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The Capacity of Local Governments to Build Flood Resilience in Informal Settlements: A Social Networks Approach

MPhil specialising in Climate Change and Sustainable Development

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Declaration

I hereby declare that I have read and understood the regulations governing the submission of MPhil specializing in Climate Change and Sustainable Development dissertations, including those relating to length and plagiarism, as contained in the rules of this University, and that this minor dissertation conforms to those regulations.

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Abstract

As greenhouse gas emissions drive anthropogenic climate change, flooding and flood related risk are likely to increase in frequency and intensity. The burden of these risks are expected to be concentrated in urban areas, particularly affecting highly vulnerable informal settlements. Adapting to these risks will largely fall under the responsibility of local governments. However local governments, in particular those in developing countries, often lack the capacity to implement effective adaptation strategies for long-term resilience. Drawing on social network analysis this research examines the role of social ties and social capital in facilitating knowledge sharing to improve the capacities of local governments to deal with flood-related risks.

Using the case studies of Nelson Mandela Bay Metropolitan Municipality and Mossel Bay Local Municipality in South Africa, this research found that patterns of social interactions in the two local governments were largely a result of the size of structures of governance. The larger Nelson Mandela Bay Metropolitan Municipality network consisted of poorly connected sub-groups with poor knowledge dispersal. This led to poor adaptive and inclusive governance because poor levels of collaboration and social learning inhibited effective flood management. The smaller Mossel Bay Local Municipality network consisted of a bonded network with high knowledge transfers. These characteristics contributed to improved adaptive and inclusive governance because strong collaboration enabled informed and flexible flood management. The poor collaboration in NMBMM is likely to negatively affect the municipality's capacity to build resilience for informal settlements by negatively affecting coping, adaptive and transformative capacity. The strong collaboration in MBLM can foster coping and adaptive capacities, but may be hampering the transformative capacity of the municipality. Thus social networks have a considerable role to play in the governance of flooding, thereby influencing the ability of the two local governments to build resilience in informal settlements.

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List of Acronyms

CCA	Climate Change Adaptation
DMC	Disaster Management Centre
EDM	Eden District Municipality
IDP	Integrated Development Plan
IPCC	Intergovernmental Panel on Climate Change
JOC	Joint Operations Centre
MBLM	Mossel Bay Local Municipality
NGO	Non-Governmental Organisation
NMBMM	Nelson Mandela Bay Metropolitan Municipality

1 Introduction

1.1 Introduction to the Study

During the 20th century the world experienced a rapid wave of urbanisation, with over half the world's population currently living in urban areas and estimates predicting this proportion to further increase to almost 70% by the year 2050 (Un-habitat, 2010; De Risi et al., 2013). This rapid urbanisation has also led to the increasing emergence and growth of informal settlements in urban areas of the developing world, which house extremely vulnerable urban poor groups (De Risi et al., 2013). The occurrence of this wave of urbanisation around the world has coincided with increasing anthropogenic changes in the global climate and an increase in climate-related risks (Revi et al., 2014).

As global temperatures continue to increase in the 21st century, the impacts of climate-related risks on complex socio-ecological systems are expected to increase. These socio-ecological systems consists of complex interactions and systems of governance between natural ecosystems and human societies (Ostrom, 2009). The risks posed to these systems by increasing intensity and frequency of climate related events and phenomena is expected to be particularly hard felt within urban areas (Carmin, Anguelovski & Roberts, 2012). As these climate risks increase in urban areas, the urban poor living in informal settlements will be the most vulnerable communities to the impacts of climate-related risks (Revi et al., 2014). Flooding threatens the lives and livelihoods of residents of informal settlements, due to various context-specific local factors making these settlements vulnerable to flood related risks (Few, 2003). Examples of such context-specific local factors are the location of informal settlements within high-risk flooding areas, high population densities, poor construction standards and a lack of sufficient drainage infrastructure (Few, 2003; Douglas et al., 2008).

As flood risk increases, gaining an understanding of how to reduce vulnerability and build resilience against flooding in informal settlements is vital in ensuring the most vulnerable communities are able to cope and adapt to the increasing intensity and frequency of flooding events. The IPCC describes resilience as "*the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding*

or reorganising in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning and transformation"(Field et al., 2014: 40). Building the resilience of socio-ecological systems thus entails making adjustments to these systems which improve the coping, adaptive, and transformative capacities of these systems in light of current and future climate-related risks (Pelling, 2003; Gaillard, 2010).

