I consulted with a number of researchers in fields that overlapped with my thesis topic to get a deeper understanding of the context. During the research development stage, I was advised by several researchers that there were strong disagreements between municipal staff and residents. Though the scope of my project prevented me from conducting interviews with residents, interviews with civil society organizations and university researchers are intended to provide additional perspectives. Three interviews with researchers were conducted formally: two at Stellenbosch University to gain perspective on risk management within Cape Town, and one interview was conducted with a University of Cape Town researcher who was embedded within the City of Cape Town.

Field work was conducted in Cape Town between July 5th, 2014 and August 28th, 2014. In total 21 informants were formally interviewed based on their knowledge and the relevance of their present work to this thesis. Two other informants, originally chosen for interviews, were informally consulted for context but not interviewed because their present work was not immediately relevant. All interviews were conducted in person, in Cape Town, save for one. This exception was interviewed over the phone following the field work period due to lack of availability in July and August.

Each interview was conducted with the guarantee of confidentiality. While various informants felt comfortable disclosing their identity, in many cases professional opinions given differed from official department or organization statements. Because of the contentiousness of service delivery in informal settlements, a blanket policy of confidentiality was given to ensure informants could be open about their professional experiences. Occasionally, informants requested that certain statements were "off the record", which was respected. Though confidentiality was maintained, I should emphasize that all informants were asked to speak from their *professional* opinion and experience. As part of the

research planning process, I requested guidance on the ethics approval process for this thesis. After reviewing my research plans and interview questions, the University Of Waterloo Office Of Research Ethics determined that this project did not require a full ethics approval. According to the University policy TCPS 2, Article 2.1:

> "In some cases, research may involve interaction with individuals who are not themselves the focus of the research in order to obtain information. For example, one may collect information from authorized personnel to release information or data in the ordinary course of their employment about organizations, policies, procedures, professional practices or statistical reports. Such individuals are not considered participants for the purposes of this Policy. This is distinct from situations where individuals are considered participants because they are themselves the focus of the research."

The goal of this research was to understand the strategies available to the municipality. As such informants were not themselves subjects, so to speak, but rather professionals with experience and knowledge.

All interviews except for one were recorded on a handheld digital recorder and signed consent forms. The exception was Interview 21, CSO which was transcribed by hand due to last minute scheduling and the noise levels of the venue making recording difficult; the last minute scheduling also resulted in a verbal agreement with no consent forms signed. However, because informants were asked for their professional perspective and written consent was not required, this interview was included in the analysis. Additional consent was sought by reviewing notes with the informant immediately following the interview and supplying the informant with a copy of my notes.

In addition to the formal methods employed above, my field work included a number of informal activities that contributed to my understanding of the research problem and helped ground the findings presented in the next chapters. This included reading theses and dissertations by local students working in informal settlements, as well as discussing my research and potential challenges with local researchers. In addition, I spent time in the Khayelitsha area based on available contacts and the density and flood risk concentrated in this area, though interviews encompassed the entire Cape Flats region. Activities included a tour of notable areas in Khayelitsha, volunteering at a local non-governmental organization, and informal discussions with friends and other individuals I met along the way, both professionals and residents. In addition, living in Cape Town for two months and closely following media reports on informal settlements and flooding helped contribute to my contextual understanding.

3.3 Analysis

Transcription of interviews was conducted by myself between September and December 2014. Following transcription, full interview transcripts were sent to each informant for review. Informants had ten days to reply with any changes.

To stay true to the data, the data analysis process was drawn from the grounded theory approach outlined by Corbin and Strauss (1990). First, all interviews were coded using a data-driven, descriptive coding process (Gibbs, 2007): words or phrases as close as possible to the meaning of the text were used. Descriptive coding helped identify specific categories of conversation such as: "urbanization process", "institutional arrangements", and "climate change awareness". Transcripts were re-analyzed using open coding, where "conceptually similar events/actions/interactions are grouped together to form categories and subcategories" (Corbin & Strauss, 1990, p. 12). Once categories were formed, further analysis looked for related topics across transcripts (Ibid). The second stage is axial coding. Here, the researcher continues to develop categories while identifying the relationships between pre-existing categories. Finally, in grounded theory, selective coding leads to the elimination of categories that are not developed enough to contribute to the theory-making process of the grounded theory approach. Selective coding requires the creation of a "core" category, "the central phenomenon of the study". However, Corbin and Strauss (1990) found that this does not always take place and that even experienced researchers face challenges defining a "core" category and a struggle occurs to integrate different analytic frameworks.

Through the data analysis process, one overarching category: risk. Because of the centrality of risk identified through the analysis, I discarded my initial inclination to use a resilience framework within this case study. Chapter 2 examined the central role of resilience theory in climate change adaptation research and earlier stages of thesis development strongly considered using resilience as an overarching goal for interventions in informal settlements. However, though resilience is not *irrelevant*, the complexity of risk and risk resolution in informal settlements required that this emergent category take center stage in this thesis. It is from this realization that the holistic risk framework was introduced in Chapter 2.

3.4 Reliability and validity

> "All field work done by a single field-worker invites the question, Why should we believe it?" (Bosk, 1979, p. 193 as quoted in Huberman & Miles, Matthew, 2002, p. 36)

Qualitative research has long occupied an unsteady position as research methodology, continuously legitimizing its existence against more established, and directly measurable and replicable, quantitative research methods (Maxwell, 1992). Though, in recent decades, qualitative research has become an established research method, researchers continue to debate qualitative research methods and how to judge them. Quantitative research has long been judged against the standard of reliability and validity and these standards are frequently applied to qualitative research as well; though some qualitative researchers have shunned these realist requirements which assume "that there is a single, unequivocal social reality or truth which is entirely independent of the researcher and of the research process" (Mays & Pope, 2000, p. 50). Mays and Pope (Ibid) argue, however, that the quality of qualitative research *can* be judged through the same concepts, but that concepts such as reliability must be operationalized in a way that is logical to qualitative research.

Reliability refers to "the extent to which a measurement procedure yields the same answer however and whenever it is carried out" (Kirk & Miller, 1986, p. 19). Validity, on the other hand, refers to "the extent to which it [the measurement] gives the correct answer" (Kirk & Miller, 1986, p. 19). These definitions are drawn from quantitative research but Kirk and Miller (1986) argue they can be applied in qualitative research in a modified way.

Reliability in key informant interviews relies to a large extent on the trustworthiness of the informant, and the judgement of the researcher in determining that trustworthiness. Though I committed myself to researching the local context and familiarizing myself with Cape Town and the area under study prior to conducting interviews, as a North American graduate student, I was effectively an outsider. Because of this, it was critical to incorporate the feedback and perspective of more knowledgeable local researchers. Potential participants were discussed confidentially with a local research advisor at the University of Cape Town. Furthermore, common assumptions and opinions were flagged through consultative conversations with a number of other researchers with expertise in the field. Finally, the information gathered during the interviews, though represented as fully as possible as the participants own, are balanced through triangulation with public documentation and academic literature on the topic, as well as media sources and informal activities.

Validity in key informant interviews, on the other hand, is less clear. Each participant brings with them their own experiences that inform their responses. With regards to politically sensitive topics, it is possible that participants altered their views in line with the official messaging of the organization they worked for, or that it is clouded by uninformed judgements made through news stories or personal biases. Therefore, validity in the conventional sense as the "correct" measurement is

impossible to determine when social realities are unique to the individual and informed by so many unknown variables. However, as this thesis seeks to represent the views of the participants, it is not necessary for responses to be "correct" in the positivist sense (conforming to some objective reality). Rather, responses can be considered valid if the perspective of a participant is informing the subject matter under study—in this case policy and practices in Cape Town's informal settlements. As humans are inherently error-prone, the correctness of the answer is less important than the answer's relationship to the professional conduct of the participant.

The questions posed by this thesis are epistemologically challenging: in complex environments such as informal settlements, how do we find out what we need to know? The key informant interview approach adopted for this project allowed me to answer the research questions. This approach, however, focused exclusively on professionals working in fields relevant to the research and the sample is biased towards the perspectives of experts rather than those living in informal conditions. Because residents themselves were not interviewed, further work must be done to compare and contrast the findings of the interviews presented here with the perspectives of affected residents. As such, the findings may correctly describe the perspectives of the informants interviewed but may be disputed by other stakeholders that were not involved in the research design. Effort was made through triangulation to corroborate the findings and provide context, yet this bias may still persist.

3.5 Research timeline

January to April 2014: Research proposal development.

April to June 2014: Preparations and logistics: waiting for funding decisions, consulting with the Office of Research Ethics, reviewing local policies, booking flights and accommodation, and initiating contact with the University of Cape Town.

July to August 2014: Field work in Cape Town: Dr. Gina Ziervogel of the University of Cape Town generously served as a local advisor during my time in South Africa.

September to December 2014: Transcription of interviews.

January to July 2015: Data analysis and writing.

Chapter 4 Profile of case study area

This chapter will provide detailed background information on the case study, including a review of demographics, and weather and climate in the region. Then it will summarize the findings regarding the pre-existing flood risks in Cape Town's informal settlements. Prior to answering the research questions in Chapter 5, this summary contextualizes the flood risk to provide a base understanding from where other actions spring.

4.1 Cape Town, South Africa

Cape Town is South Africa's largest city geographically and second richest city after Johannesburg. The city produces 10.58% of the country's GDP and 71.10% of the Western Cape province's GDP (City of Cape Town, 2015). In addition to its economic strength, the city has participated in a number of international competitions on governance, financial management, and sustainability[7], and has sought to position itself as a leader in the region. Though the City of Cape Town has demonstrated its leadership through climate change policy-making, and its capacity through demonstrating financial accountability and international recognition, in many areas, the urban landscape is the epitome of contemporary urbanization: a picturesque core obscures the informal sprawl on the periphery. While the municipality has been able to achieve certain best practices, it continues to struggle to heal the social, economic, and physical divisions created by apartheid.

Around 3.7 million inhabitants call Cape Town home, and this number is increasing by approximately four percent each year (Rowswell & Fairhurst, 2011). Informal settlements, however, are growing at thirteen percent a year (Ibid). In South Africa, informal settlements represent clusters of shacks occupying unused land. In some cases, this may be a few shacks in-filling available space between buildings; in others, it may be tens or hundreds of thousands of shacks spread across large areas. In Cape Town, the greatest proportion (approximately 70%) of informal settlements are located in the Cape Flats, an expansive area of flat land that is vulnerable to flooding due to high ground water levels and the presence of wetlands, ponds, and other flood-prone natural features.

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[7] For example: Thompson Reuters Public Sector Jurisdiction of the Year (Barlow & Erni, 2014); Municipal Financial Management Act award (City of Cape Town, 2014c); Institute of Municipal Finance Officers Clean Audit Award 2014 (City of Cape Town, 2014c); African Utility Week Award for water and electricity (City of Cape Town, 2014a); Earth Hour Capital 2014 (WWF, 2014); Climate Change Leadership Award (City of Cape Town, 2012c); World Design Capital 2014 (Capital, 2014); "Disaster Resilient Status" by United Nations Office for Disaster Risk Reduction (UNISDR) (Ziervogel, Waddell, et al., 2014)

South Africa is an upper-middle income country with greater resources and institutional capacity than many other countries of sub-Saharan Africa. However, South African cities are highly unequal spaces. Reducing flood risk and adapting to climate change requires focusing on those most at risk with the least amount of resources (Kates, 2000). Nationally, 1.8 million households have at least one household member on the national housing subsidy waitlist (Housing Development Agency, 2012)[8]. The result of rapid urbanization is conflict between space and population that translates into other forms of conflict, including: state-civil society, poor-rich, formal-informal. Urban informal settlements reflect the conflict between urbanization, the failure of market responses to a growing urban population, and the inadequate response of government housing intervention. The holistic risk profile in informal settlements is drastically different from that of wealthier parts of the same city.

Historically, the Cape Flats of Cape Town were apartheid's "dumping ground" for non-white South Africans when the Group Areas Act of 1950 enforced urban racial segregation (Joubert & Martindale, 2013; Lanegran & Lanegran, 2001). The term township refers to areas designated for non-whites during apartheid and were normally built on poor quality land at the periphery of the city. Formal segregation policies ended with the demise of the apartheid government in 1994, yet economic, social, and spatial realities in Cape Town, as well as other South African cities, continue to reflect the legacy of apartheid planning. In and around historic townships grew informal settlements, excluded from the central city, no longer by law but by economic forces, and unable to lay legal claim to the land they occupied. Seven percent of Cape Town residents live as backyard dwellers and 13.5% live in informal settlements. In 2012, the City of Cape Town counted approximately 378 informal settlements, both concentrated in the Cape Flats and scattered throughout the city (The Housing Development Agency, 2013b).[9]

Factors of informality that increase the risk of flooding include a lack of stormwater infrastructure, extremely dense settlement, and housing construction. The city experiences intense, unpredictable rainfall during winter months, approximately May to August, where flooding is a common occurrence in informal settlements. The combination of these factors results in cold, wet, unsafe, and unhealthy conditions for residents (Joubert & Martindale, 2013).The city in general faces

[8] Notably, Tissington et al. (2013) have argued that the notion of a waitlist is a myth and the housing process in South Africa lacks the rationale to be considered a waitlist; rather, they argue that the "waitlist" is in fact a series of disjointed and varied housing and upgrading policies and plans that are not implemented with the logic implied by a waitlist. However, the notion of a housing queue or waitlist is extremely persistent and frequently discussed in the context of the interviews conducted in this thesis and the media.
[9] Though this is the official count published in 2013, informants also cited 204, 234, etc... When asked to clarify, one informant commented "that's exactly the point… it's a moving dynamic" (Interview 17, Municipality).

increased seasonal surface runoff due to the steep mountain slopes that bound the geography, the intensity of rainfall events during the winter rainy season, hardening of soils due to unchecked development both formal and informal, as well as space issues related to dense settlement in areas of naturally high run-off (Ziervogel, Waddell, et al., 2014). The issue of regular flooding is a major concern for municipal staff (Ziervogel & Smit, 2009). Informal settlements grow where there is land available, outside of land use guidelines set in the Spatial Development Framework[10]. This thesis adopts the lens of informal settlements as spaces of accumulated environmental risk and compound impacts (da Silva et al., 2012). The holistic risk framework introduced in Chapter 2 will be applied to analyze risk and available responses.

To better understand the urbanization process and resultant growth in informal settlements, I looked to census data available for South Africa in general, and Cape Town in particular. Migration is an important component of informal settlement growth. The 2001-2011 census reported that 25% of South Africa's urban population had migrated during that period. Of this 25%, 64% moved within the same province, 24% moved from a different province, and 12% moved from another country (The Housing Development Agency, 2013a). There is a strong trend of migration from poorer to richer provinces. For example, the Eastern Cape Province has experienced negative net migration, losing 214 815 residents between 2006 and 2011 (The Housing Development Agency, 2013b). The Western Cape Province, on the other hand, has seen a positive net migration of 95 556 over that same period. 45% of those who moved to the Western Cape during the census period originated in the Eastern Cape Province, a significantly poorer area[11] (The Housing Development Agency, 2013b). Rural-urban migration is a way to cope with poverty, lack of employment opportunities, and the decline of rural livelihood opportunities (Collinson & Erasmus, 2014). However, migration as a strategy in South Africa is often considered temporary or transitory; households often consider their home as where they are from, not where they are (Collinson & Erasmus, 2014; Mels et al., 2009). This condition influences the way that informal settlements are understood by decision-makers.

The 2001-2011 census indicated that, over the ten year reporting period, there was a slight national decrease in the number of households living in informal settlements, though this has been accompanied by an increase in households living in backyard shacks—informal shacks rented on the property of a formal home owner. The Western Cape, on the other hand, has not seen a decrease in informal settlement households (12% in 2001 and 2011) and has seen an slight uptick in the

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[10] The Spatial Development Framework comprises the municipal land use planning guidelines for Cape Town.
[11] GDP/capita was R72, 031 in Western Cape and R30,249 in Eastern Cape (Statistics South Africa, 2011, 2012).

percentage of households living as backyard dwellers (The Housing Development Agency, 2013a). Since the overall population of Cape Town grew from 2 892 243 to 3 740 025 during this time, an increase of 29.3%, the overall number of households living in informal conditions has increased (City of Cape Town, 2012b). The bulk of informal dwellings are located in the Cape Flats region of the City of Cape Town, an area comprising of two planning districts: Cape Flats, and Khayelitsha/Mitchells Plain. Approximately 192 000 households live in informal settlements in Cape Town (excluding backyard dwellers).

## 4.2 Urban service delivery, flood risk & climate change

Cape Town has a Mediterranean climate with a wet winter season from June to August (Rowswell & Fairhurst, 2011). Annual rainfall depends on topography with 515mm the average for coastal plains and valleys, and 1500mm the average for mountainous areas (Ibid). The Western Cape is considered the most disaster-prone province within South Africa due to a combination of low-frequency, high-impact and high-frequency, low-impact events, predominantly due to extreme weather events (Province of Western Cape, 2007). Figure 6 shows the Risk & Vulnerability Map created by the City of Cape Town's Disaster Risk Management Centre (DRMC). This map shows flood-prone areas, predominantly in the Khayelitsha area of the Cape Flats where natural water features can be seen. This map also shows the frequency of fires in informal settlements, another major hazard. Because most settlements are inland, sea-level rise is not considered a major threat to the area.

The root causes of flooding in Cape Town are diverse; however, weather patterns play an important role. Cold fronts and cut-off lows, or "atmospheric circulation that becomes separated (or cut off) from the main flow/system and often results in heavy rainfall, galeforce winds and other severe weather", are frequently cited as a source of Cape Town's heavy rainfall that produces flooding (Holloway, Roomaney, Pharoah, Solomon, & Cousins, 2008, p. 117).

Research on climate change in Cape Town and the Western Cape province indicates that "clear evidence of the early signs of anthropogenic climate change is evident in the temperature record in the Western Cape, and that rainfall trends, though more variable, also suggest some shifts in the "normal" climate regime" (Midgley et al., 2005, p. v). Climate change is expected to increase temperatures in the region resulting in increased air pollution, water stress, and fire risk (Mukheibir & Ziervogel, 2006). Sea level rise is expected to impact coastal ecosystems and infrastructure (Ibid). A general drying trend is expected to lower winter rainfalls while possibly increasing summer ones (Midgley et al., 2005). Overall, rainfall may become more intense and more unpredictable, which indicates that flooding may increase (Ibid). The dramatic difference between rainfall in low-lying

versus mountainous areas contributes to difficulty analyzing rainfall patterns in Cape Town (Mukheibir & Ziervogel, 2006). Climate change projections continue to be mired in uncertainty. This makes decision-making around climate change difficult. However, this thesis proposes that existing risks are not well-managed and must be addressed as a process of adaptation itself.

Figure 6 - Risk & Vulnerability Map
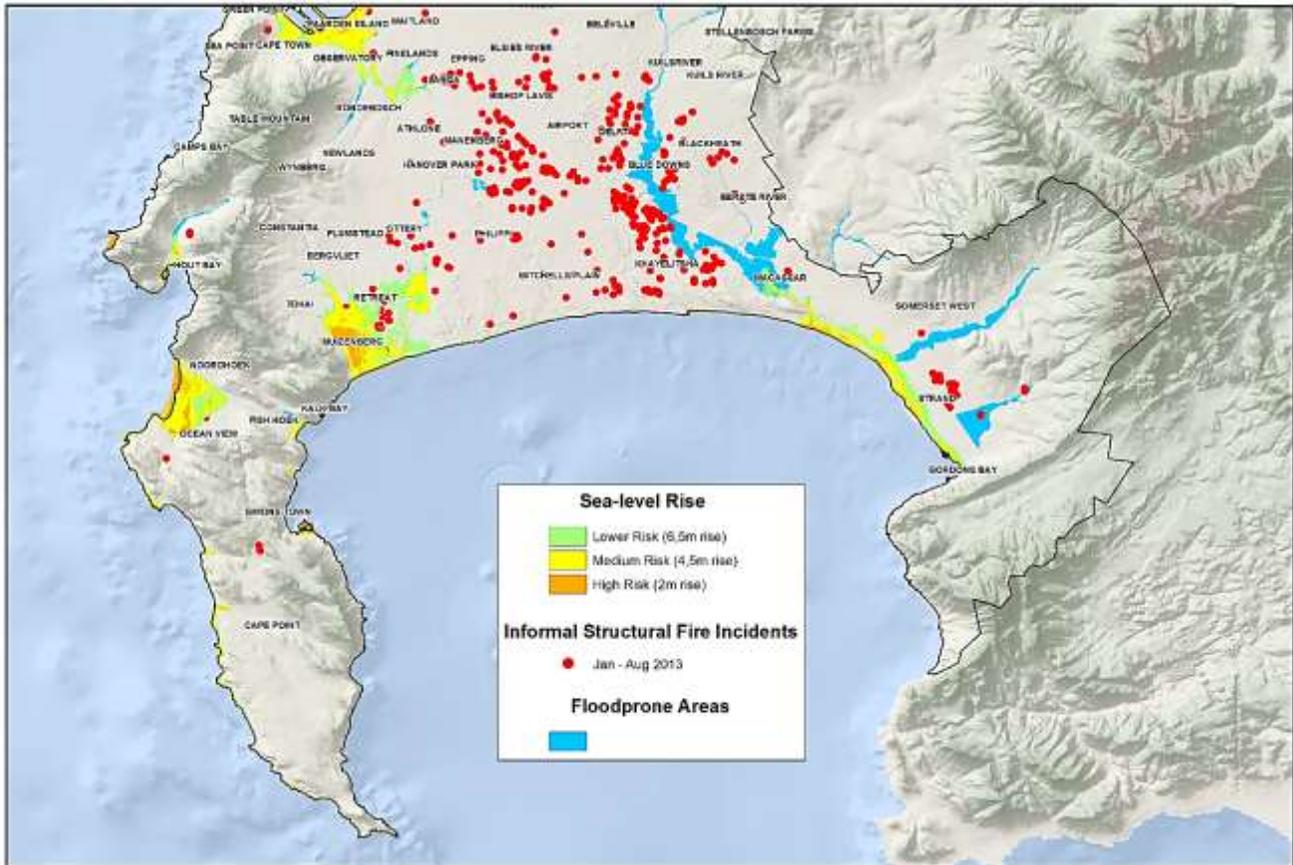
Source: Disaster Risk Management Centre, 2013

The Cape Flats are composed of two planning districts: Mitchells Plain/Khayelitsha District and Cape Flats District. For context,   Figure 7 and Figure 8 show the concentration of informal settlements in the Mitchells Plain/Khayelitsha Planning District, the main focus of this thesis, and Cape Flats Planning District.

Figure 7 - Mitchells Plain/Khayelitsha Planning District
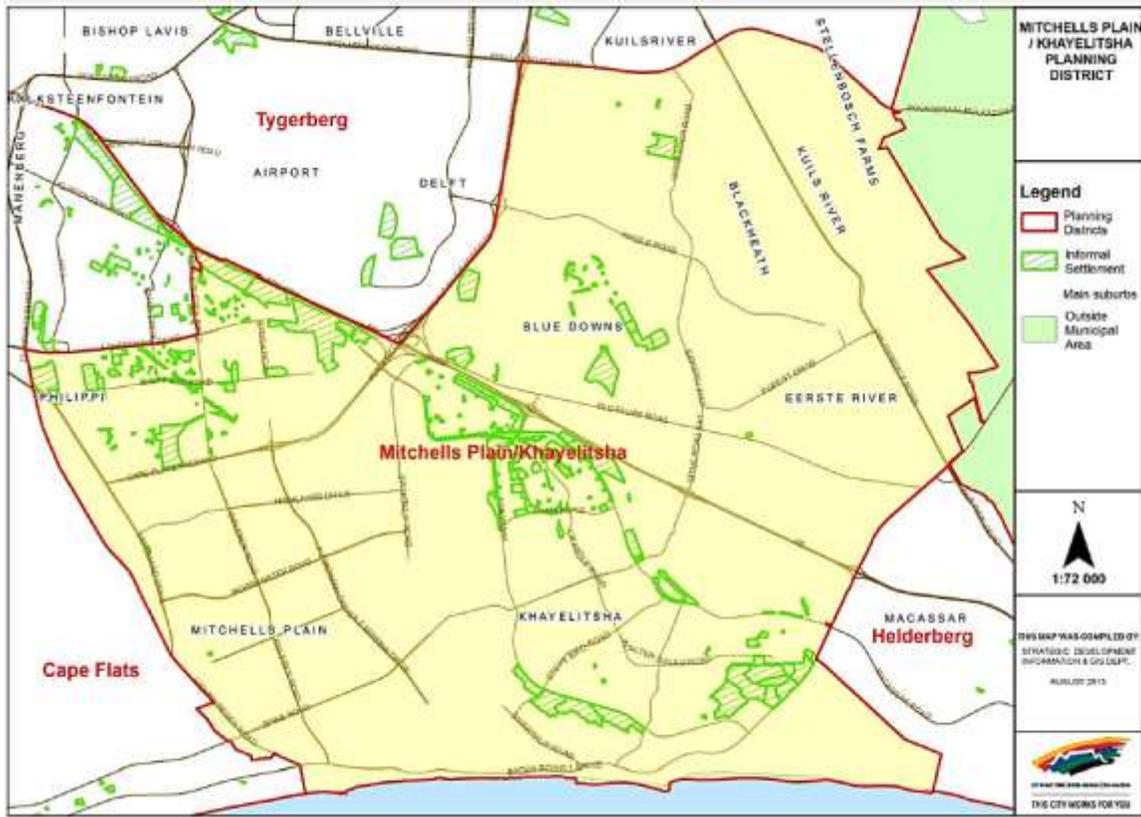
Source: City of Cape Town, 2013c

Figure 8 - Cape Flats Planning District

Source: City of Cape Town, 2013b

4.2.1 Existing flood risk

As a component of key informant interviews, each informant was asked to describe the sources of flood risk in the Cape Flats. This section summarizes the findings from these informant descriptions.

In Cape Town's informal settlements, flooding is a daily reality for many:

"[I]f you're going to go in and walk in an informal settlement, even up until November, you will have to walk in and wear gumboots. I mean everybody… even the kids are walking in gumboots. It's kind of like, if you want to have an outreach program for people in the townships, just distribute gumboots. Because the truth of the matter, people are living in water that's literally flowing all year round." (Interview 4, CSO)

Key informant interviews found seven main factors that contributed to the occurrence of flooding that spanned natural, technical, social, and human factors of flooding: seasonal weather patterns,

settlement patterns, ground water levels, density, shack construction, stormwater system and waste disposal, and water management, each of which will be described in turn.

4.2.1.1 Seasonal weather patterns and climate change

Informants cited rainfall patterns and intensity as a major contributing factor to informal settlement flooding. An informant from Disaster Risk Management Centre (DRMC) reported rainfall pattern changes:

> "[E]ven our rainfall has changed. You'll notice that Cape Town used to [have] 8-10 [day] rain. If it starts today, in 8 days it only stops, non-stop. That pattern has now changed, and so we were advised years ago… from now, we're going to have more flash floods. Everything is just going to come down. That obviously will affect us even more than your normal rain because you know how to control your normal drizzling or your continuous rain." (Interview 14, Municipality)

This observation is corroborated by the literature which shows that while rainfall has not decreased in South Africa over the 20th century, it has become more extreme with droughts punctuated by extreme rainfall (Fauchereau, Trzaska, Rouault, & Richard, 2003; Richard, Fauchereau, Poccard, Rouault, & Trzaska, 2001). Short-duration, heavy rainfall is difficult to manage due to the increased potential for flash flooding. Climate change projections parallel this trend, indicating that flooding may become a bigger problem.

4.2.1.2 Settlement location

> "[Informal Settlements department] sees flooding of informal settlements in Cape Town as mainly a problem of people being in the wrong place rather than as a problem of excess water; this is because the flooding problems they have to deal with are generally caused by people occupying low-lying, poorly drained areas that are not (in their present state) suitable for residential use." (Ziervogel, Waddell, et al., 2014, p. 8)

Despite the natural flood hazard and exposure in parts of the Cape Flats, settlement occurs in particularly high risk locations such as flood plains, wetlands, and other areas designed to receive water because of the intense competition for space. Four major factors are pushing settlement onto increasingly vulnerable land.

First, informal settlement growth is driven by migration and natural demographic growth. Densities have increased and new settlements are increasingly pushed into high risk areas. Informal settlement growth was extremely concerning to many informants at the City of Cape Town who felt they could not meet needs:

"[H]ow do you keep up with service delivery with exponential growth?" (Interview 17, Municipality)

One informant also stated that a lack of affordable housing was pushing many more people into informal settlements:

"[M]ore and more we're seeing people occupying [high risk areas]… this comes to a much bigger systemic issue around access to land, and access to affordable housing opportunities. The people are now encroaching at the back of existing informal settlements, onto land which would have been otherwise considered uninhabitable." (Informant 4, CSO)

Second, residents face competing risks associated with occupying safer but visible land and make trade-offs. For example:

"[Y]ou go to a place like Khayelitsha and there's a lot of land, vacant land, but people just will not occupy it. So, I think a lot of people have been placed in a position where they're being left with no other choice but to occupy these very high risk but not necessarily visible spaces. Um, so they become your low-lying areas which are obviously a lot more susceptible to flooding, and to obviously poor stormwater runoff." (Interview 4, CSO)

Interview 4 explained that settlement in highly visible areas increases eviction risk; residents choose environmental hazards such as flooding over potential eviction. Third, seasonal rainfall patterns influence settlement location. Residents who settle during summer months are often unaware of the potential flood risk they face (Interview 11, Municipality) (Joubert & Martindale, 2013):

"Summers are very long in Cape Town so everybody forgets about the winter when summer comes." (Interview 6, Municipality)

"Some of them would even settle in ponds, which is dry in summer, whereas in winter, it obviously, the water rises and it causes flooding." (Interview 14, Municipality).

Fourth, perverse incentives were cited in increasingly risky settlement. As mentioned above, residents seeking access to jobs and transportation may find settlement in an area that is dry during the long summer a worthwhile trade-off. One informant described the reality of living with risk:

"[P]eople are already doing this. Where they will move out… if they know, for example, that that part of the settlement is going to flood for three months of the year, they will move out of their structure, take their TVs, their clothes, their ID books with them, and go and live with a friend. And then move back into the settlement, move back into that structure when it dries up again… So they've learned how to manage it so they've got…nine months of the year where they can

occupy the structure. For three months they need to move out. That to me is that they're managing their risk." *(Interview 4, CSO)*

Other informants cited the long waitlist for subsidized housing as a perverse incentive which motivated individuals to settle in high risk areas for the purpose of increasing their chance of resettlement (Interviews 2, University; 6, Municipality; 14, Municipality; 17, Municipality). Across South Africa, the process of obtaining subsidized housing is severely backlogged. Respondents indicated that applicants may wait longer than a decade to reach their turn for housing:

> "There's also this tendency to think that informal settlement dwellers don't understand their own risks. They understand what they're living with. And in fact, the dynamic of a lot of the stuff that's going on in Cape Town… there's this what 350,000 or 400,000 people on a waiting list for housing? They'll deliberately and strategically place themselves at risk of flooding so that they jump the queue for the waiting list for housing by being in the most affected areas." *(Interview 2, University)*

Though municipal informants emphasized that they did not wish to act in a way that encouraged such tactics, one informant suggested that subsidized housing was the only way that informal settlement residents were transitioning to formal housing:

> "People will come out of the informal settlements by virtue of being on the housing waiting list. Very seldomly that they will eradicate an informal settlement… some instances that they do, but mostly people will come out of the housing waiting list." *(Interview 10, Municipality)*

Perspectives ranged from residents intentionally settling in high risk areas out of desperation to calculated strategic moves:

> "They're [informal settlement residents] quite informed about which land is indicated for housing on the Spatial Development Framework, so if they hear that a certain piece of land is earmarked for housing, it's likely there will be attempts at land invasion. Which is a problem for the city and for private owners because that's an asset that they're losing essentially and there are very complicated process to evict and resettle." *(Interview 9, Municipality)*

Though the idea of "queue jumping" was severely criticized as a myth in some literature and by a few informants (Interviews 4, CSO; 21, CSO) (Tissington et al., 2013), it was a pervasive opinion expressed during my field work. Such a perception, regardless of veracity, frames the relationship between residents and the municipality as adversarial.

Overall, settlement in naturally flood-prone areas was a major challenge for informants:

"[I]f people are in a flood plain, for instance, we can't provide them with electricity. And although the constitution says that people are entitled to services, we don't see electricity as a basic one, or an essential service, you don't need electricity to live, you need water. But speaking to communities, the first thing that they will ask for is electricity, so even before they get water… they want electricity. If people are in a flood plain, we cannot provide them with electricity, we can still give them water, we can still give them sanitation, but we are not allowed to [give electricity] and that is by law, we are not allowed to, because water and electricity, they just don't mix." (Informant 10)

4.2.1.3 Groundwater levels

Areas with high groundwater levels are prone to flooding and this is a common problem within the Cape Flats.

> "So we have a number of instances where stormwater or flooding takes place largely because of rising groundwater or being built in areas where they are prone to flooding and should never actually have dwellings built there." *(Interview 5, Municipality)*

Settlement on high groundwater levels limits the effectiveness of emergency flood responses and leaves informal settlement dwellers coping with wet conditions for much longer than conventional flash flooding:

> "Now in the informal area, because of the lack of good drainage and the gradient in the area, you're always going to have flooding. So it's not a question of actually getting the water away, by gravity, it's actually by pumping. We've found that it had limited success. Especially with people, they set up in ponds… because of the political importance also for us to do something about it, we're putting pumps in this area to actually pump out the water. Very limited success because obviously a lot of the water is groundwater so when you do pump out, just more water comes but you do have a slight dropping water in that informal settlement, alleviated of the problem for some of the people but unfortunately most of the people, when it's very aggravated, they have to be relocated." (Interview 19, Municipality)

Furthermore, groundwater in Cape Town is an importance resource to be protected. South Africa is projected to face water scarcity issues under climate change and preserving groundwater quality is a primary concern for the municipality.

4.2.1.4 Density

Though there are informal settlements throughout Cape Town, in the Cape Flats area, particularly in Khayelitsha near transportation routes, they are highly concentrated. In this area, they

exist on the periphery of otherwise formal but poor and highly dense suburbs. Figure 9 highlights the extraordinary densities concentrated in the informal areas, more in line with downtown areas filled with skyscrapers than the tightly-packed but single storey sprawl that exists. The sheer number of residents in certain areas seemed to overwhelm municipal staff:

Figure 9 - Density in Mitchells Plain/Khayelitsha
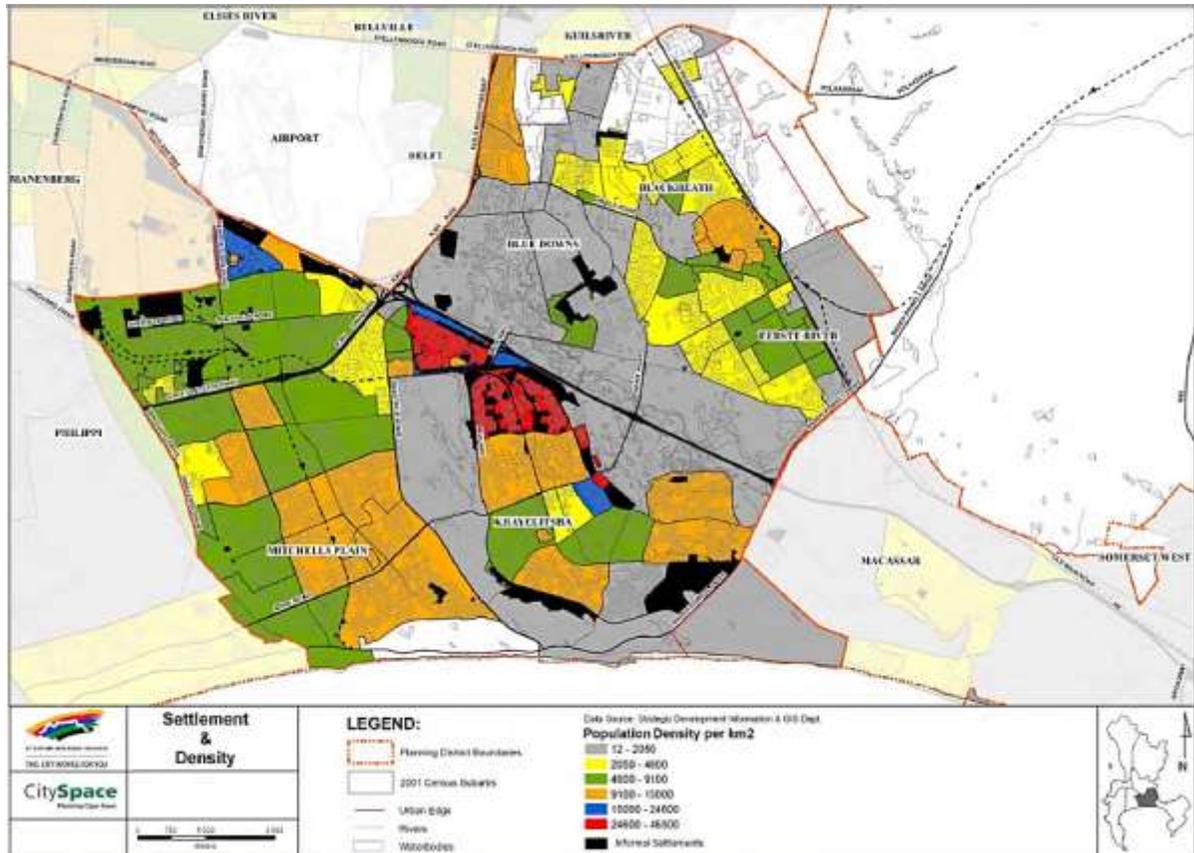
Source: City of Cape Town, 2011b

The following were common responses from informants:

> "I think the Khayelitsha area is extremely densely population, I mean, there's got almost a third of the whole city of Cape Town is just in this, but that's more than a million people in just that area." (Interview 8, Municipality)

> "[I]t's extremely dense. We've got one informal settlement with excessive of four hundred dwelling units per hectare. That's dense." (Interview 10, Municipality)

The relationship between density and flooding is threefold. First, density prevents access by emergency and service vehicles (Interview 14, Municipality; 15, Municipality). Second, density reduces the space available for infiltration, preventing water from rainfall from leaving an area:

> "Now, you cover that with a dense amount of metal, but it's not only the vertical square area but also the sides. And so it's more water now that lands up on their and that needs to go somewhere. The infiltration area is now just the space in between these dwellings. So very little infiltration can take place. And that density is a concern." (Interview 6, Municipality)

Third, density restricts the installation of stormwater networks unless residents are moved (Interview 10, Municipality).

One informant illustrated the relationship of flooding and density and the impact interventions had on residents:

> "There was flooding in two other settlements so just to get people out of the flood zone, the City, in its wisdom, created what they called a transit camp and put everybody there. And Never Never over night was transformed from this place that never flooded with bushes trees and sand dunes to a little community. I've got aerial photographs from google earth and it's easy to show you that you can see that place over a period of something like 6 years, hit the top ten list of most flooded settlements in the Western Cape, through densification." (Interview 2, University)

This informant found that flooding occurred due to density regardless of the quality of land. Even areas with no histories of flooding experienced flooding once the area was built up.

Density also spreads flood risk. As previous maps have shown, informal settlements concentrate on the periphery of formal ones in some cases, or blend in other cases, often due to proximity of services and access to transportation. However, this densification without accompanying stormwater drainage in the informal areas overwhelms stormwater infrastructure in the formal areas and directly impacts neighbouring settlements:

> "[W]e found basically there's no stormwater drainage in areas where people have squatted although it's provided elsewhere. So often the informal areas ramp up the flood risk to the formal areas." (Interview 2, University)

Furthermore, density impacts other infrastructure as well. Backyard dwellers are a housing strategy for many households where property owners rent their backyards to households who set up shacks in an informal-formal fashion. These properties may have many times the anticipated number of occupants without accompanying infrastructure.

4.2.1.5 Shack construction

Flood risk is further aggravated by shack construction. Floors are normally dug into the ground resulting in homes at a lower gradient than surrounding areas, attracting water flow during flooding. Informant expressed confusion at this practice:

> "When people build their houses, I don't know where they get the idea of digging down into the ground and then most cases their floor level is so far below ground level… so obviously it's going to flood. They think water only comes down but when the water level rises also… comes up, and that is where they're sitting with the problem. And we've been trying to educate them to look at formal housing where you will always notice that the formal house is always built…above ground, not even level with ground level, to ensure that there is no flooding. So, obviously it's people that is not used to building regulations and the reason for raising the level of your floor level, and so that's why most of them fall into the trap of building houses below the water level." (Interview 14, Municipality)

However, one informant speculated that such practice may make homes more resistant to wind:

> "People literally in knee deep water and… it's because there's been a practice of removing the inside of your shack as a way to ensure its stability against the wind. Because now you've got a rotten structure that's now if you raise internally there's somehow or there isn't access to material so people have dug it out to try and obviously… And in some cases it might be even to increase the height, it's something we need to understand. This whole clearing out of all deep or increasing heights." (Interview 4, CSO)

The combination of shack construction, density, and ground water levels severely limit potential interventions:

> "[T]he kind of stormwater engineers talk about is that these informal settlements will always flood unless you do major earthworks and, kind of, build more formal foundations that those structures can then go on top of. Because the fact that they kind of dug into what's effectively almost the water table, means that as soon as there's rain, water just comes up from below. Which is a lot of the flooding problems isn't actually kind of river overflow or anything like that, it's more groundwater that just kind of seeps up and kind of stands for days or weeks on end." (Interview 3, University/Municipality)

4.2.1.6 Stormwater system and waste disposal

> "[W]hat makes it even worse is the absence of proper drainage." (Informant 4, CSO)

Drainage is one of the most important factors in Cape Town's flooding issues. Informal settlements lack formal drainage networks and may, in fact, have been designed to receive drainage from the surrounding areas. Retention ponds and overland channels are common in informal areas and settlement near or in these high-risk areas is not unusual. In many areas, flooding is inevitable because of the capacity of the stormwater system:

> "While the City has done all that it can to mitigate the impact of the winter season, flooding and mudslides may still occur due to variable climatic conditions. Due to the very nature of flooding, this cannot be completely prevented as rainfall often exceeds the design capacity of the stormwater system." (City of Cape Town, 2014d)

The issue of drainage is twofold. First, no drainage, blocked drainage, or overcapacity drainage overrides other flood causes because drainage is the primary intervention available to cope with urban flooding. Second, without adequate drainage, other services or infrastructure investments are impossible or must be modified. Informants were skeptical over which was a greater crisis: existing drainage problems or future climate change:

> "Look, I acknowledge that the weather is changing, but I think a lot of the problems in the settlements is a lack of adequate stormwater drainage… Or drainage that's blocked. And communities not understanding that they're part of the problem and also of the solution." (Interview 2, University)

The urgency of drainage issues was often considered more pressing than climate change as it preceded adaptation. As one informant reported:

> "Now in the informal area, because of the lack of good drainage and, uh, the gradient in the area, you're **always** going to have flooding…." (Interview 19, Municipality) (emphasis added)

An exacerbating factor, however, is that existing drainage is often blocked by natural sources such as windblown debris, and human sources such as garbage and illegal dumping. The City of Cape Town copes with major issues of illegal dumping that aggravate the stormwater management situation. Some informants were concerned with the lack of enforcement:

> "And then there's no enforcement in terms of getting people to stop chucking garbage down drains and sewage pipes and blocking up pathways and whatever because a) the community feels that it's the, sort of, lack of sufficient waste management resources but at the same time, there's also this, I don't know, pervading culture of we can throw away whatever we want, wherever we want, and chuck the barber's hair stuff down the drain, and then, you know, that floods the street 100 meters away." (Interview 1, University)

Another referred to the idea of "negative work", what they defined as intentionally disrupting the efficient operation of services in an effort to create more jobs. They reported:

> "There's a lot of negative work going on in terms of dumping and if you meet someone in informal settlements, hear them dumping, and you have the courage to tell them don't do that, they need to understand why, because of negative work, you're actually wasting money." (Interview 17, Municipality)

This perception that informal settlements residents were inconsiderately or purposefully blocking drains through illegal dumping was so pervasive through my interviews, an interview with a representative of the Solid Waste Management department was arranged to ensure that the information gathered was accurate. In response, they clarified: "it's a huge problem city-wide not just in informal settlements. Illegal dumping takes place across the entire city" (Informant 20, Municipality). Construction companies and other industrial polluters played a big role in illegal dumping. This situation aggravates the stormwater management concerns of the relevant departments. It also increases risks associated with flooding as rainwater pushes waste into channels and drains which are quickly blocked. Stormwater itself also plays a central role in pushing waste into drains, as it carries debris downstream.

This perception of shack dwellers as exacerbating the problem through poor choices also contributes to the way that service delivery and state-civil society interactions are framed. Like queue-jumping, the blame placed on residents regarding waste disposal demonstrated to some informants the rampant collective blaming that occurs across sectors (Interviews 4, CSO; 13, CSO; 21, CSO).

That being said, there is no doubt that there are issues with waste disposal in informal settlements. Visits to Khayelitsha, for example, showed evidence of refuse, particularly near channels. One informant, referring to their experience with community risk assessments, said:

> "[E]verybody just walks out and puts it straight into the gutter to run into the stormwater drain, and the reason they do this is that there's no alternative. So the stormwater drain is used for everything." (Interview 2, University)

In addition to household waste, waste from enterprise operating in the informal economy are another significant contributor to system blockage (Interview 17, Municipality).

The issue of waste disposal is indicative of three concerns: access within informal settlements, cooperation of residents, and awareness of new settlements. First, the density of informal settlements often means that standard-sized vehicles are unable to enter informal neighbourhoods. This poses serious safety and security concerns—for example, police, fire, and ambulance services are unable to

get into the settlement quickly. For the management of services in settlements, access often means a different typology of service, changes to service expectations, and more human resources needed to provide an adequate level of service. Flooding often restricts access to settlements. In this context, the cooperation of residents is critical to the success of any service delivery effort, and the most basic services often require high levels of consultation. For example, one informant remarked:

> "So you cannot move into informal settlement if you have not consulted with the community. It's easier for me to build a bridge across the N1 [a major highway] than to erect one toilet in an informal settlement. The consultation process is a whole lot." (Interview 11, Municipality)

Finally, municipal service providers largely depend on residents to notify them of new settlements. This means that service implementation may be delayed until there is a formal complaint made to the City.

4.2.1.7 Water management

Finally, and related to the above flood causes, the municipality faces major challenges managing different types of waste water. First, lack of drainage options in informal settlements often means stormwater has nowhere to go. It may end up in the sewer system and cause major problems. Residents attempting to redirect water away from their homes may produce unintended consequences:

> "[W]hen it rains, [residents] would take all the water coming down from the gutters into the gullies, which means it goes into the sewer system. Rainwater in the sewer system is not good for the treatment plant because the treatment plant depends on… maintaining the bacteria levels so that it can obviously break up the feces … but if you have too much freshwater, it kills the whole sewer system, and it takes months, about three, four months, to recover the whole system again." (Interview 14, Municipality)

The sewer system in Cape Town is already overcapacity. Intake of stormwater often leads to sewer overflow, which is major health and safety risk.

Second, informants were extremely concerned with the disposal of greywater (e.g. household waste water from laundry, dishes, etc.):

> "We don't allow any greywater to go into the stormwater system because otherwise it lands up in the sea where it will obviously poison our marine life and have an effect on that industry as well." (Interview 14, Municipality)

> "It's the management of grey water, which is then a real mess because now you're sitting, it's actually not even grey, a lot of it is actually brown water, so that's containing all sorts of stuff inside it. That's not properly draining, so…" (Interview 4, CSO)

Because of a lack of domestic drainage, informants reported that residents often disposed of greywater improperly:

> "[T]he indiscriminate use of water, use and disposal of water... is one of the biggest problems. If you look at the quality of the grey water that comes from there, is that washing powders that is commercially available to the more affluent, they would add softeners in and all that...but the washing powders that the lower range in the economic spectrum would be much harder, would have high amounts of caustic soda in it... and those things are not very good for the environment when they get disposed. So grey water is one of the challenges." (Informant 6, Municipality)

> "In other cases, one would, depending on the slopes... encourage people then, instead of doing their washing right at the standpipe, and then decanting it around the standpipe, take it to their homes, where they can use the excess water for their gardening as well, so that helps in many cases . But unfortunately, with the density it becomes a challenge again, because people don't have gardens anymore and there is no space to do this in the gardens." (Interview 14, Municipality)

Aside from environmental impacts of greywater, because of the lack of drainage, many informants reported that even small amounts of water caused pooling, which created health issues:

> "There is no land available. And with so many people on top of each other, it just increased the grey water situation as well. So, you'll sometimes walk through areas in summer and it's wet all over because people, the only space they have is where the doors open and they'll just pour their stuff onto the road. That obviously, that water, grey water, is staying there, it turns green. And of course, flies breed and there you have maggots and stuff growing around those areas. And that obviously becomes a health problem." (Interview 14, Municipality)

This section provided a detail overview of existing flood causes in informal settlements. As described above, flooding is caused by a complex interaction of different factors.

Figure 10 below illustrates this complexity. What is clear is that the different factors of flooding interact and overlap. They also demonstrate the importance of addressing flooding in an integrated way: for example, when social and economic pressures are pushing settlement into high risk areas, technical stormwater solutions will have a limited impact.