The process of making adjustments in order to reduce vulnerabilities and improve capacities to cope and adapt to climate risks are referred to as climate change adaptation (CCA) (Smit & Wandel, 2006). The consideration of the impacts of climate change in local contexts are vital in implementing CCA which avoids or limits the negative impact of climate related risks on local communities (Roberts, 2008). Thus CCA on the scale of local governments offers a key space to build capacities through local development which can be both incremental (development based on needs) and/or transformative (development which seeks to address structures which produce differentiated vulnerabilities) (Field et al., 2014; Dowd et al., 2014). Co-operative and well-informed local governments thus need to mainstream climate change issues into local contexts and development plans in order to establish a foundation on which to build resilience to climate risks such as flooding (Roberts, 2008; Revi et al., 2014).

Social networks refer to the patterns of social interactions between individuals (Haythornthwaite, 1996). These networks have been proven to be extremely influential in shaping the behaviours and responses of communities to climate-related risks, and are thus recognised as one key component of building resilience against climate risks (Wolf et al., 2010). Social networks and the information flows these networks create across different levels and sectors of government are likely to play vital roles in the processes of knowledge exchange and co-production for resilience-building at institutional levels (Ingold, Balsiger & Hirschi, 2010; Granovetter, 2005).

Processes of knowledge exchange in social networks are vital for the resilience of socio-ecological systems because they aid in recoupling human societies and nature, and enable adaptive management which is able to overcome complexities and uncertainties (Pahl-Wostl, 2006). Recently there has also been a recognition of the importance of far-reaching knowledge networks and social ties within and between social networks in enabling the transformation of values and norms of social actors (Dowd et al., 2014).

Various calls are being made for collaborative local governments to build human and institutional resilience through collaborative learning) (Roberts, 2008; Revi et al., 2014; Reyers et al., 2015). However, despite these calls for collaborative governments very little work has examined how social networks in local governments, and particularly the nature of social ties within these networks, can contribute to increasing the capacity of local governments to build resilience within the most vulnerable communities.

1.2 Aims and Objectives

The aim of this research was to explore the role of social networks in the transfer of flooding risk related knowledge within local governments for improving the capacities of governments to build flood resilience in informal settlements. Two municipalities in South Africa were used as case studies. In achieving this aim the main objectives of this research were:

- To identify and characterize the types of social network ties and social capital between the actors in flood risk management
- To examine the extent to which the characteristics of social network ties contribute to knowledge exchange processes within local governments.
- To qualitatively assess the impact of social and knowledge networks on adaptive and inclusive governance practices.
- To assess the outcomes of varying social network ties and sources of knowledge on improving the capacity to build flood-related resilience in local government, through a comparative analysis of two municipalities.
- To develop a framework to evaluate how the transfer of knowledge within social networks can facilitate resilience-building at an institutional level, to better enable local governments to address flood risk in vulnerable informal settlements.

The study sites for this research will be The Nelson Mandela Bay Metropolitan Municipality (NMBMM) and Mossel Bay Local Municipality (MBLM). As a metropolitan municipality, NMBMM has a much larger population and presumably a greater diversity of stakeholders involved in flood risk management, whereas the MBLM as local, non-metropolitan municipality has a smaller population and thus presumably fewer

stakeholders (Pasquini, Cowling & Ziervogel, 2013). The differences in municipal governance structures are expected affect the patterns of social interactions as well as the sources and types of knowledge within these local governments.

1.3 Outline of this Thesis

This thesis is divided into six chapters, the first of these chapters providing an introduction to the research, followed by a literature review in chapter two. The literature review is followed by a context and methodology chapter providing a brief overview of the study sites and outlining the framework and methodology for the study. The results and discussion of this research are combined across two chapters, chapter four examining the first two objectives with chapter five examining the remaining three objectives. Chapter six concludes the research with a summary of findings and outlining potential for further studies.

2 Literature Review

The literature review chapter outlines how this study fits into previous theory by providing the literature background of the key themes in this research. The chapter begins by examining social network theory, and the strength of social ties in building resilience. This is followed by definitions of vulnerability and resilience in the context of flooding in informal settlements. The chapter is concluded by examining the role of local governments in building resilience at the local scale.

2.1 Social Network Theory

Social networks refer to groups of actors connected through social ties. According to Haythornthwaite (1996) actors form nodes of information while the ties between them act as the connections which enable the different nodes to exchange ideas. These nodes can refer either to single actors or sub-groups of actors which share identical characteristics (Leskovec et al., 2009). Each node in a social network therefore represents a unique perspective with its own sources of information.