Figure 10 - Existing flood risk
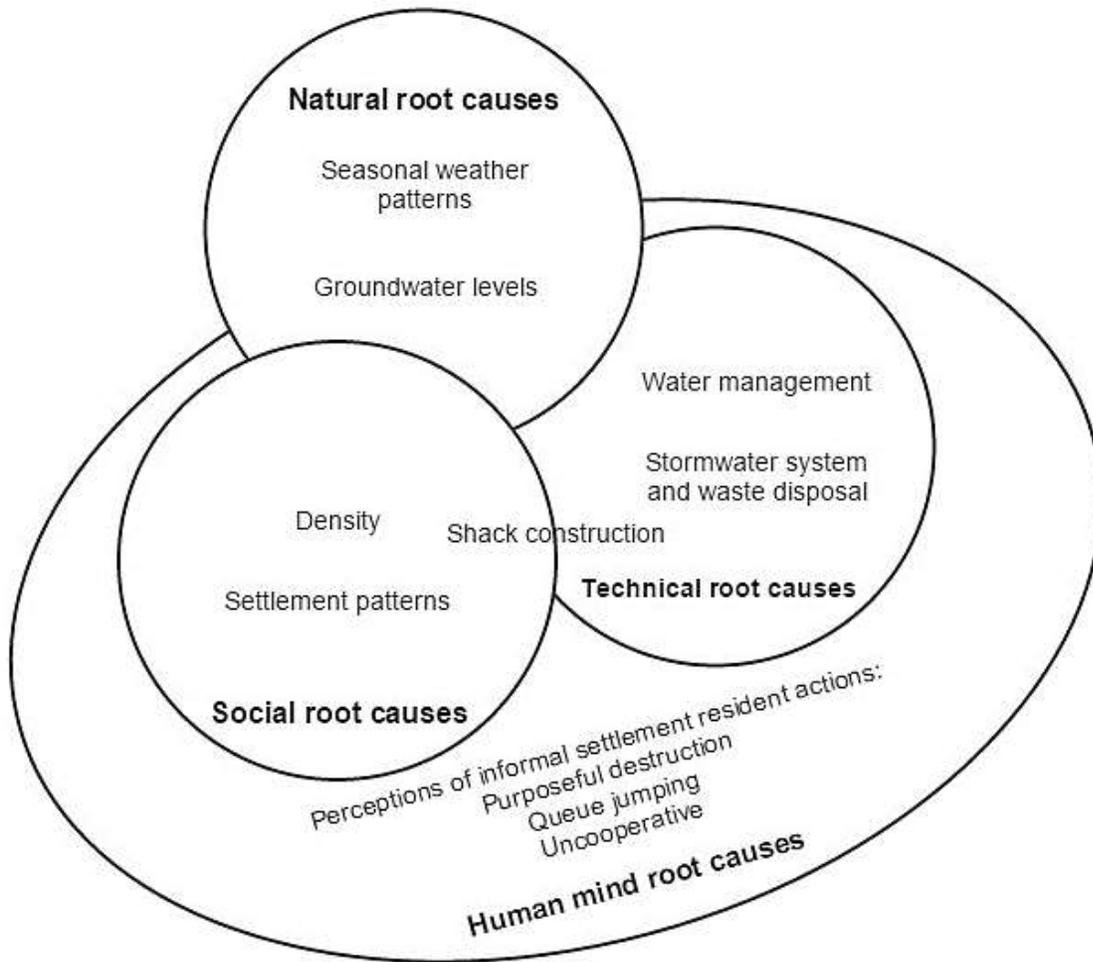
Chapter 5 Findings

This chapter summarizes the findings of the primary data collected through key informant interviews and responds to the research questions guiding this thesis project. In this chapter, each research question will be examined in detail through the data.

5.1 RQ1: Climate change, flooding, & sanitation services

1. <u>How does climate change impact the way that the City of Cape Town will need to plan municipal services for informal settlements?</u>
    a. <u>How does the city currently respond to sanitation issues caused by flooding?</u>
    b. <u>How does flooding impact the provision of sanitation services in informal settlements?</u>

5.1.1 Flooding and sanitation

Each informant was asked to identify the specific impact of flooding on sanitation. First, flooding can destroy sanitation facilities. This is due to the water itself and also the quality of the soil where facilities are built. One informant described a scenario in Khayelitsha:

> "Well, in certain areas, the sort of conditions that Khayelitsha is in… it's… built predominantly on beach sand actually, have culminated and flooding is one important element … infrastructure [is] sinking into the ground. I can show you pictures of, of enormous blocks of toilets that are just being sort of like reclaimed by the earth almost. (Interview 13, CSO)

This informant shared photographs of toilets covered with sand and debris in the aftermath of flooding.

A second major impact of flooding is the limited sanitation options available in high risk areas. Many informal settlements, due to densities and flood risk, are only able to receive sanitation services in the form of chemical toilets (porta-a-potties). These toilets must be serviced regularly to maintain usability and hygiene standards. However, flooding often prevents service vehicles from accessing these facilities which negatively impacts the service received. A number of informants identified this as a major issue:

> "Rainfall and flooding prevents access in certain areas which means that you may find a period of time where they cannot service the toilets." (Interview 12, Municipality)

"[A]ccess roads to some of the settlements is also quite a challenge. Because it's handmade roads, it's not certified roads, and so the roads department do not necessarily have to service them, so that becomes a challenge… not just for the city itself but even for service providers to be able to access and [establish a] services [schedule] when it comes to chemical toilets or other dry sanitation options that needs to be serviced regularly. When it comes to chemical toilets, container toilets, it has to be done three times a week so access is pertinent for us to be successful in carrying out those service, providing the service as required…" (Interview 14, Municipality)

A third impact of flooding is the effect uncontrolled water has on areas without any sanitation services. In areas without nearby access to toilets, residents have been reported to dig pits and use buckets. Flooding can spread improperly disposed of waste throughout a settlement, exposing residents to bacteria and contaminating belongings. The quote below describes one incident in the Hout Bay area during heavy rainfall.[12]

"[T]here were kind of pockets of the settlement where there was no access to infrastructure at all. So what they were doing, we asked them, well, what do you do? They dig pits. So now we're thinking that this is a huge problem because they're sitting right at the top of the settlement. Not only are they digging pits but as soon as it rains, all of that is leeching straight into the ground and we know that there's huge problems of flooding in the households further down the slope. Not just from surface runoff but from underground seepage. Now you've got all of this human [waste] basically essentially going into people's homes." (Interview 4, CSO)

Finally, the growth of informal settlements combined with growth in residents living in backyard dweller conditions has overwhelmed existing infrastructure. Though this was not raised during interviews, during my field work, informal discussions with workers and residents in the Khayelitsha area, for example, expressed that the sewer system frequently overflowed. The 2014 Winter Readiness Programme cites sewer overflow as a frequent winter event:

"During the winter period, sewer overflows are always higher than usual, mainly caused by illegal stormwater connections to the sewer system and made worse by inappropriate objects that have been illegally disposed of into the system… The occurrence and exposure to sewer overflow incidences poses a risk to public health and environmental integrity." (City of Cape Town, 2014d)

The capacity of the sewer system, combined with the lack of, or low capacity of, the stormwater system, often resulted in stormwater entering the sewer system. This latter scenario creates problems

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[12] Hout Bay is an area outside of the Cape Flats that has experienced rapid growth in informal settlements. The geography of this area is steep mountain slopes and faces different challenges than the Cape Flats. However, this anecdote was raised as an example of the need to appropriately manage human waste in face of flood risk.

for the entire municipal sanitation system, as stormwater negatively impacts the functioning of sewage treatment. Residents, attempting to direct water away from their homes during heavy rains, often direct this water into the sewer system. In low-lying areas without adequate stormwater infrastructure, runoff flows directly into the sewer system. As such, the sewer system makes up for the lack of capacity of the stormwater system. Informants working in stormwater management reported that freshwater in the sewer system interrupts the bacterial processes needed to breakdown human waste. In some cases, it may take months to bring the treatment system back to regular function (Interview 14, Municipality).

The following quotation summarizes the relationship between flooding and urban service delivery in informal settlements:

> "I think it compromises sanitation infrastructure significantly… flooding… really undermines any long-term projects. So it's incredibly difficult to put in… bulk sewage infrastructure without initially dealing with the fact that the areas it might be put in are flooded on an annual basis. [S]o I probably situate flooding as one of the key issues that need to be resolved through… stormwater drainage systems, before one can even sort of take other infrastructural steps." (Interview 13, CSO)

5.1.2 Climate change

There was a high level of awareness across informants regarding the projected impacts of climate change in the Western Cape Province. Fifteen informants were well-versed in climate change risk and were familiar with the particular risks facing Cape Town. Of the six that were not, three were part of group interviews and relied on colleagues with greater knowledge to answer climate change related questions. Of the other three, two were CSOs with particular focus on sanitation issues in the Cape Flats, one was interviewed for their specialized knowledge of aspects of service delivery in Cape Town.

Informants felt that the city was facing a dual battle with high temperatures and decreased overall rainfall impacting water resources. Increasingly unpredictable and intense rainfall combined with an increase in extreme weather events would aggravate flooding in the city, particularly for informal settlements (Interviews 3, University/Municipality; 7, Province). This battle against two fronts was representative of the critical nature of urban service delivery for climate change adaptation. Climate change adaptation in this context requires that all residents have access to water, sanitation, and shelter to be minimally impacted in their pursuit of livelihoods. However, the challenge of mitigating flooding under existing climatic conditions was raised as evidence of the limit to the City of Cape Town's capacity to adapt to climate change. As described above, the Cape Flats have a

natural propensity to flood, along with numerous technical and social factors that increase flood risk. The pre-existing flood risks detailed above led to a frequently cited frustration:

> "[W]e're talking about managing climate change in the future but we can't even adapt to our risks as they stand at the moment. So the last thing that somebody in an informal settlement is thinking about is climate change. They're actually thinking: how can I get by day-to-day…" (Interview 1, University)

The level of awareness across departments and sectors was indicative of the awareness-raising efforts done at all levels of government. The City of Cape Town was cited as an early initiator of climate change mitigation and adaptation efforts; as one informant reported:

> "Cape Town's taking up climate change as an issue predated, to a large extent, any mandate from national government to act on climate change." (Interview 3, University/Municipality)

This informant also cited leadership, particularly within the Environment Resource Management department, as key in driving the climate change agenda:

> "I think champions have been a big part of it. It has very much been led from within the Environmental Resource Management department, the climate change agenda. Both on the adaptation and the mitigation side. And I think it is thanks, definitely, to a few… enlightened individuals who saw this as a big issue relating to the city, and have… taken it on." (Interview 3, University/Municipality)

On the other hand, informants (Interviews 1, University; 4, CSO; 16, CSO) reported that non-governmental organizations (NGOs) were not as aware of climate change adaptation as the municipality and interviews with a small number of NGOs found a lack of uptake of adaptation into NGO-initiated development projects. As one informant said,

> "I think government is more aware of climate change issues than what… NGO sector would be. The NGO sector is more addressing the immediate need as opposed to long term strategic planning, which the government would do." (Interview 1, University)

There were, however, signs that this was changing. One CSO reported:

> "[T]here is a growing recognition in the organization that we've got to deal with the climate change adaptation agenda very cleverly... So one of the interesting things that emerged … which was very enlightening for me… do you know that they're starting a big adaptation fund…in Kwazulu-Natal [province of South Africa], this massive fund that's being done through SANBI, South African National Biodiversity Institute." (Interview 16, CSO)

Two issues that arose in relation to NGOs and climate change adaptation were: 1) the opportunities offered by new funding sources that focused on adaptation, as the quote above shows; and 2) the realization that development efforts such as informal settlement upgrading were adaptive, particularly when they reduced flood risk and other environmental hazards. The informant described meeting with an adaptation expert:

> "[T]his guy told me that when he came to Langa and looked at our flooding solutions and sanitation solutions, saying this is not upgrading guys, this is adaptation stuff…" (Interview 16, CSO)

This informant reported that it was only through contact with climate change experts that the links between adaptation and informal settlement upgrading became apparent. Though CSO informants were less aware of climate change impacts and had not yet incorporated adaptation as an explicit strategy, the link between development and climate change was well-established. As was criticism against the formal approaches conventionally adopted by the municipality:

> "[T]he only way you can deal with climate change adaptation is if you don't make the same mistake that urban planners have made. Urban planners have always… gone ahead with big national policy, provincial policy, local policies, it's very policy top-down driven like that. Unless there is a very strong program that sort of builds the capacity of communities to deal with that locally, you can't deal with this climate change issue at all. It's not going to work. So they were all talking about NAPA's[13] and those kind of things. And that was just like, it's just way out there. You don't know [how] South Africa works at all!" (Interview 16, CSO)

This quote expresses the frustration of many, both internal and external to the City of Cape Town, with the limited tools at their disposal to deal with adaptation in informal settlements.

The knowledge and vocabulary of climate change are also beginning to trickle down to residents. An interview with an informant who regularly conducted community risk assessments showed that awareness of climate change was spreading:

> "[P]eople… are really scared about the future and they're talking about and using the words climate change. And I'm talking about poorly educated people living in informal settlements and they're actually starting to use the term now." (Interview 2, University)

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[13] NAPA: National Adaptation Programmes of Action are advocated by UNFCCC for developing countries to identify adaptation priorities. In response, South Africa published a National Climate Change Response Strategy in 2004 and a National Climate Change Response White Paper in 2011. Note, the former does not mention informal settlements, though the latter highlights the particular risk informal settlements face due to poor services and increased risk of flooding due to inadequate stormwater systems.

The impression I came away with during interviews was that climate change appeared to be an accepted reality in the Western Cape. One reason for this was reported to be relatively consistent projections for the region, unlike in other places.

> "[A]ll the climate models, in terms of predictions around climate, for the Western part of the country… there's a lot less variability between the models, so we can be a lot more certain about the climate predictions, whereas the other parts of the country is a much greater variability so, and that's the whole issue about planning in the face of uncertainty. It's our uncertainty band, it's still massive, but our uncertainty band is a little bit narrower than the rest of the country. So we can kind of definitely say it's going to be hotter, it's going to be drier, more intense rainfall events, more frequent." (Interview 7, Province)

This level of perceived certainty supports the uptake of climate change projections into a variety of policies and plans, though implementation is a major issue. Only one informant expressed skepticism at approaching climate change with urgency:

> "[T]he whole concept of climate change as you know is very debateable. You have on the one hand, Mr. A saying no, it's not significant, it's actually not so bad. And on the other hand, you have the other experts, etc. So we have to take into consideration economic implications as well because if we're going to, if it's going to be a scare thing, etc., are people going to go into a panic mode? We have to be very careful and sensitive at the end of that." (Interview 17, Municipality)

This awareness of climate change impacts has influenced the way that water management, particularly flood and stormwater management, and related infrastructure are approached:

> "We're looking at how the stormwater drainage network needs to be altered to accommodate more intense rainfall events. So it is very much raising an awareness, I mean there is a good awareness that, you know, things are not good enough as it stands, but that we face increasing risks as a result of changing rainfall patterns, specifically in relation to flooding, and therefore we need to try and build those considerations into the development plans, the spatial and land use management plans that the city has." (Interview 3, University/Municipality)

> "But then also in terms of rainfall intensity, the more intense your rainfall, if our sewage networks and our stormwater networks are already over-capacitated, and we can't cope with the surface runoff now, you know, how are we going to cope with surface runoff where you know your rainfall intensity is increased? And if your development continues then surface runoff is going to be more as well." (Interview 1, University)

Flood risk increases with all forms of development, not just informal. Without implementing adequate stormwater systems, flooding in dense areas is inevitable, as the discussion of permeability in Chapter

2 highlighted. Climate change increases the burden on a system many reported was already unable to cope with seasonal flooding:

> "[S]o there's awareness that currently we're not doing enough to avoid some of the impacts of flooding, and that these might be further compounded or aggravated into the future." (Interview 3, University/Municipality)

> "Our informal settlements, the way they're currently situated, they already can't cope with normal flooding events. So flooding is starting to be, yeah, more intense, more frequent, and creating quite a lot of damage." (Informant 7, Province)

One major area of concern was the conflict between acknowledging climate risk in informal settlements, and planning and executing an adaptation strategy at the scale of need. As one informant reported:

> "I think there's more and more of a realization that if you upgrading informal settlements and providing low cost housing without taking climate change into account, you're actually doing it irresponsibly." (Interview 7, Province)

This respondent worried that continuing the current approach to formalizing informal settlements without integrating climate change into plans and designs would be detrimental in the long term. This is corroborated in the literature which points to low quality materials and construction in many subsidized housing developments (Newton, 2013)

5.2 RQ2: Response options

2. <u>What sewage and sanitation options are available to cope with increased flood events and changes in rainfall patterns due to climate change?</u>
   a. <u>What long-term sanitation infrastructure is needed to promote resilience to flooding under climate change?</u>

As discussed earlier, South Africa's rights-based approach to basic services motivates the focus of this thesis on government actors. This section will focus on the role of the municipality, in conjunction with other actors, in supporting urban service delivery, flood mitigation, and climate change adaptation. However, Chapter 6 will engage in the conflict between a rights-based approach for informal settlement residents and the constraints of public provision of housing and services within a market economy.

The climate change adaptation agenda has been primarily championed by the administrative arm of government, particularly at the City of Cape Town. In addition to being the locus of policy-making and intervention, local government is the key player in the provision of housing and services.

Though national and provincial government play a crucial role, particularly in terms of funding and mandate-setting, it is the municipality that is expected to respond to community needs and bears the brunt of criticism (Nyar & Wray, 2014).

5.2.1 Climate change adaptation options

Informants responded that climate change was a great threat because it held the potential to increase the occurrence and intensity of flooding. Informants from the municipality expressed an understanding that climate change adaptation required more than flood barriers and stormwater drains: in situ upgrading and resettlement were often cited as the only long-term solutions to existing flood risks and those posed by climate change, both due to the nature of the problem and the ineffectiveness of interim responses. However, while more holistic strategies such as these were often cited as necessary, few informants expressed hope in the reality of such an approach. Speaking to an informant from the Informal Settlement department, I asked, "Do you anticipate that [climate change] would increase the urgency that informal settlement upgrading is given?" They responded:

> "No, we can't. Although we would love to do more, there's only so much that we can do… [T]he city of Cape Town gets a budget for human settlements [from national government]. And we spend that budget every year. So, we might be able to do more, but we do not have the funding for that. And that's our problem." (Interview 10, Municipality)

Informants discussed climate change adaptation, flood mitigation, and development fluidly in regards to informal settlements, demonstrating the interconnectedness of risks *and* responses. This challenges the UNFCC definition of climate change adaptation which narrowly defines adaptation as a response to anthropogenic climate change specifically (climate change as an "additionality") (Ayers & Huq, 2009). However, in the context of large development deficits, informants could not discuss adaptation to climate change without integrating existing needs and risk factors. In this section, actions taken by the City of Cape Town in response to climate change as an "additionality" are explored first. This is followed by a detailed overview of interconnected intervention options and strategies that were cited in response to the impacts of climate change in informal settlements.

The City of Cape Town first published its Framework for Adaptation to Climate Change in the City of Cape Town in 2006. Considered an early adopter, informants noted that Cape Town's efforts spurred action in other cities, particularly Durban. In 2011, Moving Mountains: Cape Town's Action Plan for Energy and Climate Change was published. In 2012, a review was conducted and sector-specific plans were created, though informants reported that implementation has been hampered by

budget constraints. The sectoral plan for water and sanitation warned of increased rainfall intensity (defined as >100mm/24 hours) and potential seasonal changes. Potential impacts were cited as:

a. "Increased inflow and infiltration of stormwater into wastewater networks and increased chance of damage to wastewater infrastructure, including risk of overflows and contamination from the sewer system. Very high flows received at the wastewater treatment works can lead to overflows, a loss of the active bio-mass and in an extreme case to process failure and pollution to the environment.

b. Increase in peak flow rates and system flooding leading to vulnerability of reticulation infrastructure, bulk pipelines, sewer systems, etc.

c. Water supply insecurity due to changes in annual average runoff.

d. High intensity short duration rainfall events resulting in increased runoff and decreased infiltration reducing aquifer yield, thus reducing reliability of groundwater supply. It is likely that high run off rates will contain a larger silt loading that would adversely impact the rate of infiltration and thus groundwater recharge.

e. Increase in flood intensity in the event that dam overflow structures are under-designed to accommodate the high intensity rainfall events.

f. Change in location of rain falling – lead to water supply insecurity." (City of Cape Town, 2012a)

Table 4 outlines adaptation options recommended in relation to stormwater and sanitation issues created by changes in rainfall.

The City of Cape Town has also been very successful in integrating climate change adaptation into a number of other plans such as the Spatial Development Framework (SDF) and master plans for the catchment areas. They represent climate change mainstreamed into the conventional planning process and demonstrate significant progress in the uptake of climate change concerns within the municipality. Plans such as the SDF are also significant in that they outline the land use planning guidelines that the city uses to direct growth and guide development. Incorporating climate change into this plan means that future development applications will be determined against criteria which includes how appropriate development may be due to impacts of climate change.

Alongside the development of CAPAs and the integration of climate change into existing policies and plans, extensive research has been conducted on climate change impacts in Cape Town. For example, a research partnership with the University of Cape Town and University of KwaZulu-

Natal (Durban) resulted in the analysis of Cape Town's rainfall trends in conjunction with climate change modelling (Interview 5, Municipality). The relationship between the municipality and local universities was highlighted as especially important in driving climate change adaptation by, for example, engaging the city in climate change research (Interview 3, University/Municipality). The partnership of academia and government extended beyond climate change research. In another case, an informant related that he was part of a standing arrangement with a local researchers to discuss service delivery approaches:

> "[B]ecause you need the academic approach but you also need to realize what is practical. And what we're trying to do is see how we can bring in the academics and enhancing the engineering components on these sites. It's a lot, it's an open robust debate but it's well recorded. And I'm 100 percent for that." (Interview 11, Municipality)

One of the major success stories of these research partnerships has been the integration of climate change projections into local policies and plans. They have in effect been mainstreamed. For example, a 15% increase in stormwater capacity has been added as a climate change buffer which impacts all future stormwater design (Interview 5, Municipality). Similarly, projections were incorporated into flood modelling that determines flood lines:

> "[T]he policy itself hasn't changed, obviously with bringing in the climate change factor, that has changed the flood lines. So now the area that's impacted by the policy is now that much bigger. And so any development control that we do within those flood plains, now that area impacted is that much bigger as a result of the new flood plain delineations that have taken place." (Interview 5 Municipality)

Flood line changes are important for preventing development in flood-prone areas. This process increased the area under the 1-in-100 year flood line. However, this applies only to settlements that go through a formal development process. Informal settlements often settle in high risk areas because they cannot afford to live in formally developed areas. Preventing informal settlement in high risk areas is done by eviction through the Anti-Land Invasion Unit, a highly contentious process. Land in Cape Town is scarce. Increasing flood lines has had a negative impact on which settlements are eligible for in situ upgrading and land availability for low-income housing. As one informant reports:

> "In a flood plain, you can't do it, you've got no alternative. We're not allowed to even start upgrading informal settlements within a one in one hundred [year] flood line… That sterilizes a lot of land." (Interview 10, Municipality)

CAPAs and the mainstreaming of climate change into land use plans are a significant achievement. Incorporating climate change into the Spatial Development Framework (SDF) means that

future development applications will be determined against criteria that now includes the appropriateness of proposed development relative to the anticipated impacts of climate change. However, implementation of the adaptation recommendations shown in Table 4 has been a major challenge. Though a review was conducted in 2011, and sector-specific CAPAs were published in 2012 (Informant 5, Municipality), informants were not able to point to direct achievements of the CAPA documents outside changes to stormwater design and flood plain designation. As uptake of adaptation in cities globally has not yet taken off, this is an enormous achievement. However, as will be discussed in greater detail, the effectiveness of formal tools such as these is severely limited in informal settlements.

Interviewing about climate change adaptation was a challenge. Even informants working specifically on climate change weaved their way between climate change and pre-existing flood risks when discussing informal settlements. What emerged was the realization that "climate change adaptation" in informal settlements may be a misnomer. Time and again, though well-versed in the climate change projections for Cape Town, informants raised the problems associated with a lack of adaptation to the complex flood risks that already exist. However, as currently constructed within the UNFCCC, adaptation refers to climate change as an additional and separate threat (Klein, Schipper, & Dessai, 2005). As this thesis has strived to show, preparing for climate change means addressing multi-faceted risks. Some authors have argued that adapting to climate variability *in general* supports climate change adaptation because it increases the buffer available to a community to withstand shocks (Ribot, Najam, & Watson, 1996). Therefore, while the section above discussed municipal actions taken to adapt to climate change as defined by the UNFCCC, answering RQ2 takes us beyond climate-change specific actions. I now turn to non-climate change specific flood adaptation strategies identified throughout the interviews.

Table 4 - Adaptation recommendations

	5.3 Wastewater Conveyance and Treatment				
	Adaptation measure	**Projects/details**	**Research/monitor**	**Institutional**	**Project status**
5.3.1	Design and implement techniques to reduce the inflow and infiltration rate from stormwater systems into wastewater systems.	Install rubber-seal manholes in low-lying flood-prone areas.	In conjunction with Stormwater, model increased stormwater volumes and how this would impact on wastewater systems.		Efforts to reduce current infiltration already underway
5.3.2	Consider predicted climate changes and ensure that all new sanitation infrastructure is located out of high risk areas.	Ensure that all new pipes and supporting infrastructure are located well out of flood and sea level rise risk areas.		Consult City's existing risk and vulnerability listings – e.g. Sea Level Rise study (Phase 5); Catchment Management flood guidelines; etc.	
5.3.3	Consider predicted climate changes and ensure that all new sanitation infrastructure is designed with / for projected climate change specs in mind where possible.	Ensure that climate change specs are incorporated into all new infrastructure where practical.	Research design specifications that could withstand projected climate stressors.		
5.3.4	Update response plan that addresses infrastructure failure as it relates to water reticulation and wastewater treatment and disposal.	Risk Assessment and Mitigation as part of the Blue and green drop programmes		Incident Protocol, Water Safety Plan; Participate in Disaster Risk Management Task Team (Flooding & Storms and Critical Infrastructure)	
5.3.5	Conduct a climate change risk assessment of all existing sanitation related infrastructure.	On the basis of this risk assessment, plan the relocation of infrastructure currently at risk.	Research which infrastructure to prioritise and thresholds to determine when to relocate.		
		Infrastructure that cannot be relocated for economic or infrastructure reasons should be evaluated for protection measures.	Determine decision support tool to assess which infrastructure to relocate and which to protect.		
5.3.6	Evaluate alternative wastewater treatment systems for sludge handling	Consultants busy with identifying suitable technologies, siting of same and environmental impacts.			
	5.5 Education, Communication, Awareness and Capacity Building				
5.5.2	Promote and encourage the implementation of water sensitive urban designs through effective communication and education programmes.				

Source: City of Cape Town, 2012a, pp. 13–14

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5.2.2 Flood responses

> "[W]here you find people that settle in areas that are known to flood, how do you service an area like that?… It's a very sensitive issue … because once a community starts settling, there's no means of providing them with an alternative. It means that you've now got to provide the service there. So, it may become more expensive, becomes a budget thing. But the undermining is the physical conditions, it's the geography, lay of the land, which eventually, if you have flooding then you have flooding. So very physical." (Interview 12, Municipality)

> "The solution towards the flooding within the settlement, because there's nothing that exactly we can do. Because if a person is build his shack or his house in a pond, the pond is designed for the water to go there." (Interview 15, Municipality)

Flood responses in informal settlements ranged across two spectrums: formal (planned) and informal (autonomous) responses. **Informal flood responses** refer to the ad hoc strategies employed by informal settlement residents. While there were a number of informal responses to flooding identified, I was surprised to hear most of them were considered negatively by informants. However, these responses appear to be, for the most part, used only when residents see no alternative.

The first response for residents facing flooding may be staying with friends or family, something that officials also depend on:

> "So we might get in and then we feel the water inside the shack is…15 centimeters up, we feel that that person cannot use his electricity within it. So we say, fine, you people don't have to cook, try and look for accommodation within the neighbours. They're very good in accommodating each other when another person is in trouble. And then we'll cook, give them hot milk for that period time." (Interview 15, Municipality)

Residents may also dig small canals that can direct water flow away from one's home.

> "[The]…community do try to do something but they are not working as a team because you'll find that it's just an individual that is digging up a trench to lead the water to pass away from their shack, just to prevent themselves from getting flooded. But that, you'll find, that is flooding another shack that was not supposed to be flooded, that is not on the same level as him. And then you'll find that now, by digging up this trench, to, and leave it half way, you're flooding this one, and the other is going to take it to another one and flood another one. And then you just spreading flooding, and then instead of having a certain group of shacks that going to be flooded, say 10, you end up having 50." (Interview 15, Municipality)

Small-scale canalization may be successful but it may also direct water to other people's homes or to areas that do not normally flood, thereby spreading flood risk. Another flood response used by residents is filling in puddles with sand in order to make pathways walkable. This strategy was

criticized by a number of respondents because it has the adverse effect of lowering the floor level of homes in relation to paths, thereby directing even more water into homes (Interview 15, Municipality).

For those living in high risk areas such as wetlands or ponds where water naturally accumulates, residents have also been reported to construct barriers to keep water away from their homes, using sandbags or tires. However, informants reported that many of these informal actions were counter-productive in the long term. For example, efforts to reduce flooding by depositing sand or building flood barriers around wetlands degrades the ecosystem over time (Interview 16, CSO).

Such strategies have the adverse effect of harming the ecosystem and potentially reducing the ecological services—such as absorbing runoff and filtering water—provided by that ecosystem within the greater area. Informal flood response strategies are normally ad hoc and concerned with preventing immediate damage or inconvenience. Though informants were asked if they were aware of any flood response strategies initiated by residents or communities, no strategies were identified as improving flood coping. However, one informant expressed the problem with this knowledge gap:

> "I haven't heard of initiatives like that…But it may well be possible. I think one forgets, and the city often forgets, that residents are incredibly capable and often incredibly skilled, and incredibly empowered to identify what problems are and to report them. And to sort of act on them. And the city perhaps doesn't capitalize on that enough. But in terms of specific efforts to almost compensate for the city's deficiencies, I haven't heard of [that]..." (Interview 13, CSO)

Many of these ad hoc strategies stem from recommendations from the municipality (

Figure 11).

Figure 11 - Advice for residents
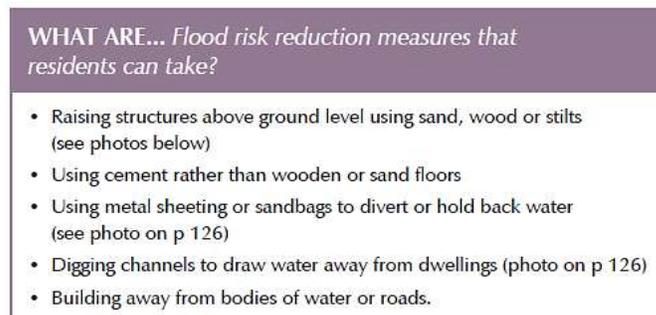
Source: Holloway et al., 2008, p. 125

Formal flood responses are those managed by the City of Cape Town or NGOs. The major flood mitigation policy for the City of Cape Town is the Winter Readiness Programme (also called Winter Preparedness Strategy) initiated by the Disaster Risk Management Centre (DRMC). The Programme was often cited as a milestone in Cape Town's flood mitigation efforts and resulted in lowering the number of residents impacted by flooding each year; many of the strategies identified below stem from this document. However, unlike most policy and planning documents at the City of Cape Town, this one is for internal use only, even though this strategy is widely publicized ahead of the winter season by the municipality. Due to the lack of access to the full document for 2014, informant quotes regarding the Winter Readiness Programme are cited in conjunction with the City of Cape Town's 2014 media release detailing the Programme actions.

Flood mitigation begins with pre-winter public education. The Environmental Health department, in collaboration with the Disaster Risk Management Centre, is primarily responsible for conducting a public education campaign on seasonal flooding (Interviews 14, Municipality; 15, Municipality):

> "As part of this preparedness programme, residents are given practical tips on how to raise floor levels, divert flood waters, as well as reduce health hazards associated with stagnant water. An information calendar (in English, Afrikaans and Xhosa) is being distributed to residents in high-risk flood area." (City of Cape Town, 2014d)

The Winter Readiness Programme and informants strongly emphasize the role of residents in mitigating flooding:

> "Reducing the flood risk is a shared responsibility and the City appeals to residents to do their bit by:
>
> - Clearing out drainage systems on their properties
> - Raising the floor level of their homes so that it is higher than the land outside
> - Moving to higher ground if they stay in a flood-prone area
> - Digging trenches around the house to divert water away from the home
> - Reporting blocked rains, intakes and illegal dumping
> - Waterproofing roofs, clearing gutters and removing dead tree branches"
> (City of Cape Town, 2014d)

Informants reported challenges with public education campaigns:

"And we've been trying to educate them to look at formal housing where you will always notice that the formal house is always built… above ground. Not even level with ground level. To ensure that there is no flooding. So, obviously it's people that is not used building regulations and the reason for raising the level of your floor level, and so that's why most of them fall into the trap of building houses below the water level." (Interview 14, Municipality)

And a lack of initiative on the part of residents:

"If there's no problem, the government don't know about them. Nobody knows or tell the government to say, guys, we find ourselves into this situation because of the housing shortage, how can you help us? Let's say to prepare themselves for the long term or for the winter, for the rainy season." (Interview 15, Municipality)

The major pre-winter action taken by the municipality is clearing stormwater drains as blocked drainage is one of the biggest flood risks during heavy rainfall. In 2014, 660 temporary labourers were hired to aid this process (City of Cape Town, 2014d). However, some informants found the frequency of clearing stormwater systems to be inadequate:

"I know the city has its own pre-rain, pre-winter program of unblocking all the stormwater drains. But, I mean they do it once and if you see the numbers of people who rely on the stormwater drains for just throwing out everything… I think it just needs to be more regular." (Interview 2, University)

The municipality also shipped sand and sand bags into informal settlements that are intended for residents to raise the floor of their shacks. This was done before and during flooding as an anticipatory and immediate response strategy. However, residents were reported to use sand to fill in puddles in pathways and to make walkways more accessible. The advice for residents highlighted in

Figure 11 also recommends raising floors using stilts; however, this was not raised by any informant.

Before and during flooding, the municipality will dig ditches or channels to redirect water away from settlements. Water taps are also strategically placed on the periphery of settlements. This is because without proper drainage, even small amounts of water, such as that used domestically by households, creates pooling and damp in the settlement (Interview 4, CSO). Water must be kept out of the settlement to prevent flooding but this may make services less accessible to residents. Furthermore, the household use of water and disposal within settlements leads to ponding and greywater management issues.

The next level of flood response in areas without drainage is electrical pumps to extract the water. This was often the only option available for low-lying areas where gravity-based interventions such as canalization need a downhill slope. However, as these informants responded:

> "[W]e get the roads and stormwater [department] involved, they've got major pumps, if you can then over-pump into a lower area, where water run away. If that obviously doesn't work, because if you're in a dip, you can pump out there but you still going down so the water's going to continually seep into that area." (Interview 14, Municipality)

> "Now in the informal area, because of the lack of good drainage and the gradient in the area, you're always going to have flooding. So it's not a question of actually getting the water away, by gravity, it's actually by pumping. We've found that it had limited success. Especially with people, they set up in ponds… because of the political importance also for us to do something about it, we're putting pumps in this area to actually pump out the water. Very limited success because obviously a lot of the water is ground water so when you do pump out, just more water comes but you do have a slight dropping water in that informal settlement, uh, alleviated of the problem for some of the people but unfortunately most of the people, when it's very aggravated, they have to be relocated." (Interview 19, Municipality)

In extreme cases, residents are moved in the short term to emergency shelters or medium-to-long term, Temporary Relocation Areas:

> "When there's flooding… our immediate response to try and help and solve the problem is to look at the short term. Mostly the short term is to dig up trenches. Provide accommodation if the matters are getting worse, like at present we're using our municipal halls. We will use that, if we feel that those halls within the area, it's full up and then we can try and look at the churches, look at the schools in the area." (Interview 15, Municipality)

> "What… the city has done, is in order to be able to relieve the situation, they have identified certain open spaces, and they would then make into TRA, Temporary Relocation Areas, so they would take those people here, put them into the TRA, so that this space is now open for developing." (Interview 14, Municipality)

The only long term options to manage continual flooding in informal settlements is relocating residents settled in or near flood-prone ecological features (e.g. wetlands) or the installation of a formal stormwater management system in areas where development is possible. Table 5 summarizes flood response options across a spectrum of interventions.

5.2.3 Service delivery approach

The constitutional right to water and sanitation is expressed by minimal service levels defined through ratios (service units (e.g. taps) per number of households). Informants frequently discussed whether or not these ratios were being met. Informants from the municipalities considered this the best available indicator of whether minimal levels have been provided. However, they also accepted that a ratio system does not acknowledge discrepancies between settlements and admitted that some areas were "over-serviced", meaning they had more than the minimum required service units per number of households, while others were under-serviced (Interview 12, Municipality).

CSOs interviewed strongly criticized the ratio system as masking systemic problems and obscuring local realities. For example, one informant described how communal toilet blocks are often located in a central area that is not always accessible to residents further away. To make up for the distance, residents use buckets at home and dispose of them in the communal toilets, creating a "dual system" of formal and informal sanitation (Interview 4, CSO). This is particularly problematic as "bucket eradication" is a major priority for both the City of Cape Town and the national government (Interview 12, Municipality). Furthermore, the ratio system of service delivery also fails to account for vandalism of facilities, service disruption due to plugged toilets, or service disruption due to limited access, for example from flooding.

In addition to increasing the likelihood of residents using alternate sanitation options such as buckets, which the municipality has strongly discouraged, a lack of consideration of how residents use sanitation facilities increases the potential for violence that is often experienced by residents attempting to access services. One respondent described accessing toilets as "the most dangerous part about living in Khayelitsha" because walking a long distance to communal facilities exposes residents to violence such as sexual assault or robbery (Interview 13, CSO).

5.2.3.1 Sanitation options

The City of Cape Town has four major types of sanitation options available for informal settlements. These are: concrete toilet blocks, panel toilets, port-a-potties, and portable flush toilets. None have been without controversy but most informants identified full-flush, concrete toilet blocks as the preferred option. The viability of each of these options is dependent on settlement location and density. Concrete toilet blocks, the most permanent solution, includes water-borne sewage. They are the sturdiest option and more difficult to destroy – though toilet plugging is not uncommon, due to vandalism, misuse, or lack of servicing. However, because concrete toilet blocks require installing underground sewage, they are difficult to implement in very dense areas and are often found on the

periphery of a settlement. They require enough land to house them and to install underground sewage infrastructure. They also may require negotiations for relocation with some residents.

> "[T]he main, possibly the safest and most dignified technology that's used [is] blocks of formal, flush toilets. They're communal, they're shared by, it ranges, it's supposed to be a ratio of 1 to 4 families, 1 toilet to 4 families, that's a lot higher in some areas, and lower in others." (Interview 13, CSO)

A variant on concrete toilet blocks are concrete cast panel toilets which are used in very high density areas.

> "We've got for instance what we call "panel cast toilets". Due to the densities, [we use] panels, you carry it in, and then you erect it. Now the peoples' need to stay dry is higher than to use the toilet, so they demolish it and then they put the slabs down as walkways." (Interview 11, Municipality)

During heavy rainfall when the ground floods and water pools along walkways, informants reported that residents would break down the panels to use as a walkway. Because localized flooding interrupts the ability of residents to go to work, school, and other obligations, using panels to walk on was prioritized.

> Chemical toilets (port-a-potties) are used where installing underground infrastructure may not be feasible. Like concrete toilet blocks, they require space.

> "[W]e use chemical toilets. In South Africa, chemical toilets is a very interesting concept because some other cities just can't afford it or on a large scale, it's too expensive. When you use a chemical toilet, for instance, you must have access to service it. So mostly you will find it peripheral, where a truck can enter and suck and clean it out and the whole lot." (Interview 11, Municipality)

In areas that are extremely dense and peripheral toilets would not provide enough service for the number of residents, port-a-potties are used. These are used particularly when installing underground sewage is not an option due to densities or because the settlement is located in an area that is restricted from development—a flood plain, for example.

> "[W]here it's so dense that I can't enter like this, I have to go like this [gestures moving sideways], then you need what we call a containerized toilet so there's detergents in it, similar to that of a chemical toilet. In Europe they call them port-a-potties, by the way, chemical toilet. So then you've got a fixed structure, a point agreed with the community, and then you remove just that container and then you replace immediately with a clean serviced one." (Interview 11, Municipality)

Port-a-potties were not considered popular by informants and were highly susceptible to vandalism, such as being tipped over. Port-a-potties also require frequent servicing to maintain cleanliness and continued usage. As discussed earlier, servicing may be interrupted by flooding.

The final, and most controversial option is portable flush toilets (PFTs). These arose as an option for families to use in their own homes. PFTs are containerized toilets with a sealed portion that must be taken away and sanitized at regular intervals. These have been heavily criticized for numerous reasons. The two major ones are dignity and hygiene. As many informal settlement residents live in one room shacks, the use of toilets inside the house became a burden that many found to be intolerable. Because family members using the toilet did so in a shared space, they undermined privacy and dignity (Interview 21, CSO).

Some considered using a containerized toilet inside the house a hygienic issue (Interview 21, CSO). The small nature of shacks meant that the toilet was easily accessible to children. This informant also reported that service levels for PFTs were unacceptable and often resulted in human waste lingering for significantly longer than originally promised by the municipality. The so-called 'poo wars' of 2013, where dissatisfied residents brought PFTs full human waste and dumped them in public places such as provincial government buildings, Cape Town International Airport, and N2, the major highway, were indicative of discontent over servicing of sanitation facilities in informal settlements (Robins, 2014).

PFTs are an interesting example of unintended consequences. Speaking with informants at the municipality, PFTs were initially introduced as a response to safety concerns around using toilet blocks at night. The prevalence of rape and other forms of violence in informal settlements is high depending on the area. The municipality felt that PFTs were a solution to this problem by providing an opportunity for residents to stay home at night rather than walk to the toilet facilities. However, one informant, who was a strong opponent of PFTs, explained that the reality of one-room shacks shared by families made using PFTs humiliating for many residents (Interview 21, CSO). Discussing PFTs with the municipality, the relevant department insisted that they were an optional service in response to safety issues:

> "[T]hat's where PFTs come in and said, right, you don't have to walk in the night, it's a top up service, it's free, and it's there, if you want it, take it, if you don't want it, we're not going to force it on you." (Interview 11, Municipality)

Some respondents brought up pit latrines as one sanitation option that could not be considered in the Cape Flats. Though pit latrines are common in informal settlements in other places, they

represent the conflict between the need for basic services and environmental protection. The potential for groundwater contamination due to pit latrines was considered too high, particularly as climate change is projected to negatively impact Cape Town's water resources (City of Cape Town, 2012a; Town, 2008):

> "If you look way back, 15 years ago, the Department of Water Affairs had a program where they were looking at VIP [Ventilated Improved Pit] toilets, right. In Cape Town, because of high water tables, more often than not it's impossible to use VIPS..." (Interview 12, Municipality)

5.2.3.2 Long term development in informal settlements

Four long-term development strategies were identified during the interviews. Admittedly, I began this research project with the assumption that because of the scale and long-term reality of informal settlements like those in Cape Town, there would be some confidence in interim development strategies such as the sanitation options listed above. However, the primary conclusion that I walked away with was best expressed by the following informant:

> "There's no permanent solution unless the area is fully developed, the infrastructure is put in there and proper houses are built. That ultimately has to happen for this whole thing to be completely resolved." (Interview 14, Municipality)

In this section, I will describe the four stages of development used in Cape Town. I will conclude with a discussion of the major barriers and limitations of these approaches, particularly in the context of flooding. First, **business as usual**, or the provision of basic services with the continued existence of informal settlements. The provision of basic services is the first response to the emergence of new settlements:

> "Now the first layer of service that we provide, well the city provides, is the basic and essential services. If there's a new settlement for any reason, they will look after the basic and essential services, and that service is being rendered by utilities, water and sanitation... they will go in and they will render the first, let's call it, line of defense in service delivery." (Interview 10, Municipality).

This was described as the first stage of an incremental approach to development (Interview 10, Municipality). The municipality viewed the long-term outlook of these settlements as formalization, through one or another of the available approaches. However, there was little confidence expressed in the long-term outlook:

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"Maybe in thirty years, or forty years, they'll be able to eradicate the informal settlements, not now. Those that are where they are, they're still going to be there for a long time." (Interview 15, Municipality)

Second, **in situ upgrading**, recently gained traction in Cape Town. In situ upgrading in Cape Town is most often called reblocking for the process of physically altering the housing and street placement of informal settlement neighbourhoods to allow room for roads, underground services, and emergency vehicles. Interview 16, CSO represented a CSO that was directly involved in the reblocking process. Through the interview, this informant described the process in detail. Reblocking is a partnership between residents and the municipality, and CSOs, Community Organization Resource Centre and Informal Settlement Network, act as both partner and intermediary between residents and the municipality. The city installs all services and infrastructure, residents are not responsible for contributing to this portion of the project (Interview 10, Municipality). CSOs work directly with residents of a chosen site to create a community plan to "re-block" homes and pathways. Residents contribute financially to the top structure only, which is designed and provided for by the CSOs (Interviews 10 Municipality, 16, CSO). As part of the process, residents must break down their original shack and are not allowed to reuse the materials for their homes, though they may sell them (Interview 16, CSO). While infrastructure is installed and shacks are rebuilt, residents must find alternative accommodation with friends or family (Ibid).

Reblocking was initiated as a pilot project in Sheffield Road, an informal settlement near the N2 highway in Philippi (Figure 7, top-left corner of outlined area) in 2010 (Interview 16, CSO). The pilot aimed to demonstrate to the municipality the potential for a community-led planning process with residents contributing some funding. The pilot improved service delivery substantially but the speed at which it was implemented resulted in poorly implemented flood risk reduction. The CSOs involved also reported initial difficulties generating community ownership and financial contribution. As such, the CSO and municipality learned from the pilot project lessons that they brought into later iterations (Interview 16, CSO). It was considered by many informants as the most promising innovation to flood risk and service delivery challenges in informal settlements.

However, there were a number of barriers scaling in situ upgrading to the population of informal settlements:

"But it is… relatively small scale. There's no way you can do it in big settlement of say a couple of thousand structures…You would have to de-densify first. Find alternative land, repair that land, take some of these people over there, and then on that cleared space you can do some work… That's the only way that you can

do it. And that is, of course, where you can do it. In a flood plain, you can't do it, you've got no alternative." (Interview 10, Municipality)

The last point this informant made—the limitations of in situ interventions in flood plains—highlights some of the issues with accepted approaches to informal settlements. There are many locations that are not acceptable for development. Recommendations for in situ upgrading or granting tenure to such residents does not provide the expected benefits.

Regardless of the positive impact of reblocking, it is an interim response, continued but improved informality, while residents waited for a formal house:

"[N]ow reblocking is the reconfiguration of an existing informal settlement… we move the structures around, we re-block them, and we improve the lives of the people of that informal settlements, whilst they are waiting for a formal opportunity." (Interview 10, Municipality)

Third, **incremental development areas**, a less talked about option. Through this, the city provides underground infrastructural services and residents are able to occupy a piece of land and build their own structures on top. In many cases this means continued informality but, in theory, allows the neighbourhood to incrementally formalize. By providing underground structures prior to informal settlement, formalization is made significantly easier. The most difficult problem of servicing informal settlements is retroactively installing underground services as this requires large-scale relocation of many residents. However, incremental development areas are difficult to establish in Cape Town due to lack of available land.

The final option is **resettlement** into formal housing. This is the most established and high demand option. The subsidized housing program which holds the promise for many their first formal home and, for some, restitution for the legacy of apartheid and years living in informal settlements. The backlog for subsidized formal housing is enormous throughout South Africa. In the long term, formalization appears necessary to achieve better service delivery and reduce flood risks. Informality restricts the range of options available for residents in terms of water and sanitation and precludes providing individual toilet facilities for each household.

Table 5 - Summary of response options

	Emergency response	Managing risk	Long term solution
Sanitation	PFTs, chemical toilets	Panel toilets, concrete toilet blocks	Formal housing with household toilets
Flooding – formal	Pumping, flood and blanket packets, emergency shelters	Clearing drainage, canalizing, increasing floor level with sand	Formal stormwater system

Flooding – informal	Staying with friends/family	Raising floor levels with sand or blocks; constructing barriers around ponds/wetlands (e.g. tires)	Transitioning into formal housing
Housing	Basic service delivery (business as usual)	Incremental development areas (IDAs), reblocking (informal with formal underground infrastructure and road access)	Resettlement into formal housing

5.2.4 Policy approach

Though flooding is a persistent issue in informal settlements, these settlements are often considered temporary or transitional within policies, despite many having existed for decades (Interview 13, CSO). The long-term goal is the transition of informal settlements dwellers into formal housing and this is reflected in the history of South Africa's informal settlement policy. However, informants were adamant that informal settlements were a long term reality for South Africa (Interviews 15, Municipality; 13, CSO)

The responses to informal settlements are often formalization or relocation which leads to the perception that they are temporary or transitional in the housing process. The result is that two main approaches exist: flooding and other emergencies are dealt with on a disaster relief or risk management basis; long term residence is dealt with through resettlement into formal housing or upgrading. However, one informant identified a major problem with this approach:

> "[I]t definitely is a kind of missing middle – it doesn't really tackle the reality many of these informal settlements are here to stay, they might be growing in fact, they themselves are densifying and many of them are, almost on an annual basis, affected by flooding." (Interview 3, University/Municipality)

This dual approach does not necessarily address the systemic nature of informal settlements.

Another informant pointed to the lack of housing opportunities, not only through the subsidized housing program but through the market as well (Interview 4, CSO). This informant also argued that due to the barriers of entry to the formal housing market, and the lack of housing opportunities in general, the demographics in informal settlements were changing:

> "Now what that does it starts to create a kind of very dual city where you've got the kind of middle income which is also struggling to afford but can still afford to access bonds and housing. And then you've got your, kind of, not your poorest of your poor, people, sort of, earning between, sort of, 3, 5 and even 12 thousand rand, now sitting with no options at all. So, you've got a whole lot of people who are either going into rental, backyard rental or into informal settlements." (Interview 4, CSO)

Conceptualizations of Cape Town as a dual city and one of stark inequality were raised primarily by informants from universities and CSOs. Though municipal staff are well aware of issues of systemic poverty and the legacy of apartheid, they rarely referred to inequality or the contrast between formal and informal areas, outside of reference to technical constraints. Municipal staff were also much more concerned with economic pressures driving people from rural areas to Cape Town.

Emerging from discussions with informants was the widely held view that policies and plans were of critical importance for positive outcomes. All municipal staff interviewed regularly referred to municipal policies such as the Integrated Development Plan and the Spatial Development Framework. These formal documents are important in guiding the work of each department. However, they face numerous barriers to implementation. Though a policy may be published, policy goals have not necessarily been formally mandated and budgeted for (Interview, 7, Province). Without a formal mandate and budget line, it is unlikely that a policy can be implemented. This was a major problem with Cape Town's CAPA documents. The second major barrier is the use of formal tools in informal areas. Spatial development guidelines and urban planning practice as conventionally employed are often in direct conflict with the reality of informal settlements, especially those on the scale of the Cape Flats. A third barrier to implementation was delegation of responsibility and cooperation (or lack thereof) among different levels of government.

5.2.5 Role of municipal departments

> "I will say that the City of Cape Town's Disaster Risk Management Centre is probably, I'm not sure, but probably the most well-capacitated Disaster Risk Management Centre in Africa, probably. They have more staff than what national has, in South Africa." (Interview 1, University)

Cited as the most developed function of local government, the Disaster Risk Management Centre (DRMC) was the primary body responsible for immediate flood response. Their role varied from pre-winter education and awareness-raising, weather warnings, provision of food and blankets, and emergency shelter during flood events, to coordinating with the Human Settlements Directorate and other departments when flood areas required residents to be relocated. They played an important role in managing flood risks and have led the way of integrating climate change adaptation into local planning. Specifically, the department created the Winter Readiness Programme, which is the main tool for anticipating and responding to flooding in the City of Cape Town. Though the Programme covers the entire city, informal settlements play a prominent role in the document.

Though DRMC has been commended on its capacity, it has been criticized, along with other municipal departments, for taking a reactive approach to informal settlements. This criticism was also directed at a number of functions such as waste management, sanitation service, and roads and stormwater. Rather than planning, many informants found that the municipality was coping with, rather than anticipating, flooding and service issues. This presented a major obstacle for them in terms of climate change adaptation, as many considered this to be inherently proactive.

One of the other major barriers to adaptation and flood mitigation is capacity, with capacity unevenly distributed across departments. The Disaster Risk Management Centre was regularly commended for its work and the high level of resources devoted to municipal disaster risk functions. However, in terms of climate change adaptation, and addressing other systemic issues in informal settlements, capacity was severely restricted by lack of funding and a lack of formal mandate.

While climate change awareness appeared to be high in all departments interviewed at the City of Cape Town, adaptation is subsumed under general informal settlement development or stormwater management. Though certain adaptation actions have been taken, for example, increasing flood lines, no actions appeared to directly address informal settlement risk. Rather, many expressed that in situ upgrading or formal housing resettlement were the only long term hopes for adaptation. This challenged many of my assumptions, which were based on secondary literature readings, of this project.

The main takeaway from interviewing City of Cape Town staff and other stakeholders such as university researchers and CSOs was that adaptation in informal settlements must be mainstreamed into existing service delivery and development programs. Because of limited funding, any adaptation efforts must respond to multiple problems to be politically salient, not just climate change risk. Finally, increasing resilience was equated with formalization. None of the informants offered an alternative scenario to formalization. Rather, it was widely acknowledged that informal settlements are risky and will stay risky until the municipality or some other actor is able to intervene.

Though informants did not imagine a future where informal settlements could be places of safety and resilience, a number of alternatives were proposed to the current mechanisms for service delivery and housing. The informal settlement directorate, in collaboration with numerous other departments involved in service delivery and housing in informal settlements, were excited about a new program monitoring system they referred to as the Development Matrix. This Matrix would streamline the informal settlement upgrading and housing subsidy process. Through calculation of waitlist time, risk factors, and other inputs, the Matrix would allow different departments to prioritize

their effort from basic service delivery to formal housing. This system is hoped to help the city alleviate the pressure of numerous demands on municipal resources by filtering requests through prioritization. It is also hoped that the Matrix would be a source of transparency for the municipality in communicating with residents. By systematically understanding when service delivery and housing would be provided, informants hoped they would be able to provide more accurate information to residents and reduce conflict. However, one NGO strongly critiqued the Development Matrix for taking too long to develop and potentially being out of date as soon as it was launched.

> "[T]he city keeps developing these matri[ces], [this] development matrix...is just full of rubbish. By the time they develop it... the settlements dynamics have changed and they actually are two years behind." (Interview 16, CSO)

This comment reflects the pervasive attitude that informal settlements grow and change so rapidly that efforts to keep track of changes and interventions are futile or continuously frustrated.

Several of the university researchers and CSOs interviewed expressed the need for more community-driven processes. One major component of this was community risk assessments, conducted in conjunction with residents. This was particularly important as many felt that aggregate data, such as proxy statistics for flood victims, were inaccurate. Such a process is also intended to empower residents with information on their own risks and inclusion in the decision-making process:

> "We've found that when we do these risk assessments, the volunteers in the room come to a common, shared understanding that they can be part of the solution." (Interview 2, University)

Another alternative that has been used successfully by one NGO interviewed was savings collectives. Many of the interviews suggested that residents of informal settlements were unable or unwilling to contribute to services or housing. However, the case of reblocking demonstrates that this is not an accurate perception. Discussing the process of reblocking, one informant said:

> "[W]e were really being able to show precedent scale, the community contributing R160 000 for a community that wasn't even willing to put a rand on the table..." (Interview 16, CSO)

Savings collectives were regularly used by one of the CSOs interviewed to pool community resources for development efforts. Though many informal settlement residents are poor, it appeared that residents were open, when able, to contributing to projects that would benefit their neighbourhoods and quality of life (Interview 16, CSO). For example, all reblocking efforts thus far have included a community contribution, an outcome that appeared to surprise municipal staff. This also points to

problems with the perception that residents are not responsible for their environments. Rather, there may be underlying reasons for residents to not engage with community maintenance that have little to do with willingness or care. Savings collectives provide an opportunity for residents to join together in making their homes and areas safer and better to live in. The process of resource pooling through reblocking also showed that it could overcome some of the social issues that plague informal settlements (Interview 16, CSO). Though more time-consuming, the reblocking process appeared to bring benefits far beyond installing underground infrastructure including bringing residents together, bridging communication barriers between residents and the city, and ensuring that investments have a long term benefit.

Criticisms of reblocking, however, focused on the inability to scale the process because of the level of engagement required and the conflict that arises when residents are chosen for upgrading:

> "What is very interesting in this thing is academically, wonderful process, when they sold it first to communities, the first community: brilliant, they love it. But then politics. If you're going to relocate and re-block me, I'm still going to live in a zinc hut, I want a brick and mortar house." (Interview 11, Municipality)

These was a general sense that more experimentation needed to happen to reduce flood risk and prepare for climate change. Informants expressed that the current processes of in situ upgrading and resettlement into formal housing was inadequate to address long term risks and the enormous scale of informal settlements in Cape Town. Opening up space and opportunities for experimentation, however, directly challenges the status quo and requires a level of coordination that many did not feel was possible under existing institutional structures at the municipality.

5.3 RQ3: Monitoring, barriers, and opportunities

3. How can the City of Cape Town define and measure successful flood and/or climate change adaptation in the context of informal settlements?

5.3.1 Monitoring

Monitoring progress in informal settlements was a major issue for informants. Four themes arose under the umbrella of monitoring: the importance of accountability, the need to track city progress, the usefulness of monitoring for staff learning, and the need for an adaptation baseline.

The major conclusion drawn from interviews is that monitoring and evaluation of both flood interventions and climate change adaptation are absent or weak. The municipality's primary monitoring and evaluation tool is the five-year corporate scorecard, the indicators used for the Integrated Development Plan. This aggregate tool was considered by some to be critically important,

particularly in terms of communicating results to the Mayor and Council. However, many municipal staff members expressed a lack of monitoring in their departments, or inadequate monitoring. One of the major challenges of monitoring the success of service delivery in informal settlements was the difficulty of measuring baseline status and changes. Many informants reported that their goals were always a moving target.

> "[D]ynamics are moving, the numbers could be correct today but tomorrow it has to be updated." (Interview 7, Province)

Others found that the measures used were proxy measures at best. For example, the number of flood victims is calculated based on how many blankets or food parcels were given out following a flood event. This was generally considered a poor measure. Municipal staff considered it an overestimate, arguing that they believed many individuals who claim emergency packets are not true flood victims but rather "jumping on the bandwagon to get free food and blankets" (Interview 5, Municipality). However, other informants argued that such proxy measures fail to account for the near-constant occurrence of localized flooding and dampness that impacted many residents' lives and that such assumptions contributed to patterns of collective blaming.

With regards to climate change adaptation, particularly the CAPA documents, one informant strongly argued that monitoring and evaluation processes were a key barrier in the process and lack of implementation:

> "[T]here's no effective monitoring or evaluation mechanism that actually keeps a track of… these, say, 82 measures laid out, where are we on each of them? Which of them are currently under implementation? Which are still on the backburner? How much funding is each getting? All that kind of stuff. We've got no way of knowing that." (Interview 3, University/Municipality)

In addition to a lack of monitoring and evaluation, this informant argued that though the city had created CAPAs, there was no prioritization and sequencing of actions that would support implementation. Recognizing that the City of Cape Town faces limitations in terms of staff capacity, resources, and funding, without understanding which actions identified by CAPAs are most urgent, and what order they should be done in, it is difficult for action to be initiated. Furthermore, a number of informants responded that a critical component of adaptation was determining a baseline measure for flood impacts in Cape Town. Without such a measure, it would be difficult to determine how resident were impacted or whether adaptation actions were making a difference (Interview 5, Municipality).

Though most informants found monitoring and evaluation processes to be lacking, they all agreed that it was critical for their work for the following reasons: accountability to Mayor and

Council, and to residents; the role of feedback in staff learning; and as data to justify experimentation or scaling up of innovative approaches. One informant, who expressed cynicism at the possibility that any intervention would be "just right" said the following:

> "[I]t's all about monitoring and evaluation and learning. So you learn that there are technical things that you can do better. There [are] social process[es] that you can manage better but there's always going to be a trade-off and one is going to take over the other." (Informant 16, CSO)

The political nature of urban service delivery and the explosive potential of disasters such as flooding made providing data to mayor and council important for informants, as well as critics. One informant responded:

> "[T]he point I want to make is that there are NGOs out there that are scrutinizing us…And so we have to prove that, yes, we run a well-organized business out of accountability, sustainability…" (Interview 11, Municipality)

Numerous informants responded that the City of Cape Town had a conservative and risk averse culture that restricted new ideas and experimentation. Monitoring and evaluation systems could help change this culture by providing feedback when things were not working and supporting evidence-based decision-making (UN-Habitat, 2009a). In terms of experimenting with new approaches, monitoring and evaluation may help provide the data needed to step outside of the box.

With regards to informal settlements, the issue of pilot projects was raise a few times. Informants reported that the city often conducted pilot projects (reblocking being one) without good monitoring and evaluation. This meant that the process and potential data generated was not used effectively to improve strategy:

> "[W]hat the city has found recently that they've spent a lot of [money] on small projects that are a little bit ad hoc, there hasn't really been a focus on a particular area that can leverage private sector investment, that regenerates and uplifts the area, they do all these little projects everywhere, and they either get vandalized or they don't have enough of an impact to, uh, to broaden outwards." (Interview 9, Municipality)

Another informant reported on an effort to consolidate adaptation strategies across the province. Monitoring was cited as one of the barriers to better adaptation:

> "Everyone is still doing pilot projects. Everyone is struggling with the same issues but on their own." (Interview 7, Province)

One issue regarding monitoring and evaluation and climate change adaptation that was passionately discussed by a few informants was the importance of keeping monitoring and evaluation (M&E) processes simple. Complicated M&E processes reduce compliance and take staff time and resources away from project implementation (Seasons, 2003). Furthermore, monitoring that requires data from informal settlement residents or CSOs presents a particular challenge. As one respondent who worked for an organization that acted as an intermediary during in situ upgrading reported:

> "Every time we try to do it, it becomes a tedious process and it's, like, we can't expect communities to fill out, like, twenty forms every time they go for a meeting… we're trying to find the right balance right now between having a monitoring and evaluation system but that's responsive enough for communities to run it."

5.3.2 Proactive vs. reactive

The City of Cape Town's approach to informal settlements was frequently labeled reactive, even by city staff. A major theme that emerged was coping vs. planning, in terms of climate change adaptation, but also as a general challenge to municipality interventions. The need for an overarching and executable strategy was a pressing issue and many called for the municipality to take a more proactive approach in terms of service delivery and flood mitigation. In terms of the latter, most recognized that budget and capacity restraints prevented this.

> "Yeah, so we deal with it mainly through the disaster risk side but there is a big awareness that the approach to flooding, addressing flooding, has been reactive rather than proactive." (Interview 7, Province)

> "So the funding from national is very reactive. So basically, once a disaster has happened, and you've lost x-million or billion in infrastructure, the province then applies to national government for the shortfall. So they fund a lot of it, they apply for the shortfall. That shortfall sometimes comes, sometimes doesn't. And if it does, it comes 3, 4 years later. We've got certain municipalities that have the same bridge washing away year after year, or roads, they know exactly what the problem is, they know how to fix it, they have the costing, but they don't have the funds to do it. So we're trying, that's something which needs to be looked at more and that's something I want to focus on in the city space is trying to look at how do you get that proactive funding in place. So that you can actually prevent disasters rather than reacting to them." (Interview 7, province)

Asked if the municipality provides flood warnings to CSOs and residents, some informants even found that it was residents or CSOs notifying the city of flood events:

> "[P]robably reverse the situation, I'd say our members occasionally come in to say their shacks are in the process of being flooded. Sometimes even by sewage, we've had cases where literally, like, raw sewage is run through houses. And we've actually had to, sort of, alert the City of Cape Town to get there, in the case of rain flooding, the disaster risk management teams out there, or emergency plumbing services, in the case of sewage issues. So I wouldn't, I don't think we receive reports from the City of Cape Town." (Interview 13, CSO)

The city was generally considered very conservative in its approach:

> "[A]nd the kind of legal structure under which the city operates that often limits, sort of, innovation and experimentation with different models for doing things that might alleviate flood risk. So the city tends to be quite conservative" (Interview 3, University/Municipality)

This is due to a number of reasons. First, the funding structure and downloading of responsibilities from national to municipal government restricts local initiatives. For municipal government to have access to national funding programs, there must exist a funded mandate for the initiative. Implementing climate change adaptation policy has been limited by this (Interview 7, Province). Though policy exists, the allocation of funding has not been confirmed, restricting access to resources. Funding for disaster is provided by national government only after the fact. Municipalities do not have the resources for large-scale proactive disaster risk reduction (Interview 7, Province). Second, the political culture in South Africa is extremely adversarial. Informants reported that the city feared being viewed as wasteful. Though the City of Cape Town was often remarked as having clean audits and excellent financial accounting, informants reported that the preoccupation with this prevented experimentation and investment in innovation projects (Interview 7, Province). The City of Cape Town and Western Cape Province area also run by the opposition party to the national government. Because of this, informants perceived that the City of Cape Town was the target of higher levels of criticism that other South African municipalities.

5.3.3 Barriers

Conversations on monitoring often led to the topic of barriers to interventions, in terms of urban service delivery, flood mitigation, and climate change adaptation. Though informants generally understood the relationship between these three priorities, addressing them together was difficult due to the scale of informal settlements and the path dependency of present approaches. Repeatedly, informants would express a sense that they were overwhelmed at the continual growth of informal settlements. Efforts to implement sanitation services, on the other hand, were often met by cycles of service failure and/or destruction. Though many municipal staff members interviewed felt that they

were slowly getting somewhere and working to continually improve service levels, others felt that there was little progress. This section examines these barriers within the holistic risk framework presented in Chapter 2 (Figure 2).

5.3.3.1 Natural factors

Geography plays an important role in available interventions. Sanitation services, flood mitigation efforts, and climate change adaptation are all limited in settlements on high risk land such as wetlands. Sanitation services require alternate typologies:

> "So I suppose some of the biggest challenges confronted within Cape Town is a number of things. One, is that a lot of settlements are not located on land that would be considered suitable for permanent upgrading. So, the city has had to, I suppose, make a decision around whether or not they're going to install full service, or full basic services, or kind of look at interim rudimentary service. And I think in a lot of instances, you've got settlements underneath power lines, in particular road reserves that are sort of sitting with rudimentary services." (Interview 4, CSO)

Flood mitigation within flood lines or ponds was reported to be impossible because of the land's natural propensity to flood that precluded upgrading. Relocation in these cases is problematic due to lack of resources and available land. Furthermore, resettling newer residents in high risk areas often provokes anger and frustration amongst longer-term residents who are in less risky areas.

5.3.3.2 Technical factors

Density is produced by social and economic factors and competition for space, but it severely restricts technical interventions. Like natural factors, density requires alternate typologies where space for services and infrastructure is limited:

> "[T]here's other settlements that could be upgraded but that have very high densities so they become further constrained. There they might have a slightly higher level of service but because of the densities, you often tend to find, rather than having those dynamite toilets, you know those plastic toilets, you now suddenly have toilet blocks." (Interview 4, CSO)

Retroactively installing infrastructure and services once a settlement has reached a certain level of density was considered a major barrier to any intervention.

Though this thesis focused extensively on the technical interventions available in informal settlements, the success of these interventions is limited without consideration of the social realities where residents live or human factors that influence how problem-solving is approached. Furthermore, the options available to the municipality for climate change adaptation are highly formal planning

tools, such as: policy-making, changes to flood line designations, and increases in stormwater design capacity. These formal planning tools have limited efficacy in informal areas that are built up without consideration for building regulations, and who are often considered illegally settled.

When promising options bridging technical and social factors did arise, as in the case of reblocking, scaling such an approach to need was considered difficult or impossible. Furthermore, though small pilot projects were cited as common, there was a lack of cohesion among projects, and it did not appear that the different stakeholders involved were learning from each other. This limits their usefulness in creating new opportunities for intervention (Interview 7, Province).

Finally, I include budget here as a major factor that impacts the success of interventions. Informants reported inadequate funding sources, funding focused on disaster relief and not prevention, and the lack of a climate change adaptation funding mandate from national government.

5.3.3.3 Social factors

The reality of informal settlements points to a lack of capacity in the economy and pressure to migrate from poorer areas into cities. Many informants cited the housing crises as contributing to informal settlement growth. Interventions to reduce flooding or adapt to climate change are frustrated with growth of new settlements and expansion of older ones. Informants felt that they were chasing a moving target in terms of providing adequate services for residents. Informality is indicative of systemic issues and will not be solved purely through technical interventions. Flooding is one consequence of the growth of informal settlements. However, to reduce flooding in the long term, the underlying issues that contribute to informality must be addressed.

Other social factors that prevent or limit intervention are social realities that make consultation both necessary and challenging. The adversarial relationship between poor residents and local governments makes it difficult for development interventions to succeed. Competition for work, housing, and resources exists within informal settlements. The high level of unemployment points to the need to link development efforts with job opportunities for residents. Furthermore, settlements are also not cohesive, but rather a mix of groups, cultures, and hierarches that are difficult to untangle. The most successful consultative approaches, such as reblocking, are highly time intensive and small scale—informants reported needing to overcome challenges such as neighbourhood strife, drug use, and other issues prior to being able to engage residents on the issue of community planning.

5.3.3.4 Human factors

Finally, human factors played an important role in how both barriers and opportunities were framed. Informants frequently placed the locus of responsibility on residents for issues such as informal flood responses and the upkeep of communal infrastructure such as toilets. The perception that residents are undermining the municipality's work was pervasive and led to negative attitudes with respect to the effectiveness of strategies. This is also demonstrative of the low levels of trust between local government and residents.

Sanitation services, flood mitigation, and climate change adaptation are seen as competing priorities, rather than contingent on each other. This is buttressed by funding structures and departmental mandates that separate goals and tasks. However, this limits the appropriateness of responses and their long term sustainability.

Though intersecting with social and technical factors, the division of responsibility between different levels of government, and challenges to inter-departmental collaboration also impact the type of approaches adopted by the municipality. Currently, Cape Town takes a reactive and conservative approach to issues in informal settlements. Efforts to transition to a proactive and experimental approach would require challenging the status quo within institutional structures.

5.4 Opportunities

A number of opportunities for climate change adaptation and better integration of priorities were cited. First, Cape Town has relatively high capacity for a municipality within the country (Interviews 1, University; 3, University/Municipality; 10, Municipality). However, to drive the agenda for better approaches in the informal settlements, one informant said:

> "I think we need some success stories and people to see what works so they can replicate it." (Interview 2, University)

The pilot project cycle cited earlier meant that while innovation was happening, those projects were not emerging as success stories to motivate further action. The example of reblocking demonstrates the power of a successful strategy to motivate further investment and action. Though originally skeptical, the outcome proved to municipal staff that such an approach could work. Though reblocking faces a number of constraints for further scaling, the excitement it generated demonstrated the need for success stories to spur further action in reducing the risks informal settlement residents face.

Many informants cited how frequently they worked with other departments, particularly within informal settlements, interdepartmental collaboration was cited as a major issue for climate change

adaptation. It appears this is one area where a concentrated effort has been made to improve collaborative structures. However, some informants did cite limitations to collaboration, particularly in the area of climate change adaptation where there was no central impetus to implement adaptation strategies. However, long-term development action, an area heavily reliant on collaboration among departments, is in many ways 'de facto adaptation'. One opportunity is for climate change adaptation to integrate into existing processes.

The inherently cross-departmental nature of adaptation was also cited as an opportunity for better governance and increased collaboration among departments. Collaboration is both an opportunity—if climate change adaptation is integrated along existing collaborative structures—as well as a barrier—should adaptation fall outside established networks.

Finally, the City of Cape Town has already integrated flood risk and climate change adaptation into numerous policies and plans, not as standalone issues but within the boundaries of existing departments and municipal functions. Though implementation is a major stumbling block, the policy framework already exists for integrating service delivery, flood mitigation, and climate change adaptation.

5.5 Major themes for future planning

This chapter has provided a detailed overview of the findings in relation to the research questions posed. Barriers and opportunities were identified for both current projects and future initiatives. This section summarizes the key themes identified for better planning in informal settlements.

First, **the relationship between residents and leadership:**

> "I mean another big disconnect is a leadership disconnect because you get grassroots leadership and the next one up is your ward councillor. But very seldom do informal communities really work with their ward councillors, they work with their own grassroots leadership structure. And if those councillors were passing on information to grassroots leaders it would get down to the community but the communities are just so disconnected from their councillors, informal communities I mean." (Interview 2, University)

Informants emphasized the distrust and poor relationships between the municipality and residents. One component of this is that elected councillors, which are expected to be the main representation and point of contact for residents, are often not trusted, or they compete with other grassroots-type leadership. This makes it difficult for municipal departments to engage with residents through official channels as those individuals may not hold much influence or esteem within the community they serve.

Second, through the interviews, there was extensive discussion on the **role of the community** itself. Surprisingly, I found that informants could not identify significant organized community-initiated responses to issues around housing and sanitation services. While some informant were in positions quite separate from this kind of on-the-ground knowledge, a number worked intimately with informal settlement communities in executing municipality-led initiatives or through community risk assessments, for example.

Another challenge was the issue of community cooperation. Many municipality staff expressed negative feelings regarding how well communities cooperate with city efforts or with each other. Frustration was expressed regarding deliberate efforts by individuals and groups to undermine infrastructure or services provided by the municipality, particularly with regards to theft and vandalism. However, this was strongly critiqued in some interviews as collective blaming. Many individuals working in service delivery capacities expressed that they felt communities were deliberately undermining their efforts. Others, however, highlighted that vandalism and theft certainly occurred but were perpetrated by individuals or small groups, not communities or neighbourhoods. Such collective blaming painted whole informal settlements as criminal and led to what some informants thought was a lack of police action against actual criminals and protection for communities that were in fact themselves victims of vandalism. The victim of vandalism was ambiguous: for some, it was the city as service provider dealing with vandalized infrastructure; for others, the community that may now have limited or no access to sanitation or other services.

Third, in regards to both service delivery and climate change adaptation, there were many concerns regarding the **division of responsibility** between levels of government. Municipal approaches to providing housing and services were constrained by funding structures whereby municipalities depend on funding allocated by the national government but distributed by the provincial government (Interview 15, Municipality). Bureaucratic procedures complicated the process for engaging with communities and getting projects off the ground (Interview 15, Municipality).

Fourth, in regards to all components of this thesis, **cross-sectoral collaboration** was cited as a major component to the success of any project. However, governance structures do not necessarily support such collaboration:

> "[T]here is a real need to move more collaboratively with residents and businesses and research institutions, and all that kind of thing. But, that, sort of institutional architecture isn't very well designed to facilitate that collaboration." (Interview 3, University/Municipality)

This is the reason reblocking was so enthusiastically discussed by informants. It created a structure and forum for intense collaboration between the municipality, CSO, and residents. Though conventional approaches to informal settlements have long required some form of consultation, reblocking appeared to set a new standard and capacity to overcome previous stumbling blocks.

Fifth, the need for **alternative approaches to planning and housing provision**. There is a major gap between housing need and the capacity of either the state or market to respond. Presently, subsidized housing is most often represented through the provision of single detached family homes. This is extremely problematic for a number of reasons. First, the City already faces land shortages with regards to identifying areas available for subsidized housing. Second, Cape Town is a sprawling city and such growth patterns are counter to planning best practices that strive for higher density, transit-oriented development. Sprawl puts pressure on local ecosystems and increases flood risk through urbanization. Sprawl also makes it harder to deliver affordable and accessible transportation to the city's millions of residents. Third, the farther new housing development are located, the more difficult it becomes for residents to access the benefits of living in an urban area and the more segregated residents become from other neighbourhoods. Fourth, this approach is fiscally unsustainable. Overall, the housing shortfall for over half a million residents points to the necessity of new approaches to urban planning and housing.

Sixth and finally, the issue of **trade-offs** emerged as the main consideration for any strategy or intervention in informal settlements. This applied to residents and the actions they took to maintain their homes and livelihoods, to CSOs and the success of their work, and to municipality actions which have consequences beyond their initial scope. One informant shared lessons learnt:

> "So, I think there are trade-offs in all of these projects and I've kind of accepted that. It's all about, like you said, it's all about monitoring and evaluation and learning. So you learn that there are technical things that you can do better. Uh, there social process that you can manage better but there's always going to be a trade-off and one is going to take over the other." (Interview 16, CSO)

5.6 Take away

- The location of informal settlements and the density of these settlements severely restricts the types of service delivery options available for implementation in situ.
- Efforts to reduce flooding or increase the quality of urban service delivery in the long term may require the relocation of some residents, initiating complex consultative processes.

- Climate change adaptation has been primarily implemented through changing flood line guidelines and improving drain capacity and clearance. Formal adaptation options are of limited efficacy in informal areas which cope with many underlying risk factors.
- Long term resilience to climate variability and climate change is imagined through different forms of formalization: particularly, in situ upgrading or resettlement.

Chapter 6 Discussion

6.1 Thesis conclusions

This thesis explored the critical intersection between urban sanitation services, flood risk, and climate change in informal settlements. Through a case study approach highlighting the City of Cape Town, the risk profile of informal settlements was unpacked with climate change identified as an aggravating factor to the natural, technical, social, and human factors of flooding. Qualitative analysis of key informant interviews was used to answer the research questions which guided this study. In this Chapter, the major conclusions of this thesis will be analyzed within the holistic risk framework in relation to the literature.

6.2 Natural factors

This study provided a detailed overview of the natural processes that contribute to flooding in informal settlements in the Cape Flats. The location of settlements near or within natural features such as wetlands and ponds raises significant barriers to the delivery of sanitation services and requires alternate typologies of infrastructure. Existing conditions include: seasonal rainfall patterns, high ground water levels, poor natural drainage, flat topography, increased runoff from surrounding areas, and the prevalence of flood-prone features such as wetlands and ponds. Flooding highly impacts services and infrastructure in informal settlements, as well as access of emergency vehicles, and prevents increasing the quality of services in some areas.

Climate change is expected to alter rainfall patterns, decreasing overall rainfall but increasing the intensity of rain when it does come (de Wit & Stankiewicz, 2011). Climate change presents such a threat due to the pre-existing challenges face by informal settlement residents and the limited options available for in situ sanitation delivery and upgrading. Extreme weather events are expected to be more frequent and temperatures are projected to increase (Midgley et al., 2005). Increased flooding is expected, though it is already considered difficult to manage and a major obstacle to development efforts.

Current development patterns, particularly unplanned urbanization, seen through the formation of informal settlements, reduce ecosystem services that may normally mitigate flooding (Ziervogel, New, et al., 2014). To preserve these services, new approaches to coping with population growth must be considered. This cannot be done without engaging residents. Cape Town has incorporated a climate change buffer in future stormwater system design and in guidelines for designating flood lines. This is

intended to anticipate increased runoff due to more intense rainfall and extreme weather events and to avoid development in high risk areas. However, increased flood lines may make more land undevelopable. In Cape Town, land for affordable housing is already scarce. There is a risk that increased flood lines have reduced that availability of land for housing. One informant questioned whether environmental hazards may be used to evict residents in high-risk areas. This points to trade-offs in climate change adaptation policy that must be considered to ensure long-term planning takes into account social justice issues.

One informant cited the potential for communities to engage in ecosystem management practices that reduce flood risk for people while rehabilitating ecologically sensitive areas that are common in the Cape Flats. One informant highlighted the importance of linking natural and social factors in environmental management:

> "[W]e're looking at [a project] right now which is very ambitious… to actually rehabilitate uh a wetland in Khayelitsha with communities that… constantly causes flooding and so on… [W}e've got very good support from the community around that kind of project… And that's where you really enter the very, very interesting space of you know, how does in-situ upgrading and environmental agenda really get spearheaded by, by the communities themselves." (Interview 16, CSO)

This informant, however, reported that numerous barriers exist to integrating at-risk communities with the environmental management process. One barrier is the challenges of legality when residents live in shacks on land that is private, ecologically sensitive and not suitable for settlement, or otherwise illegally settled. Another is the highly formal processes used by environmental planners and the dependence on expertise and top-down planning. Such processes do not easily locate community management. Table 6 summarizes possible interventions, barriers, and opportunities within natural factors of flooding.

Table 6 - Natural factors: interventions, barriers & opportunities

Possible interventions	Barriers	Opportunities
• Resettlement away from irremediable areas • In situ upgrading with major earthworks: re-leveling land, installation of stormwater system • Chemical toilets • Public education on settling in high-risk areas • Ad hoc flood preventions strategies (blocking or redirecting water) • Flood line buffer	• Most options are extremely expensive • Resettlement those in high risk areas may create conflict with other residents waiting for housing • Major earthworks and reblocking require temporary resettlement • Chemical toilets are unpopular and easily destroyed • Public education is considered	• Reblocking pilots have demonstrated small-scale success • Better use of CSOs as mediators for information and community engagement • Community-based ecosystem management

	relatively ineffective	

6.3 Technical factors:

Though there are numerous natural root causes constraining service delivery and flood mitigation in the Cape Flats, informal settlements generally lack the stormwater systems necessary to prevent flooding in such dense areas. In cases where stormwater infrastructure exists, it is often overcapacity for the number of residents served or faces frequent blockages from natural and man-made debris. Current technical responses to flooding include pumping, canalization, and clearing of drains. Residents also dig small canals to direct water away from their homes or block water from wetland spaces with tires and other barriers.

Technical factors of flooding are problematic in high-density areas, particularly informal settlements, because of issues of access. Informants reported that installing stormwater drainage requires relocating residents, temporarily or permanently. Technical interventions, though frequently cited as necessary, must always incorporate consideration for the social conditions of how people live. This includes the potential consequences of moving people away from where they have social ties, where their children go to school, and where they may have easier access to transportation and employment. The issue of trade-offs is paramount.

Reblocking was considered by many to be the most promising technical innovation for installing quality sanitation infrastructure, stormwater drainage, and road access, all which increase quality of life for residents, and reduce flood risk. These strategies also contribute to reducing the risks associated with climate change because reblocking also improves the quality of housing for residents, installs the required infrastructure to cope with flooding, and improves access for emergency vehicles in case of disaster. Reblocking also married natural, technical, social, and human factors. It involves re-levelling land in some cases to improve natural drainage and includes the installation of necessary infrastructure. Most importantly, however, reblocking requires extensive community engagement that deals directly with the social aspects of how informal settlement residents live and how they interact with the municipality. Furthermore, reblocking changed what many believed was possible, bringing in the human factor to flooding and flood interventions. Currently, it is considered small-scale and informants were skeptical about whether such an intensively consultative process could be scaled to need in a city with half-a-million residents living in informal settlements. However, experimentation proved that the process of installing technical interventions could be beneficial far beyond the immediate impacts of improved infrastructure.

In areas where flooding cannot be feasibly mitigated through technical interventions, informants cited relocation as the primary strategy. However, citizens waiting for a housing subsidy may be waiting for years or even decades before seeing any results. However, researchers, such as Pharoah (2014) have highlighted that rapid construction of low-cost housing often proves detrimental when quality and future maintenance are not considered in design. The subsidized housing program in South Africa has been mired in accusations of corruption and graft. Poor quality homes—built for quantity, not quality—have been reported to leak and flood despite having been technically 'formal' developments. Finally, homes do not come with jobs—poor residents who move into subsidized housing often find themselves with expenses and maintenance costs they had not anticipated and cannot afford. All these issues raise concerns about the sustainability of massive housing delivery programs, particularly should climate change impact existing conditions.

Furthermore, Cape Town is facing a land shortage. Already a sprawling city, mountains and oceans restrict continued outward expansion. The current practice of providing detached homes to those applying for subsidized housing was not considered to be sustainable by informants. A long term solution through high-rise development was proposed by one informant working in the Urbanization department. However, though there are mid-rise buildings built in the townships, this did not appear to be the next big policy direction.

Informal settlements exist in an otherwise economically successful city. Property values increasing in other parts of the city conflict with the idea of "illegal" settlement. The legitimacy of informal settlements to exist as they do is continuously challenged by the ideology of capitalism and property rights. Planners, water and sanitation specialists, stormwater technicians, and other professionals face a dissonance between the rules of the formal city and the reality of informality. This is further exacerbated by the limited tools available to professionals to engage with informal settlements. Zoning by-laws and building codes do little to maintain safety and standards for the 15% of Cape Town's population that cannot afford such luxuries.

The interviews conducted concluded that monitoring and evaluation of interventions was critical to addressing urban service delivery, flood mitigation, and climate change adaptation. Without appropriate monitoring, practitioners were stuck in a series of pilot projects, re-inventing the wheel continuously. In environments where resources and capacity are limited, monitoring and evaluation are needed for both practitioners and residents to learn from mistakes and maintain accountability.

However, current monitoring and evaluation frameworks are rooted in approaches better suited for developed country contexts, where even in higher-capacity arenas they are often not

properly implemented. The insights of key informant interviews concluded that M&E in the context of informal settlement must be both simple and accurate. It is not necessary to collect every bit of information possible but the key pieces must be identified to inform decision-making and monitor progress. Table 7 summarizes interventions, barriers, and opportunities associated with technical factors of flooding.

Table 7 - Technical factors: interventions, barriers, & opportunities

Possible interventions	Barriers	Opportunities
• Resettlement into formal housing • In situ upgrading (Reblocking) • Sites and services • Alternate sanitation typologies • Installation of stormwater and sewer system • Incorporation of 'climate change buffer' • Public education	• Budget • Scale • Require high level of community engagement • Lack of integration between natural, technical, and social factors of flooding • Capacity	• Existing integration of climate change into policies and plans • Changes to flood lines and stormwater design requirement are already done • Better M&E

6.4 Social factors:

Social factors inform, and are informed by, natural and technical root causes. Settlement in high-risk areas prone to flood hazard is a product of economic pressures as well as underlying social factors, such as avoiding settlement in areas vulnerable to eviction. The presence of settlement in areas exposed to these hazards are the result of a history of apartheid planning which forced Black and Coloured South Africans onto poor quality peripheral land. Existing social and economic realities in the Western Cape and the rest of South Africa continue to replicate apartheid spatial divisions as poor households are financially restricted from accessing better housing. Migration from rural areas of the Western Cape and other parts of Africa due to economic pressures are increasing informal settlement size.

This thesis referred generally to informal settlements within the Cape Flats. However, the settlements are by no means a unified whole. South Africa's eleven official languages are indicative of the diversity of the country. One informant considered the Cape Flats a city within a city due to its size and diversity of stakeholders (Interview 6, Municipality). Neighbourhoods in informal settlements possess their own social structures and leadership arrangements that impact interaction between the municipality, CSOs, and residents. Official communication channels, such as elected ward councillors, were often cited as ineffective or counterproductive to engaging residents because of pre-existing leadership structures.

Furthermore, there is not only a lack of cohesion, but outright conflict, between different areas and between residents themselves. The recent xenophobic violence that has erupted in Durban and other South African cities is indicative of the tensions over culture, race, and economic opportunities (Karimi, 2015). Housing programs and in situ upgrading target South African residents. Though this thesis did not focus on the issue of international migrants from neighbouring countries, recent events point to the critical nature of conflict within informal settlements themselves. Competition of jobs and housing is at an all-time high. The lack of trust between government and residents erodes the potential for interventions to succeed. Competition for housing allocation and job opportunities are major concerns, both because they slow the process and because they are indicative of the dearth of economic and housing opportunities.

Social practices also contribute to flood risk, most probably unknowingly. One practice that was frequently cited is that of digging into the ground during the construction of a shack. Shack floors below ground level increased flood risk as well as general wet conditions that could be felt long after a localized flooding event had disappeared. Responses to the social root causes of flood require education, understanding, and opportunities for collaboration among residents, and with CSOs and the municipality.

Reblocking was the main strategy cited as holding the potential to overcome social and state-civil society conflict. The reblocking process, as one informant reported, was personally challenging for the CSOs staff involved (Interview, 16, CSO). Social issues such as violence and drug use seemed to be an insurmountable barrier. However, slowly and through consistent engagement, the CSO as intermediary between residents and local government, was able to bring the pilot communities to the table. This process not only achieved better housing, the installation of infrastructure, and access roads, it empowered residents by giving them the tools to engage the municipality in a productive way. It also demonstrated to the City of Cape Town staff that residents were willing and able to not only collaborate on community planning issues, but contribute both financially and personally through giving their time and resources to the process.

One note about reblocking. Reblocking was a major success for the many stakeholders involved. However, the issue of residents contributing to their own development is highly contentious in South Africa. Municipal informants strongly emphasized that residents did not pay for any of the infrastructure or services rendered (Interview 10, Municipality). The reason is that a previous program for providing additional toilets to poor residents was a public relations disaster for the City of Cape Town, and eventually the national government as well. In this case, the municipality, following

consultation with residents, agreed to provide additional toilets to individual households (beyond the minimum ratio) with the condition that the City would provide the toilet and underground sewage infrastructure, while residents would pay to enclose the toilet. Though the vast majority of toilets were enclosed without incidence, roughly 50 were left open with residents claiming they could not afford to pay for enclosure. This led to very public denunciation of the City of Cape Town's approach to development and poor residents. The South African Human Rights Commission later reprimanded the municipality. This case highlights one of the challenges of working in an environment with longstanding distrust and resentment for the state.

Addressing social root causes of flooding requires political will to address the discrepancy between market and government rationalities in face of sprawling informality. Political infighting was frequently cited as a barrier to innovation in Cape Town. The municipality and province are governed by the opposition party to the national government. Party politics appeared to have many municipal staff on edge. Informants within the city and at other organizations frequently commented that efforts to avoid criticism severely limited the municipality's potential action. This contributed to an overall conservative approach, which may limit the ability of the municipality to act on pressing social and environmental crises. At the administrative level, further work is required to integrate housing, urban service delivery, adapting to environmental risks including flooding and climate.

South Africa's constitution enshrines a rights-based approach to urban service delivery. Such a configuration is expressed through demands against the state for access to water and sanitation, most often in the form of protests and/or legal action through the South African Human Rights Commission (Nyar & Wray, 2014; Roberts, 2014; SAHRC, 2014) . As such "service delivery protests" are common throughout South Africa, with Cape Town particularly prominent due to the media coverage around the 2013 'poo protest' where residents deposited human feces at the Provincial government offices in Cape Town's Central Business District (CBD), at Cape Town' International Airport, and along a major highway (Hill & Rivett, 2015).

Though there is consensus among development actors in affirming the rights of poor citizens, Patel and Mitlin (2009) argue that we must go beyond rights-based approaches to development and engage state actors for a different type of development process. Through the lens of Shack/Slum Dwellers International (SDI)—an umbrella organization that works with informal settlement residents and CSOs in Africa, Asia, and Latin America, and that figures prominently in Cape Town—the authors raise three issues with the rights-based approach that is relevant to the case studied in this thesis. First, rights-based tactics rely on legal mechanism which may be unaffordable or ineffective. Poor residents,

though legally entitled to, may be unable to claim their civil rights or counter violations to their rights because of the costs of legal mechanisms and/or because their basic survival needs preclude even considering taking such action (Kabeer, 2006). Furthermore, Patel and Mitlin (2009, p. 109) argue that "The tendency toward legal confrontation in the rights-based approach also entails potentially counterproductive methods…often involves a media campaign presenting externally validated, professionally managed documentation to the world…and confronts the nation-state or other violator". Though they recognize the importance of establishing global rights norms and the impetus international media coverage can bring on local action, such approaches also "maintain the position of the poor as perpetual victims" and undermine the impact of local action and activism (Ibid, pg. 110). Such approaches also contribute to adversarial relations between local government and residents that is difficult to overcome. One informant described the evolution of their organization's approach:

> "[I]t wasn't just about engaging local government but perhaps like taking a step forward and saying we would much rather proactively work with government rather than sort of you know stand on the sidelines and say you're not doing your job" (Interview 16, CSO)

The second issue raised by Patel and Mitlin is the conflict between individual rights and group rights where rights-based approaches tend to focus on an individualistic approach to rights. This particular issue was raised in different ways during the interview. Interventions that help some residents, but not all, frequently led to new demands against the municipality. Community-level projects came with the expectation of employment opportunities for individual residents. Also, though there are some culturally homogenous groups within informal settlements, there is significant diversity that precludes referring to informal settlements as a cohesive community. Who gets what benefits becomes highly contentious in such an environment. Roithmayr (2010) has argued for a refocusing on the commons rather than individual rights.

Finally, the third issue raised is that the needs for informal settlement residents often "go beyond simply claiming the right to this or that resource or status" and require new approaches for dealing with the needs of residents (Patel & Mitlin, 2009, p. 111). Because of this, SDI, as discussed in this book, seek more than demands against the state through adversarial relations; they seek for state actors to explore and accept alternatives to status quo development approaches and work to establish precedents for action (Ibid). Such an approach was highlighted by the reblocking process, initiated by CORC and Ikhayalami, both offshoots of SDI in South Africa. The following informant discussed the pilot project for reblocking:

> "[W]e were really being able to show precedent scale, the community contributing 160 000 rand for a community that wasn't even willing to put a rand on the table…" (Interview 16, CSO)

Roithmayr (2009, quoted in Bond, 2010) further argues that rights-based approaches dilute original claims and turn civil rights into technical or bureaucratic interventions. This may be seen in South Africa where constitutional rights are often expressed through ratios and minimal standards. She further argues that the enshrinement of constitutional rights often drowns out moral claims made by citizens that may be significantly broader than how legal rights are narrowly imagined.

Through interviews, it appeared that a major focus on rights contributed to the extremely problematic but pervasive attitude that residents make demands but do not contribute to their own development:

> "They're not prepared to do anything for themselves, they depend on the city to do everything for them." (Interview 14, Municipality)

It was evident through the interviews that reblocking challenged many notions both CSOs and the municipality held regarding the potential contribution of beneficiary residents from involvement in the community planning process to financial contributions. The critiques presented here of rights-based approaches do not counter the need for legal rights and expectations regarding service delivery and housing in poor communities. However, they do align with findings from the interview that alternative approaches to development are needed, ones that actively involve community members in the process both for initial buy-in and long-term sustainability. Furthermore, processes of engagement that go further than basic consultation also empower community members in working together to get projects of the ground as well as provide an education to engaging with the city in new ways. This is particularly important in the context of extremely tense state-civil society relations often seen in urban areas with informal settlements.

The conclusions of this thesis support the findings of other South African researchers which call for greater interdepartmental collaboration and *governance* over government (Ziervogel, Waddell, et al., 2014). Innovations such as reblocking and other measures that require cooperation with civil society organizations can support building trust between the municipality and residents. Identifying further opportunities would enhance efforts to deliver services and reduce flooding. Though more time-intensive, collaborative approaches help overcome challenges with leadership structures in informal settlement neighbourhoods. They also empower residents to learn about development options and contribute ideas and knowledge that may make efforts more successful.

Climate change adaptation must be incorporated into the implementation of not only flood mitigation efforts but into service delivery approaches in general. Increased flooding will impact sanitation facilities by either destroying them or making them difficult to service. Mainstreaming climate change adaptation is the best way to ensure that present investments last in spite of flood risks. However, climate change adaptation through existing plans and development controls are limited in their efficacy in informal spaces. Further experimentation on engaging residents of informal settlement who lack tenure or in areas where permanent tenure is not desirable or possible (e.g. within flood plains). Table 8 summarizes interventions, barriers, and opportunities associated with social factors of flooding.

Table 8 - Social factors: interventions, barriers, & opportunities

Interventions	Barriers	Opportunities
• Public education • Community engagement, partnership, and collaboration • Support for employment opportunities and the informal economy	• Political will • Conflict between political parties • Legality of settlement • Lack of social cohesion • Conflict between residents (racial, cultural, xenophobic) • Conflict between residents and the state • State violence (policing, Anti-Land Invasion Unit) • Collective Blaming	• Collaborative processes • CSOs as mediators between state and residents • Grassroots action

6.5 Human factors:

Human factors, the values and beliefs we hold that influence our approach to problems, play an important role in response strategies in informal settlements. Informants at the City of Cape Town frequently expressed that the issues their departments were addressing in informal settlements were overwhelming. Flooding is most often conceptualized within conventional approaches that focus on technical interventions to natural root causes of flooding exacerbated by unchecked settlement patterns. However, as this thesis has demonstrated, there are numerous other factors, such as our beliefs and perceptions, a play that contribute to flooding in informal settlements and reduce the effectiveness of conventional approaches.

The negative conceptualization of informal settlements within popular culture frames how municipal actors approach work in these spaces. This was demonstrated in my interviews where informants frequently speculated on the motivation of residents. Though residents may not always cooperate and some individuals or groups may intentionally destroy infrastructure, a belief that the

occurrence of these incidences is representative of all residents is problematic to overcoming the human factors that prevent better flood responses and improved service delivery. In contrast, confidence in climate change projections demonstrated that positive points of view can help motivate policy action. For all relevant stakeholders—from government staff and politicians, to civil society organizations and residents—the interview responses pointed to the ways that beliefs and perceptions of action (or non-action) strongly impact the processes that shape government programs and strategies.

Efforts within the municipality and local CSOs also pointed to awareness of the human factors that shape the implementation and success of interventions. This was seen in the success of research partnerships between local universities and the municipality, which, for example, helped to provide the data necessary to convince policy-makers of the urgency of climate change action and support the uptake of climate change into policy-making. Similarly, innovations such as reblocking seek to overcome long-standing barriers to successful in situ upgrading, accomplishing multiple service delivery goals and reducing environmental risks while building trust between government and residents. The findings of the interviews point to the need to create spaces of empowerment for stakeholders, where preconceived notions can be challenged and trust can be built. Reblocking was cited as an opportunity to do just that. Through the mediation of local CSOs, residents and the municipality were able to demonstrate commitment and follow-through and overcome negative perceptions.

In the following section, the limits of formal planning tools and the opportunities afforded by collaboration are discussed in the context of human factors to flooding.

6.5.1 Formal tools and informal realities

As an urban planning scholar, the startling conclusion of this thesis is the inappropriateness of current planning tools such as policies, plans, and formal municipal strategies in informal settlements, as well as the physical equipment municipal workers used in urban development:

> "Our department are not designed, and there are some of them are not even equipped to work in the informal settlement. E.g. the machinery that works on the road, like who bulldozes, those things, the access there is equal to two wheels of a car. Now if you want to go and have a road access for sanitation, let's say for the guy that does the chemical toilet to service those things or to install the water meters, the water standpipes in the area. It's so difficult if there's one car standing in that road. And then there's no driver. And then your service is out for the whole day. That's another challenge we're having." (Interview 15, Municipality)

The conclusions drawn in thesis, in conjunction with literature on urban planning and informal settlements, suggest that alternative approaches are needed. First, within the approaches municipalities

take in regards to informal settlements. And second, in urban planning theory and academic research on informal settlements.

Parnell et al. (2009, p. 235) take the strong stance that numerous global issues associated with inequality and resource depletion represent "the bankruptcy of current planning thinking and on-the-ground responses." At the same time, Parnell and others are arguing for a stronger, though different, role for the planning profession for the present context of global urbanization (e.g. Parnell et al., 2009; UN-Habitat, 2009a; Watson, 2009a). This starts with the 'right to the city' for informal settlement residents.

6.5.2 Cooperation, collaboration, and communication

The key findings demonstrate the critical nature of communication, collaboration, and cooperation between a diverse set of actors. The intersection of urban service delivery, flood mitigation, and climate change adaptation is inherently multidisciplinary and complex. As interviews showed, cooperation between departments and with partner organizations was crucial, though often institutional structures and policy mandates restricted the level of cooperation possible.

Furthermore, the need for collaboration with residents themselves in the implementation of any form of development intervention was highlighted frequently both as an opportunity and a source of barriers. Community consultations are intense, time-consuming processes that do not always result in perfect outcomes. Mustelin et al. (2013, p. 191) argue that while research on adaptation indicates that high participation increases the success of such projects (Conde & Lonsdale, 2005), "very few report on the complexities and difficulties in stakeholder engagement processes that clearly impact on the process and subsequent identification of adaptation priorities and strategies". This is a research gap that I would argue needs to partner with existing work on community consultations in local government and development, rather than embark specifically on a climate change adaptation agenda.

Finally, existing strategies for informal settlements faced numerous communication barriers between the municipality and residents. Informants frequently complained that residents were not listening, or intentionally undermining, their efforts at urban service delivery or flood mitigation. CSOs reported, however, that public awareness strategies (e.g. pamphlets) were largely ineffective and not engaging residents at the appropriate level. The opportunities presented by the success of reblocking pilot projects indicates that the use of CSOs as intermediary can help bridge this gap. It also points to the conflict in state-civil society relations where mediation is needed to move forward on innovative

approaches. Table 9 summarizes interventions, barriers and opportunities associated with human factors of flooding.

Table 9 - Human factors: Interventions, barriers, & opportunities

Interventions	Barriers	Opportunities
• University-municipality research partnerships • Engagement with CSOs • Experimentation in collaborative approaches	• Belief that climate change exists/requires action • Confidence in climate change projections to guide action • Formal processes difficult in informal spaces • Perception of informal settlement residents • Conflict between residents and local government	• Collaborative practices • CSOs as mediators between state and residents • Data-driven decision-making

6.5.3 Climate change adaptation and holistic flood risk

The research findings presented in this thesis demonstrate the inextricability of climate change adaptation from development, represented in Cape Town as efforts to ensure urban service delivery and housing in informal settlements. The findings support the conclusions of other researchers who argue that approaching adaptation by focusing on the additional risk factors introduced by anthropogenic climate change limits our ability to address the complex risk environment in contexts such as informal settlements. Schipper (2007, p. 10) argues, "A disproportionate focus on the impacts of climate change are obscuring opportunities for addressing vulnerability reduction. An isolated adaptation discourse is unhelpful, and threatens to be insignificant if larger development issues are not considered." The current approach centered around UNFCCC's definition of adaptation raises blinders to researchers and decision-makers seeking to protect communities from the cumulative risks of which climate change is one (Ibid). Figure 12 outlines the two dominate approaches to adaptation: one that focuses on adaptation as the starting point, the other development. Though the "adaptation approach" reduces climate change risks, it does not address the underlying sources of risk (and specifically for Schipper, vulnerability) that contribute to the potential impact of climate change.

Furthermore, Mustelin et al. (2013, p. 190) argue that as climate change adaptation has become a discipline in its own right, it has become an increasingly "self-referencing, inward-looking entity". They argue that, rather, multidisciplinary research has been the biggest success for adaptation research. This thesis grappled with the intersection of urban service delivery, flood mitigation, and climate change adaptation, choosing, to the best of my ability, to maintain the integrity of these respective disciplines. Though climate change adaptation is an overarching theme here, it would be, in

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a word, wasteful to ignore the decades of work in related fields that contributes to our understanding of working in development contexts. Schipper (2007, p. 10) argues that the inward nature of climate change research leads us to "a willingness to 'reinvent the wheel'" rather than building off the legacy of related fields.

Figure 12 - Adaptation vs. development

Adaptation Approach

Adaptation to Climate Change Impacts → Vulnerability Reduction → Development

In this view, adaptation is carried out in response to the observed and experienced impacts of climate change on society (including ecosystems). These responses ensure that the vulnerability to the impacts is reduced. This in turn ensures that less is lost each time a climate-related hazard takes place, which means risk is reduced. With reduced risk, development can be more sustainable.

Vulnerability Reduction Approach

Development → Vulnerability Reduction → Impact Reduction → Adaptation

In this view, development processes help reduce vulnerability to climate change. By reducing the vulnerability, impacts of climate hazards are also reduced, as there is less sensitivity and exposure to the hazards. This translates into a process of adaptation to climate change.

Source: Schipper, 2007, p. 8

6.6 Limitations

With any study, limitations must be addressed. Though there were many insights on social and human factors through interviews, informants focused primarily on technical solutions to flooding and the natural processes that limited ideal solutions. Though innovative technical solutions are necessary to reduce flood risk or respond to sanitation challenges, it is necessary to look beyond these to understand why even the most innovative solutions may fail when the social and human factors are not addressed. Further research would benefit from more in-depth study on the role of CSOs and the challenges facing residents. While there is significant work in this area, particularly in community-based development and adaptation, the focus of this thesis on key informants limited my ability to understand factors and responses from the perspective of residents.

This work focused on municipal efforts in urban service delivery and flood mitigation. Though governance issues are prominent, this work did not seek to identify the types of governance structures needed to support reducing risks in informal settlements and engaging residents. Though there is

significant work on urban governance and climate change, further work addressing how residents in informal settlements engage with governance structures is necessary. Formal channels of communication between residents and elected officials often fail due to grassroots leadership structures that municipal departments may not be able to adequately engage with, particularly when procedures advising otherwise exist.

Positionality in research, particularly qualitative research, must be acknowledged. As a young, white female interviewer from Canada, I also played a role in the data collection and the limits to these findings. Though I made a significant effort to orient myself to the nuances of Cape Town, I came to this research as an outsider, without the lived experience of growing up in South Africa, and especially without the experience of living in a shack in an informal settlement. I approached my role as an investigator and sought to connect the experiences of key informants in Cape Town with the literature to learn where adaptation can take place and how it could connect with underlying risks and existing strategies in a more integrated way. I began this project concerned with the possibility that informants would be skeptical of my position and that conversations might be superficial or limited to official answers, and it is quite possible that some were. However, efforts to understand the culture of the city through reading local publications, theses, and academic literature, as well as through conversations and consultations with researchers in the field, helped me navigate these limitations. As an outsider, I also brought a different perspective to the interviews. This was seen through the often startling honestly with which informants discussed the challenges they faced, without consideration for political correctness. Without a doubt, however, I believe there is an important role to be played by local researchers, and residents in informal settlements must play an active role in research in this context. Though I do not pretend to know how to further facilitate this, I do know that informal settlement residents and other poor residents in the Cape Flats are already extremely active in different forms of political engagement, activism, and development. In complex environments such as informal settlements, residents must play a greater role in the production of knowledge.

6.7 Conclusions

In this thesis, I demonstrated the integrated nature of urban service delivery, flood mitigation, and climate change adaptation. Though the four research gaps identified in Chapter 2 were addressed, questions remain. Following a discussion of the research gaps, this thesis concludes with a summary of practice- and research-oriented recommendations.

First, interviews with key informants within the municipality, province, local civil society organizations, and universities demonstrated the underlying risks that produce flooding in informal

settlements and the inability to address climate change separately from these underlying risks. Reducing flooding and adapting to climate change are intricately connected processes; the separation of these two fields undermines the actual reduction of risk.

Second, findings showed that technical interventions into flood risk in informal settlements found limited success. Social and human factors, as well as unresolvable natural factors, frequently frustrated efforts by the municipality to address flooding in conventional ways. To reduce flooding in the long-term, informants cited processes such as reblocking that required extensive collaboration with residents, and other actors such as CSOs, to overcome persistent barriers to successful flood reduction.

Third, promising innovations such as reblocking emphasized collaboration and avoiding displacing residents. However, in situ upgrading efforts, such as reblocking, were also cited by informants as problematic on a large scale due to issues of availability of space, time, and resources. The reality for some informal settlements is that their location (e.g. within a wetland) precludes in situ upgrading. In these cases, providing tenure and in situ solutions for housing and services is not possible or undesirable.

Fourth, and finally, efforts by the City of Cape Town to integrate climate change adaptation into policies and plans, though commendable, demonstrated the limited impact plan-making has in informal settlements. Unguided by formal development processes, informal settlements are not supported by new rules and regulations that seek to avoid settlement in high risk areas under climate change. However, this challenge points to the larger issue of understanding how informal settlements work in cities, how cities can plan for informality, and what tools are needed to produce a positive impact in informal settings.

6.7.1 Recommendations for future practice

1. **The importance of addressing holistic risk in climate change adaptation:** Flood risk is the result of numerous factors: underlying natural processes, technical failures, social realities, and human beliefs and values; Sanitation, flood risk, and climate change are interconnected; climate change adaptation cannot solely focus on the additional risk factors produced by climate change. Interviews demonstrated that for municipal actors tasked with providing basic services and housing in informal settlements, climate change adaptation cannot be separated from existing needs.

2. **The social and human factors which undermine technical interventions:** Available interventions to improve sanitation services and/or reduce flooding in informal settlements are highly technical, however, implementing them requires overcoming social and human factors. Social factors include:

poverty and lack of employment; economic pressure to settle in high risk areas; adversarial state-civil society relations; and conflicts within informal settlements. Human factors include: the beliefs and stereotypes about informal settlements and their residents that cloud how service providers view their work; the conflict between formal planning tools and informal spaces; and the need for overcoming potentially differing world views between shack dwellers and the professionals meant to serve them. Adaptation to climate change is as much about reorienting urban populations and their basic needs as it is about preparing for specific threats.

3. **The reality of trade-offs**: All potential interventions have trade-offs. Informal settlements residents understand this when considering whether to settle somewhere with access to transportation or employment, or whether to move farther away to avoid flooding. Informants at CSOs recognized that consultative processes are long and often personally difficult from individuals involved. Coming to an acceptable agreement with all parties involved invariably requires some priorities receiving more attention than others. Municipal informants found that regardless of what they did, they could never make everyone happy or satisfied, the scale of need is too large.

4. **The role of experimentation and collaboration**: Experimentation with technical interventions, consultative approaches, and financial mechanisms were cited as necessary to break through into helping informal settlements adapt to climate change. Existing formalized structures that require strict procedures were found to hinder experimentation. Collaboration was cited as critical in a number of areas. First among them is the need for collaborative approaches in interventions for shack dwellers. Reblocking was cited as such a crucial step forward because of the new opportunities to engage residents and move past adversarial relations. Collaboration was also critical between the municipality, CSOs, and universities, from their role as mediators and for the knowledge and information the municipality needed to make informed decisions. Finally, collaboration between departments and between different levels of government was highlighted to overcome perceived conservativeness and fear of innovation.

6.7.2 Recommendations for future research

1. **The limitations of formal planning tools:** The formal tools available to the municipality to reduce flood risk and guide land uses are inadequate or inappropriate in an informal context. Urban planning practice and theory must engage in informal spaces in ways that are outside the comfort zone of experts and technocrats.

2. **The need to theorize cities from the reality of urban spaces in the global South:** The reorientation of planning theory towards and from the global South holds the potential to bring planning education and practice 'up to speed' for success in contemporary cities.

References

Abbott, J. (2001). Use of spatial data to support the integration of informal settlements into the formal city. *International Journal of Applied Earth Observation and Geoinformation*, *3*(3), 267–277. doi:10.1016/S0303-2434(01)85033-9

Abbott, J. (2002). An analysis of informal settlement upgrading and critique of existing methodological approaches. *Habitat International*, *26*(3), 303–315. doi:10.1016/S0197-3975(01)00049-2

ActionAid. (2006). *Climate change , urban flooding and the rights of the urban poor in Africa Key findings from six African cities*. London, UK.

Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography*, *24*, 347–364. doi:10.1191/030913200701540465

Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, *16*, 268–281. doi:10.1016/j.gloenvcha.2006.02.006

Adger, W. N., & Kelly, M. P. (1999). Social Vulnerability to Climate Change and the Architecture of Entitlements. *Mitigation and Adaptation Strategies for Global Change*, *3-4*, 253–266.

Agrawal, A. (2008). *The Role of Local Institutions in Adaptation to Climate Change*. Washington, DC.

Aigbavboa, C. O., & Thwala, W. D. (2010). Lessons learned from in situ upgrading and eradication of informal settlement in Gauteng Province in South Africa. *International Journal of Housing Markets and Analysis*, *3*(3), 233–244. doi:10.1108/17538271011063898

Armitage, N. (2011). *The challenges of sustainable urban drainage in developing countries*. Cape Town, South Africa: SWITCH.

Armitage, N., & Rooseboom, A. (2000). The removal of urban litter from stormwater conduits and streams: Paper 1 - The quantities involve and catchment litter management options. *Water SA*, *26*(2), 181–188.

Ashipala, N., & Armitage, N. P. (2011). Impediments to the adoption of alternative sewerage in South African urban informal settlements. *Water Science and Technology*, *64*(9), 1781–1789. doi:10.2166/wst.2011.746

Ashley, R. M., Balmforth, D. J., Saul, a J., & Blanskby, J. D. (2005). Flooding in the future--predicting climate change, risks and responses in urban areas. *Water Science and Technology : A Journal of the International Association on Water Pollution Research*, *52*(5), 265–273.

Ayers, J. M., & Huq, S. (2009). Supporting adaptation to climate change: What role for official development assistance? *Development Policy Review*, *27*(6), 675–692. doi:10.1111/j.1467-7679.2009.00465.x

Ayers, J. M., Huq, S., Faisal, A. M., & Hussain, S. T. (2014). Mainstreaming climate change adaptation into development: A case study of Bangladesh. *Wiley Interdisciplinary Reviews: Climate Change*, *5*(4), 37–51. doi:10.1002/wcc.226

Bankoff, G., Frerks, G., & Hilhorst, D. (Eds.). (2004). *Mapping vulnerability: Disasters, development and people*. London, UK: EARTHSCAN.

Barlow, C., & Erni, B. (2014, September 25). City of Cape Town Selected by Thompson Reuters as Public Sector Jurisdiction of the Year. *Thompson Reuters*. Retrieved from http://thomsonreuters.com/press-releases/092014/city-of-cape-town-selected-by-thomson-reuters-as-public-sector-jurisdiction-of-the-year

Barnett, J., & O'Neill, S. (2010). Maladaptation. *Global Environmental Change*, *20*(2), 211–213. doi:10.1016/j.gloenvcha.2009.11.004

Béné, C., Wood, R. G., Newsham, A., & Davies, M. (2012). *Resilience: new utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability reduction programmes*. *IDS Working Paper* (Vol. 2012). doi:10.1111/j.2040-0209.2012.00405.x

Benitez, G., Perez-Vazquez, a., Nava-Tablada, M., Equihua, M., & Alvarez-Palacios, J. L. (2012). Urban expansion and the environmental effects of informal settlements on the outskirts of Xalapa city, Veracruz, Mexico. *Environment and Urbanization*, *24*(3), 149–166. doi:10.1177/0956247812437520

Berrang-Ford, L., Ford, J. D., & Paterson, J. (2011). Are we adapting to climate change? *Global Environmental Change*, *21*(1), 25–33. doi:10.1016/j.gloenvcha.2010.09.012

Biagini, B., Bierbaum, R., Stults, M., Dobardzic, S., & McNeeley, S. M. (2014). A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility. *Global Environmental Change*, *25*(November 2013), 97–108. doi:10.1016/j.gloenvcha.2014.01.003

Biggs, R., Schlüter, M., Biggs, D., Bohensky, E. L., BurnSilver, S., Cundill, G., … West, P. C. (2012). Toward Principles for Enhancing the Resilience of Ecosystem Services. *Annual Review of Environment and Resources*, *37*, 421–448. doi:10.1146/annurev-environ-051211-123836

Bond, P. (2004). From Racial to Class Apartheid: South Africa' s Frustrating Decade of Freedom. *Monthly Review*, 45–59.

Bond, P. (2010). Capitalism, the privatisation of basic social services and the implementation of socio-economic rights: Challenges and advocacy strategies for human rights and social justice actors, learning from the Johannesburg water defeat. In *International Commission of Jurists Southern Africa Socio-Economic Rights Camp: Economic Social and Cultural Rights Advocacy and Litigation*. Johannesburg, South Africa.

Bond, P., & Dugard, J. (2008). Water, Human Rights and Social Conflict: South African Experiences. *Law, Social Justice & Global Development*, *1*(February), 1–21.

Bosk, C. (1979). *Forgive and remember: Managing medical failure*. Chicago: University of Chicago Press.

Burton, I. (1997). Vulnerability and adaptive response in the context of climate and climate change. *Climatic Change, 36*, 185–196.

Cairncross, S., & Ouano, E. A. R. (1990). Surface water drainage in urban areas. In J. E. Hardoy, S. Cairncross, & D. Satterthwaite (Eds.), *The poor die young: housing and heath in Third World cities* (pp. 158–168). London, UK: EARTHSCAN.

Caldeira, T. P. R. (1996). Fortified enclaves: The new urban segregation. *Public Culture, 8*(2), 303–328. doi:10.1215/08992363-8-2-303

Capital, W. D. (2014). World Design Capitals. *www.worlddesigncapital.com*. Retrieved February 12, 2015, from http://www.worlddesigncapital.com/world-design-capitals/future-capital-cape-town/

Carmin, J., Anguelovski, I., & Roberts, D. (2012). Urban Climate Adaptation in the Global South: Planning in an Emerging Policy Domain. *Journal of Planning Education and Research, 32*(1), 18–32. doi:10.1177/0739456X11430951

Carter, J. G., Cavan, G., Connelly, A., Guy, S., Handley, J., & Kazmierczak, A. (2014). Climate change and the city: Building capacity for urban adaptation. *Progress in Planning, 95*, 1–66. doi:10.1016/j.progress.2013.08.001

Chitiga-Mabugu, M., & Monkam, N. (2013). *Assessing fiscal capacity at the local government level in South Africa* (No. 76). Pretoria, South Africa.

Chuku, C. A. (2010). Pursuing an integrated development and climate policy framework in Africa: Options for mainstreaming. *Mitigation and Adaptation Strategies for Global Change, 15*, 41–52. doi:10.1007/s11027-009-9203-8

City of Cape Town. (2009). *Winter Preparedness Strategy*. Cape Town, South Africa.

City of Cape Town. (2011a). *Khayelitsha/Mitchells Plain District Plan*. Cape Town, South Africa.

City of Cape Town. (2011b). *Moving Mountains: Cape Town's Action Plan for Energy and Climate Change*.

City of Cape Town. (2012a). Annexure A: Water and Sanitation Sector-Based Climate Adaptation Plan of Action (CAPA). City of Cape Town.

City of Cape Town. (2012b). *City of Cape Town – 2011 Census – Cape Town*. Cape Town, South Africa.

City of Cape Town. (2012c). Climate Change Leadership Awards. *www.capetown.gov.za*. Retrieved February 12, 2015, from

http://www.capetown.gov.za/en/achievementsandawards/Pages/Climate-Change-Leadership-Awards.aspx

City of Cape Town. (2012d). *Spatial Development Framwork: Statutory Report*. Cape Town.

City of Cape Town. (2013a). *Cape Town: 2011 Census Suburbs Map*. Cape Town, South Africa: City of Cape Town.

City of Cape Town. (2013b). *City of Cape Town – 2011 Census - Cape Flats Planning District*. Cape Town.

City of Cape Town. (2013c). *City of Cape Town – 2011 Census – Mitchells Plain/Khayelitsha*. Cape Town, South Africa.

City of Cape Town. (2014a). City scoops award as top municipality for water and electricity services. *www.capetown.gov.za*. Retrieved February 12, 2015, from https://www.capetown.gov.za/en/Pages/Cityawardtopmunicipalitywaterelectricityservices.aspx

City of Cape Town. (2014b). *Integrated Development Plan 2012-2017: 2014/15 Review*. Cape Town.

City of Cape Town. (2014c). Speech by the City's Executive Mayor, Patricia Lille, on Receipt of MFMA Award. *www.capetown.gov.za*. Retrieved February 12, 2015, from https://www.capetown.gov.za/en/MediaReleases/Pages/MAYORPATRICIADELILLEONRECEIPTO FMFMAAWARD.aspx

City of Cape Town. (2014d, April 30). City battens down the hatches for winter. *Media Release*. Cape Town, South Africa. Retrieved from https://www.capetown.gov.za/en/MediaReleases/Pages/Citybattensdownthehatchesforwinter.a spx

City of Cape Town. (2015). Economic Statistics. *www.capetown.gov.za*.

Collinson, M., & Erasmus, B. (2014). Rural Outmigration, Natural Capital, and Livelihoods in South Africa. *Population, Space and Place*, *420*(March 2013), 402–420.

Conde, C., & Lonsdale, K. (2005). Engaging stakeholders in the adaptation process. In B. Lim, E. Spanger-Siegfried, I. Burton, E. L. Malone, & S. Huq (Eds.), *Adaptation policy frameworks for climate change: Developing strategies, policies, and measures* (pp. 47–66). Cambridge, UK; New York, USA.

Corbin, J., & Strauss, A. (1990). Grounded Theory Research: Procesures, Canons and Evaluative Criteria. *Quali*, *13*(1), 3–21. doi:http://dx.doi.org/10.1007/BF00988593

Da Silva, J., Kernaghan, S., & Luque, A. (2012). A systems approach to meeting the challenges of urban climate change. *International Journal of Urban Sustainable Development*, *4*(2), 125–145. doi:10.1080/19463138.2012.718279

De Risi, R., Jalayer, F., de Paola, F., Iervolino, I., Giugni, M., Topa, M. E., … Gasparini, P. (2013). Flood risk assessment for informal settlements. *Natural Hazards*, *69*, 1003–1032. doi:10.1007/s11069-013-0749-0

De Wit, M., & Stankiewicz. (2011). Changes in Surface Water Supply. *Science*, *311*(2006), 1917–1921. doi:10.1126/science.1119929

Dieleman, H. (2013). Organizational learning for resilient cities, through realizing eco-cultural innovations. *Journal of Cleaner Production*, *50*, 171–180. doi:10.1016/j.jclepro.2012.11.027

Disaster Risk Management Centre. (2013). Risk & Vulnerability Map. *City of Cape Town*. Cape Town, South Africa. Retrieved from https://www.capetown.gov.za/en/DRM/PublishingImages/DRM_Map.jpg

Douglas, I., Alam, K., Maghenda, M., Mcdonnell, Y., Mclean, L., & Campbell, J. (2008). Unjust waters: climate change, flooding and the urban poor in Africa. *Environment and Urbanization*, *20*(1), 187–205. doi:10.1177/0956247808089156

Dovey, K. (2012). Informal urbanism and complex adaptive assemblage. *International Development Planning Review*, *34*(4), 349–368. doi:10.3828/idpr.2012.23

Durand-Lasserve, A., & Clerc, V. (1996). *Regularization and integration of irregular settlements: Lessons from experience*. Nairobi, Kenya. Retrieved from http://ww2.unhabitat.org/programmes/ump/documents/wp6.pdf

Fauchereau, N., Trzaska, S., Rouault, M., & Richard, Y. (2003). Rainfall variability and changes in Southern Africa during the 20th century in the global warming context. *Natural Hazards*, *29*, 139–154. doi:10.1023/A:1023630924100

Few, R. (2003). Flooding, vulnerability and coping strategies: local responses to a global threat. *Progress in Development Studies*, *3*(1), 43–58. doi:10.1191/1464993403ps049ra

Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, *12*(2), 219–245.

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., & Chapin, T. (2010). Resilience Thinking : Integrating Resilience, Adaptability and Transformability. *Ecology and Society*, *15*(4), 20.

Ford, J. D., Berrang-ford, L., Lesnikowski, A., Barrera, M., & Heymann, S. J. (2013). How to Track Adaptation to Climate Change : A Typology of Approaches for National-Level Application, *18*(3).

Ford, J. D., Keskitalo, E. C. H., Smith, T., Pearce, T., Berrang-Ford, L., Duerden, F., & Smit, B. (2010). Case study and analogue methodologies in climate change vulnerability research. *Wiley Interdisciplinary Reviews: Climate Change*, *1*(3), 374–392. doi:10.1002/wcc.48

Friend, R., & Moench, M. (2013). What is the purpose of urban climate resilience? Implications for addressing poverty and vulnerability. *Urban Climate*, *6*(4), 98–113. doi:10.1016/j.uclim.2013.09.002

Füssel, H.-M. (2007). Adaptation planning for climate change: concepts, assessment approaches, and key lessons. *Sustainability Science*, *2*(2), 265–275. doi:10.1007/s11625-007-0032-y

Geyer, H. S. J., Geyer, H. S., du Plessis, D. J., & van Eeden, A. (2012). Differential urbanisation trends in South Africa-regional and local equivalents. *Environment and Planning A*, *44*, 2940–2956. doi:10.1068/a4528

Gibbs, G. R. (2007). Thematic coding and categorizing. In *Analyzing Qualitative Data* (pp. 38–56). London, UK: SAGE Publications, Ltd. doi:10.4135/9781849208574

Govender, T., Barnes, J. M., & Pieper, C. H. (2011). Housing conditions, sanitation status and associated health risks in selected subsidized low-cost housing settlements in Cape Town, South Africa. *Habitat International*, *35*(2), 335–342. doi:10.1016/j.habitatint.2010.11.001

Hardoy, J., & Pandiella, G. (2009). Urban poverty and vulnerability to climate change in Latin America. *Environment and Urbanization*, *21*(1), 203–224. doi:10.1177/0956247809103019

Harrison, P. (2013). Making planning theory real. *Planning Theory*, *13*(2012), 65–81. doi:10.1177/1473095213484144

Hart, K. (1973). Informal income opportunities and urban employment in Ghana. *The Journal of Modern African Studies*, *11*(1), 61–89.

Harvey, D. (2008). The right to the city. *New Left Review*, *53*, 23–40. doi:10.1080/13604819608713449

Healey, P. (2011). The universal and the contingent: Some reflections on the transnational flow of planning ideas and practices. *Planning Theory*, *11*(2), 188–207. doi:10.1177/1473095211419333

Heath, T. T., Parker, a. H., & Weatherhead, E. K. (2012). Testing a rapid climate change adaptation assessment for water and sanitation providers in informal settlements in three cities in sub-Saharan Africa. *Environment and Urbanization*, *24*(2), 619–637. doi:10.1177/0956247812453540

Heltberg, R., Siegel, P. B., & Jorgensen, S. L. (2009). Addressing human vulnerability to climate change: Toward a "no-regrets" approach. *Global Environmental Change*, *19*, 89–99. doi:10.1016/j.gloenvcha.2008.11.003

Hendler, P., & Wolfson, T. (2013). The Planning and the "Unplanning" of Urban Space 1913 to 2013: Privatised Urban Development and the Role of Municipal Governments. In *Land Divided: Land and South African Society in 2013, in Comparative Perspective*. Cape Town: University of Cape Town.

Hill, W. C., & Rivett, U. R. (2015). Amplifying apartheid: Access to the City of Cape Town' s water and sanitation fault reporting system Amplifying Apartheid : Access to the City of Cape Town ' s. In *Young Water Professionals (YWP) 2015*. Kuala Lumpur, Malaysia.

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, *4*(1973), 1–23. doi:10.1146/annurev.es.04.110173.000245

Holling, C. S., Schindler, D. W., Walker, B. W., & Roughgarden, J. (1995). Biodiversity in the functioning of ecosystems: an ecological synthesis. In *Biodiversity loss: economic and ecological issues* (pp. 44–83). Cambridge, UK: Cambridge University Press.

Holloway, A., Roomaney, R., Pharoah, R., Solomon, F. J., & Cousins, D. (2008). *Weathering the storm: Participatory risk assessment for informal settlements*. (U. of C. T. Disaster Mitigation for Sustainable Livelihoods Programme, Ed.). Cape Town, South Africa: Periperi Publications. Retrieved from http://www.preventionweb.net/files/4163_weathering.pdf

Housing Development Agency. (2012). *South Africa: Informal settlements status*. Johannesbrug, South Africa.

Huberman, A. M., & Miles, Matthew, B. (2002). Understanding and validity in qualitative research. In *The Qualitative Researcher's Companion* (pp. 36–65). Thousand Oaks: Sage Publications, Inc. doi:10.4135/9781412986274

Huchzermeyer, M. (2011). *Cities with "Slums."* Cape Town, South Africa: UCT Press.

Hughes, S. (2013). Justice in Urban Climate Change Adaptation: Criteria and Application to Delhi. *Ecology and Society*, *18*(48).

Hustable, J., & Yen, N. T. (2009). Mainstreaming climate change cdaptation: A practioner's handbook. CARE. Retrieved from www.ngocentre.org.vn/?q+node/5457

IPCC. (2014a). Annex II - Glossary. In J. Agard & L. F. Schipper (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability* (pp. 1757–1776). Cambridge, UK: Cambridge University Press.

IPCC. (2014b). Chapter 8: Urban Areas. In P. Aldunce, J. P. Ometto, N. Raholijao, & K. Yasuhara (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1–113). Geneva: IPCC.

IPCC. (2014c). Climate Change 2014 Synthesis Report. In [Core Writing Team, R.K. Pachauri, & L. A. Meyer] (Eds.), *Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1–151). Geneva, Switzerland: IPCC.

IPCC. (2014d). Climate Change 2014 Synthesis Report Summary Chapter for Policymakers. In R. K. Pachauri & L. A. Meyer (Eds.), *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (p. 151). Geneva, Switzerland: IPCC.

IPCC. (2014e). *Summary for Policy Makers. Climate Change 2014: Impacts, Adaptation and Vulnerability - Contributions of the Working Group II to the Fifth Assessment Report.* doi:10.1016/j.renene.2009.11.012

IPCC. (2014f). *Technical Summary.* (P. Aldunce, J. P. Ometto, N. Raholijao, & K. Yasuhara, Eds.)*Climate Change 2014: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Geneva: IPCC.

Ireland, P. (2010). Climate change adaptation and disaster risk reduction: Contested spaces and emerging opportunities in development theory and practice. *Climate and Development*, *2*(4), 332–345. doi:10.3763/cdev.2010.0053

Jiusto, S., & Kenney, M. (2015). Hard rain gonna fall: Strategies for sustainable urban drainage in informal settlements. *Urban Water Journal*, 37–41. doi:10.1080/1573062X.2014.991329

Joubert, L., & Martindale, L. (2013). *Rising Waters: working together on Cape Town's flooding.* Cape Town, South Africa: African Centre for Cities, University of Cape Town.

Kabeer, N. (2006). Citizenship, affiliation and exclusion: Perspectives from the south. *IDS Bulletin*, *37*(4), 91–101. doi:10.1111/j.1759-5436.2006.tb00291.x

Kamete, A. Y. (2013). Missing the point? Urban planning and the normalisation of "pathological" spaces in southern Africa. *Transactions of the Institute of British Geographers*, *38*(4), 639–651. doi:10.1111/j.1475-5661.2012.00552.x

Karimi, F. (2015, April 19). What's behind xenophobic attacks in South Africa? *CNN*. Retrieved from http://www.cnn.com/2015/04/18/africa/south-africa-xenophobia-explainer/

Kates, R. W. (2000). Cautionary tales: adaptation and the global poor. *Climatic Change*, *45*, 5–17.

Kelly, P. M., & Adger, W. N. (2000). Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change*, *47*, 325–352. doi:10.1023/A:1005627828199

Kirk, J., & Miller, M. L. (1986). Reliability and validity. In *Reliabilty and validity in qualitative research* (pp. 14–22). Newbury Park: Sage Publications, Inc. doi:10.1080/0951839880010110

Kiunsi, R. (2013). The constraints on climate change adaptation in a city with a large development deficit: the case of Dar es Salaam. *Environment and Urbanization*, *25*(2), 321–337. doi:10.1177/0956247813489617

Klein, R. J. T., Eriksen, S. E. H., Naess, L. O., Hammill, A., Tanner, T. M., Robledo, C., & O'Brien, K. (2007). Portfolio screening to support the mainstreaming of adaptation to climate change into development assistance. *Climatic Change*, *84*, 23–44. doi:10.1007/s10584-007-9268-x

Klein, R. J. T., Schipper, E. L. F., & Dessai, S. (2005). Integrating mitigation and adaptation into climate and development policy: Three research questions. *Environmental Science and Policy*, *8*, 579–588. doi:10.1016/j.envsci.2005.06.010

Lanegran, K., & Lanegran, D. (2001). South Africa'S National Housing Subsidy Program and Apartheid'S Urban Legacy. *Urban Geography*, *22*(7), 671–687. doi:10.2747/0272-3638.22.7.671

Laukkonen, J., Blanco, P. K., Lenhart, J., Keiner, M., Cavric, B., & Kinuthia-Njenga, C. (2009). Combining climate change adaptation and mitigation measures at the local level. *Habitat International*, *33*(3), 287–292. doi:10.1016/j.habitatint.2008.10.003

Lefebvre, H. (1968). *Le droit à la ville*. Paris, France: Anthopos.

Massey, R. T. (2013). Competing rationalities and informal settlement upgrading in Cape Town, South Africa: A recipe for failure. *Journal of Housing and the Built Environment*, *28*, 605–613. doi:10.1007/s10901-013-9346-5

Matthews, L. C. (2014). *Climate Change and Winter Road Maintenance: Planning for Change in the City of Prince George, British Columbia*. University of Waterloo.

Maxwell, J. A. (1992). Understanding and validity in qualitative research. *Harvard Educational Review*, *62*(3), 279–300. doi:0017-8055

Mays, N., & Pope, C. (2000). Assessing quality in qualitative research. *BMJ : British Medical Journal*, *320*(7226), 50–52.

Mels, A., Castellano, D., Braadbaart, O., Veenstra, S., Dijkstra, I., Meulman, B., … Wilsenach, J. a. (2009). Sanitation services for the informal settlements of Cape Town, South Africa. *Desalination*, *248*(1-3), 330–337. doi:10.1016/j.desal.2008.05.072

Midgley, G. F., Chapman, R. A., Hewitson, B., Johnston, P., De Wit, M., Ziervogel, G., … Forsyth, G. . (2005). *A status quo, vulnerability and adaptation assessment of the physical and socio-economic effects of climate change in the Western Cape*.

Moser, C. O. N. (1998). The Asset Vulnerability Framework: Reassessing Urban Poverty Reduction Strategies. *World Development*, *26*(1), 1–19.

Mukheibir, P., & Ziervogel, G. (2006). *Framework for Adaptation to Climate Change in the City of Cape Town*. Cape Town, South Africa.

Mukhija, V. (2001). Upgrading housing settlements in developing countries: The impact of existing physical conditions. *Cities*, *18*(4), 213–222. doi:10.1016/S0264-2751(01)00014-2

Mustelin, J., Kuruppu, N., Kramer, A. M., Daron, J., de Bruin, K., & Noriega, A. G. (2013). Climate adaptation research for the next generation. *Climate and Development*, *5*(3), 189–193. doi:10.1080/17565529.2013.812953

Natural Resources Canada. (2015). Mountain pine beetle (factsheet). *nrcan.gc.ca*. Retrieved July 11, 2015, from http://www.nrcan.gc.ca/forests/fire-insects-disturbances/top-insects/13397

Newton, C. (2013). The peoples housing process … getting the quality in the quantity? *Journal of Housing and the Built Environment*, *28*(4), 639–651. doi:10.1007/s10901-013-9349-2

Nyar, A., & Wray, C. (2014). Understanding protest action : some data collection challenges for South Africa Article Understanding protest action : some data collection challenges for South Africa. *Transformation: Critical Perspectives on Southern Africa*, *80*, 22–43. doi:10.1353/trn.2012.0050

O'Brien, K., Eriksen, S., Nygaard, L. P., & Schjolden, a N. E. (2007). Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy*, *7*, 73–88. doi:10.1080/14693062.2007.9685639

O'Brien, K., Eriksen, S., Schjolden, A., & Nygaard, L. (2004). *What's in a word? Conflicting interpretations of vulnerability in climate change research*.

Palys, T., & Atchison, C. (2014). *Research Decisions: Quantitative, Qualitative, and Mixed Method Approaches* (5th ed.). Toronto, Canada: Nelson Education.

Parnell, S., & Pieterse, E. (2010). The "right to the city": Institutional imperatives of a developmental state. *International Journal of Urban and Regional Research*, *34*(1), 146–162. doi:10.1111/j.1468-2427.2010.00954.x

Parnell, S., Pieterse, E., & Watson, V. (2009). Chapter 5: Planning for cities in the global South: an African research agenda for sustainable human settlements. *Progress in Planning*, *72*(4), 233–241. doi:10.1016/j.progress.2009.09.001

Parnell, S., Simon, D., & Vogel, C. (2007). Global environmental change: conceptualising the growing challenge for cities in poor countries. *Area*, *39*(3), 357–369. doi:10.1111/j.1475-4762.2007.00760.x

Patel, S., & Mitlin, Di. (2009). Reinterpreting the rights-based approach: A grassroots perspective on rights and development. In S. Hickey & D. Mitlin (Eds.), *Rights-based Approaches to Development: Exploring the Potential and Pitfalls* (pp. 107–124). Sterling, Virgina: Kumarian Press.

Payne, G. (2001). Urban land tenure policy options: Titles or rights? *Habitat International*, *25*(June 2000), 415–429. doi:10.1016/S0197-3975(01)00014-5

Pharoah, R. (2014). Built-in Risk: Linking Housing Concerns and Flood Risk in Subsidized Housing Settlements in Cape Town, South Africa. *International Journal of Disaster Risk Science*, *5*(4), 313–322. doi:10.1007/s13753-014-0032-3

Pope, K. O., & Terrell, J. E. (2008). Environmental setting of human migrations in the circum-Pacific region. *Journal of Biogeography*, *35*(1), 1–21. doi:10.1111/j.1365-2699.2007.01797.x

Province of Western Cape. The Western Cape Disaster Managmenet Framework: Disaster Management Act, 2002 (Act No. 57 of 2002) (2007). South Africa.

Rauken, T., Mydske, P. K., & Winsvold, M. (2014). Mainstreaming climate change adaptation at the local level. *Local Environment*, *20*(4), 1–16. doi:10.1080/13549839.2014.880412

Ribot, J. C., Najam, A., & Watson, G. (1996). Climate variation, vulnerability and sustainable development in the semi-arid tropics. In J. C. Ribot, A. R. Magalhaes, & S. S. Panagides (Eds.), *Climate Variability, Climate Change and Social Vulnerability in the Semi-arid Tropics* (pp. 13–54). Cambridge, UK: Cambridge University Press.

Richard, Y., Fauchereau, N., Poccard, I., Rouault, M., & Trzaska, S. (2001). 20th century droughts in Southern Africa: Spatial and temporal variability, teleconnections with oceanic and atmospheric conditions. *International Journal of Climatology*, *21*, 873–885. doi:10.1002/joc.656

Roberts, B. J. (2014). Your Place or Mine? Beliefs About Inequality and Redress Preferences in South Africa. *Social Indicators Research*, *118*, 1167–1190. doi:10.1007/s11205-013-0458-9

Robins, S. (2014). Poo wars as matter out of place: "Toilets for Africa" in Cape Town. *Anthropology Today*, *30*(1), 1–3. doi:10.1111/1467-8322.12081

Roithmayr, D. (2010). Lessons from Mazibuko: Persistent inequality and the commons. *Constitutional Court Review*, *3*, 317–346.

Rowswell, P., & Fairhurst, L. (2011). Sub-saharan African cities: A five-year network to pioneer climate adaptation through participatory research and local action: Cape Town baseline study. In L. V. Kemp & S. Birch (Eds.), (pp. 0–50).

Roy, A. (2005). Urban Informality: Toward an Epistemology of Planning. *Journal of the American Planning Association*, *71*(2), 147–158. doi:10.1080/01944360508976689

Rydin, Y., Bleahu, A., Davies, M., Dávila, J. D., Friel, S., De Grandis, G., … Wilson, J. (2012). Shaping cities for health: Complexity and the planning of urban environments in the 21st century. *The Lancet*, *379*(9831), 2079–2108. doi:10.1016/S0140-6736(12)60435-8

SAHRC. (2014). *Report on the Right to Access Sufficient Water and Decent Sanitation in South Africa : 2014.*

Sandelowski, M. (2000). Whatever happened to qualitative description? *Research in Nursing & Health*, *23*(4), 334–340. doi:10.1002/1098-240x(200008)23:4<334::aid-nur9>3.0.co;2-g

Satterthwaite, D. (2008). *Climate Change and Urbanization: Effects and Implications for Urban Governance*. *UN Expert Group Meeting on Population Distribution, Urbanization, Internal Migration and Development*. New York: International Institute for Environment and Development (IIED). Retrieved from http://www.un.org/esa/population/meetings/EGM_PopDist/P16_Satterthwaite.pdf

Schipper, E. L. F. (2007). *Climate Change Adaptation and Development : Exploring the Linkages Climate* (No. Working Paper No. 107) (Vol. 107). Norwich, UK. Retrieved from http://www.preventionweb.net/files/7782_twp107.pdf

Schwandt, T. A. (Ed.). (2007). Qualitative inquiry. In *The SAGE Dictionary of Qualitative Inquiry* (pp. 248–250). Thousand Oaks: SAGE Publications. Retrieved from http://srmo.sagepub.com.proxy.lib.uwaterloo.ca/view/the-sage-dictionary-of-qualitative-inquiry/SAGE.xml

Seasons, M. (2003). Monitoring and Evaluation in Municipal Planning: Considering the Realities. *Journal of the American Institute of Planners*, *69*(4), 430–440.

Sharma, D., & Tomar, S. (2010). Mainstreaming climate change adaptation in Indian cities. *Environment and Urbanization*, *22*(2), 451–465. doi:10.1177/0956247810377390

Shefer, D., & Antonio, M. (2013). Spatial Inequality Between and Within Urban Areas: The Case of Israeli Cities. *European Planning Studies*, *21*(3), 373–387. doi:10.1080/09654313.2012.718198

Smit, B. (1993). *Adaptation to Climatic Variability and Change: Report of the Task Force on Climate Adaptation*. Guelph, Ontario.

Smit, B., Burton, I., Klein, R. J. T., & Wandel, J. (2000). An anatomy of adaptation to climate change and variability. *Climate Change*.

Smith, A., & Stirling, A. (2008). Social-ecological resilience and socio-technical transitions: critical issues for sustainability governance. Retrieved from http://www.mendeley.com/research/socialecological-resilience-and-sociotechnical-transitions-critical-issues-for-sustainability-governance/

Statistics South Africa. (2011). *Regional economic growth*. Pretoria.

Statistics South Africa. (2012). *Mid-year population estimates: 2010. Africa*. Pretoria. Retrieved from http://www.statssa.gov.za/publications/P0302/P03022011.pdf

Tadross, M., & Johnston, P. (2012). *Climate change projections for Cape Town : Adding value through downscaling*. Cape Town, South Africa.

Taylor, B. A., & Peter, C. (2014). *Strengthening climate resilience in African cities A framework for working with informality*. Cape Town.

The Housing Development Agency. (2013a). *South Africa : Informal Settlements Status (2013)*. Johannesburg, South Africa.

The Housing Development Agency. (2013b). *Western Cape : Informal settlements Status (2013)*. Johannesbrug, South Africa.

The World Bank. (2010). *Natural Hazards, UnNatural Disasters: The Economics of Effective Prevention*. Washington, DC: The International Bank for Reconstruction and Development/The World Bank.

Thompson, A., & Climate Central. (2015, June 4). The Climate Context for India's Deadly Heat Wave. *Scientific American*. Retrieved from http://www.scientificamerican.com/article/the-climate-context-for-india-s-deadly-heat-wave/

Tissington, K., Munshi, N., Mirugi-Mukundi, G., & Durojaye, E. (2013). *" Jumping the Queue " Waiting lists and other myths: Perceptions and practice around housing demand and allocation in South Africa.*

Town, C. of C. (2008). *Water and sanitation service standard*. Cape Town, South Africa.

Uittenbroek, C. J., Janssen-Jansen, L. B., & Runhaar, H. A. C. (2012). Mainstreaming climate adaptation into urban planning: overcoming barriers, seizing opportunities and evaluating the results in two Dutch case studies. *Regional Environmental Change*, *13*(2), 399–411. doi:10.1007/s10113-012-0348-8

UN-Habitat. (2003). *The Challenge of Slums: Global Report on Human Settlements 2003*. London, UK: EARTHSCAN.

UN-Habitat. (2006). *The state of the world's cities*. London, UK: EARTHSCAN.

UN-Habitat. (2009a). *Planning Sustainable Cities*. London: EARTHSCAN.

UN-Habitat. (2009b). *Planning Sustainable Cities: Policy Directions: Global Report on Human Settlements 2009 (Abdridged Edition)*.

UNISDR. (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. *International Stratergy for Disaster Reduction (ISDR)*. Geneva, Switzerland. Retrieved from www.unisdr.org/publications

United Nations. (2014). *The Millennium Development Goals Report*. Retrieved from https://visit.un.org/millenniumgoals/2008highlevel/pdf/MDG_Report_2008_Addendum.pdf

United Nations Inter-Agency and Expert Group on MDG Indicators. (2013). *The Millennium Development Goals Report 2013*. New York.

Vale, L. J. (2014). The politics of resilient cities: whose resilience and whose city? *Building Research & Information*, *42*(2), 191–201. doi:10.1080/09613218.2014.850602

Vojinovic, Z., & Abbott, M. B. (2012). *Flood risk and social justice: from quantitative to qualitative flood risk assessment and mitigation*. London, UK: IWA Publishing.

Wamsler, C., Luederitz, C., & Brink, E. (2014). Local levers for change : Mainstreaming ecosystem-based adaptation into municipal planning to foster sustainability transitions. *Global Environmental Change*, *29*, 189–201. doi:10.1016/j.gloenvcha.2014.09.008

Wandel, J., Cowing, Z., & Springer, R. (2015). Scaling out climate change vulnerability and adaptation assessments: the case of Small Island Developing States. In *Canadian Association of Geographers Annual Meeting*. Vancouver.

Watson, V. (2003). Conflicting rationalities: implications for planning theory and ethics. *Planning Theory & Practice*, *4*(4), 395–407. doi:10.1080/1464935032000146318

Watson, V. (2009a). Seeing from the South: Refocusing Urban Planning on the Globe's Central Urban Issues. *Urban Studies*, *46*(11), 2259–2275. doi:10.1177/0042098009342598

Watson, V. (2009b). "The planned city sweeps the poor away…": Urban planning and 21st century urbanisation. *Progress in Planning*, *72*(3), 151–193. doi:10.1016/j.progress.2009.06.002

Wekesa, B. W., Steyn, G. S., & Otieno, F. a O. (2011). A review of physical and socio-economic characteristics and intervention approaches of informal settlements. *Habitat International*, *35*(2), 238–245. doi:10.1016/j.habitatint.2010.09.006

Wilby, R. L., & Keenan, R. (2012). Adapting to flood risk under climate change. *Progress in Physical Geography*, *36*(3), 348–378. doi:10.1177/0309133312438908

WWF. (2014, March 27). Cape Town triumphs as global Earth House Capital 2014. *WWF*. Retrieved February 12, 2015, from http://www.wwf.ca/newsroom/?unewsid=15045

Yin, R. K. (1994). *Case study research: Design and methods*. Thousand Oaks: SAGE Publications.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Los Angeles: SAGE Publications.

Yin, R. K. (2011). *Qualitative research: From start to finish*. New York, NY: The Guilford Press.

Ziervogel, G., New, M., Archer van Garderen, E., Midgley, G., Taylor, A., Hamann, R., … Warburton, M. (2014). Climate change impacts and adaptation in South Africa. *Wiley Interdisciplinary Reviews: Climate Change*, *5*(October), 605–620. doi:10.1002/wcc.295

Ziervogel, G., Shale, M., & Du, M. (2010). Climate change adaptation in a developing country context: The case of urban water supply in Cape Town. *Climate and Development*, *2*(2006), 94–110. doi:10.3763/cdev.2010.0036

Ziervogel, G., & Smit, W. (2009). Learning to swim : Strengthening flooding governance in the City of Cape Town. In *2009 Amsterdam Conference on the Human Dimensions of Global Environmental Change "Eart System Governance: People, Places and the Planet"* (pp. 1–16). Ambsterdam.

Ziervogel, G., Waddell, J., Smit, W., & Taylor, A. (2014). Flooding in Cape Town's informal settlements: barriers to collaborative urban risk governance. *South African Geographical Journal*, (January 2015), 1–20. doi:10.1080/03736245.2014.924867

Appendices

Appendix A - Interview Guidebook

Date:
Interview #:
Location:
Type of Organization:
Government-Municipal

Government-Provincial

CSO

University

Organization name:
Position title of informant:
Name of informant:

Background:
1) What is the role of your department (or organization) in informal settlements?
2) In your role, do you work exclusively with informal settlements?
3) What is your day-to-day role in relation to informal settlements?
4) How is sanitation and waste management currently implemented in informal settlements?
    a) What strategies?
    b) How? (Piecemeal vs. general policy)
    c) Where? (Specific settlements?)

Current Risks and Responses
5) What are the major concerns your office has with regard to rainfall and flooding in informal settlements?
6) How do you get reports on how rainfall and flooding are impacting informal settlement residents?
7) How does rainfall and flooding impact sewage and sanitation services in informal settlements?
8) How does your office currently deal with the rainfall and flooding issues?
9) What are the short term response strategies for this year or the next few years?
    a) What are informal household responses to flooding?
    b) Are there any community groups or NGOs involved with coping with flooding?
10) Is there a long(er) term strategy for ensuring sewage and sanitation are not affected (or at least less affected) by flooding?
11) Is the current strategy sufficient?
    a) If no, what are better options?
    b) What are the barriers/challenges to implementing these options?
    c) What motivates investment into new strategies (technology, infrastructure, behavior, education, etc.)?
12) Which policies and/or plans guide the work that your office does?
13) Does your office coordinate with other departments or organizations to execute your mandate?
    a) If yes, which ones?

        b)   Through which platforms? (I.e. partnerships with Universities, Flood Task Team?)

Climate Change Risks and Responses
14) Does your office anticipate that climate change will aggravate existing flood risk?
15) How do you anticipate sewage and sanitation will be impacted by climate change?
        a)   Do you anticipate that current flood strategies will need to change?
        b)   If yes, how should they change?
16) Has your office incorporated climate change into long term planning?
        a)   If yes, how does it incorporate climate change into long term planning?
i)   What solutions were considered?
1)   ii) Which were chosen and why?
2)   iii) Has implementation begun? What is the timeline?
17) Is informal settlement upgrading considered an adaptation strategy?
        a)   Has concern over climate change influenced any projects within informal settlements?
18) Which policies and/or plans are most relevant for climate change in your department?
19) Does your office coordinate with other departments or organizations in planning for climate change?
        a)   If yes, which ones?

Monitoring and assessment
20) How are residents involved in decision-making?
21) What is the follow-up process once a strategy is implemented?
        a)   How do you know a strategy is working?
22) What monitoring processes does your office have in place to measure the implementation of a project?
23) Do you set indicators of success?
24) How do you measure successful flood and/or climate change adaptation?
25) Does your office have a post-hoc evaluation process?
26) In your view, how has flood mitigation evolved in informal settlements in Cape Town?
27) Do you have any comments on how it compares to other South African cities?

Appendix B - Key Informant Organizational Information & Coding

Municipal Government					
Branch	Department	Directorate	Level	Interview Date	Interview label
N/A	Environment Rsource Management (ERM)	Economic, Environmental, & Spatial Planning	Department	August 11th, 2014	**3, University/Municipality**
Stormwater & Sustainability	Planning	Transport for Cape Town	Branch	August 14th, 2014	**5, Municpality**
Stormwater & Sustainability	Planning	Transport for Cape Town	Branch	August 14th, 2014	**6, Municipality**
Spatial Planning (Cape Flats)	Spatial Planning & Design	Economic, Environmental, & Spatial Planning	Branch	August 15th, 2014	**8, Municipality**
Spatial Planning (Khayelitsha)	Spatial Planning & Design	Economic, Environmental, & Spatial Planning	Branch	August 15th, 2014	**9, Municipality**
N/A	Informal Settlements	Human Settlements	Department	August 20th, 2014	**10, Municipality**
N/A	Water & Sanitation	Utility Services	Department	August 22nd, 2014	**11, Municipality**
N/A	N/A	Utility Services	Directorate	August 22nd, 2014	**12, Municipality**
N/A	Water & Sanitation	Utility Services	Branch	August 25th, 2014	**14, Municipality**
N/A	Disaster Risk Management Centre	N/A	Department	August 25th, 2014	**15, Municipality**
Stormwater & Sustainability	Planning	Transport for Cape Town	Branch	August 28th, 2014	**17, Municipality**
Stormwater & Sustainability	Planning	Transport for Cape Town	Branch	August 28th, 2014	**18, Municipality**
Civil Engineering	Planning	Transport for Cape Town	Branch	August 28th, 2014	**19, Municipality**
Cleansing	Solid Waste Management	Utility Services	Branch	September 12th, 2014	**20, Municipality**
Provincial Government					
Department		Ministry			
Climate Change		Environmental Affairs and Development		August 14th, 2014	**7, Province**
Civil Society Organizations					
Organization name					
Development Action Group (DAG)				August 14th, 2014	**4, CSO**
Social Justice Coalition (SJC)				August 25th, 2014	**13, CSO**
Community Organization Resource Centre (CORC)				August 28th, 2014	**16, CSO**
Ses'khona Peoples Rights Movement				August 25th, 2014	**21, CSO**
University					
Stellenbosch University				August 4th, 2014	**1, University**
Stellenbosch University				August 4th, 2014	**2, University**
University of Cape Town				August 11th, 2014	**3, University/Municipality**