Social ties have been argued to be extremely influential in shaping cognitive values and practices, due to their role in the knowledge exchange between actors in the network (Brass & Krackhardt, 2012; Fischer et al., 2014; Leombruni, 2015). Knowledge exchange within networks occurs as a dynamic process of sharing, generation and co-production of different forms of knowledge between the actors within social networks (Fazey et al., 2013). The nature and form of ties between actors thus influence the spread of information and the patterns of social behaviours of actors within these networks (Doreian & Stokman, 1997; Zhao, Li & Jin, 2016). It can thus be argued that the outcome of social network processes produce social capital.

Social network analysis is a tool which has been utilized to explain how the structure and processes within social networks influence the behaviours of the actors within these networks (Crona et al., 2011). Two key aspects of social network analysis involve

examining the strength of social ties and the types of social capital. These two components will be examined in the following sections.

2.1.1 Social Ties, Homophily, and Social Cohesion

The strength social ties between actors within a network have a significant impact on the willingness of actors to collaborate and share knowledge (Reagans & McEvily, 2003). A balance between strong and weak ties is beneficial for a social network because weak ties allow new information and ideas to enter the network while strong ties ensures new information and ideas are assimilated into the network (Wang, 2016). Thus strong social networks can be described as networks which feature strong ties between actors within sub-groups and multiple far reaching ties with actors from other sub-groups and network (Dowd et al., 2014).

Strong social ties can be defined as ties between actors sharing social closeness within a network (Kossinets & Watts, 2009). These strong ties are characterised by relationships between actors who share high dependency on each other, share regular interactions and have similar demographics and values (Sanders, Nee & Sernau, 2002; Reagans & McEvily, 2003; Kossinets & Watts, 2009). Furthermore, strong ties often represent long-standing relationships between actors who share mutual trust (Buvik & Rolfsen, 2015). In contrast weak ties exist between actors who do not share a mutual dependency, interact infrequently or lack trust between each other (Ingold, 2017).

According to Kossinets and Watts (2009) actors who share similar values or characteristics are more likely to form strong ties. These relationships between similar actors produce homophily within a network (Anagnostopoulos, Kumar & Mahdian, 2008). This homophily refers to actors within a network sharing either similar social characteristics (race, gender, etc.) or similar values, attitudes and goals (Anagnostopoulos, Kumar & Mahdian, 2008; Leombruni, 2015). Homophily within a social network either occurs when actors choose to form strong ties with similar actors (Louch, 2000; Kossinets & Watts, 2009), or when strong ties enforce social norms, beliefs and behaviours between actors (Leombruni, 2015).

As homophily within a network suggests strong ties between similar actors, homophily also ensures social cohesion within a network (Barrington et al., 2009). Social cohesion within a network is described as strong relationships between actors which enable collaboration (Luthe, Wyss & Schuckert, 2012). Networks with clearly defined sub-groups and weak connections between sub-groups often lack cohesion due to weak ties limiting knowledge exchange and co-operation between actors (Luthe, Wyss & Schuckert, 2012). Social cohesion is thus evident in dense networks with strong ties which facilitate social interactions between actors and co-ordinate co-operation (Barrington et al., 2009).

Strong social ties should facilitate homophily between values, attitudes and goals between actors. These strong ties also facilitate social cohesion which enables actors to collaborate, suggesting strong ties may be vital in creating shared values, and facilitating social collaboration to enable local government actors to respond to the impacts of climate change. However network homophily and social cohesion could potential produce pitfalls in social networks, Firstly social networks are limited in the size of the network and the strength of ties, as maintaining homophily and social cohesion between large numbers of actors requires vast network maintenance (Hansen, Podolny & Pfeffer, 2001; Roberts et al., 2009). Secondly strong social cohesion and homophily may result in the preservation of social norms within social networks (Barrington et al., 2009). This could result in the spread of inaccurate information and actors being influenced by dominant actors within the network (Leombruni, 2015; Zhao, Li & Jin, 2016). Thirdly too much network homophily could also negatively affect network diversity by preventing new information from entering networks, thereby inhibiting social change and innovation (Sosa, 2011). Thus examination of social networks of local governments should go beyond assessment of the strength of ties to examine the structure of these ties and the types of social capital (to be discussed in the following section) they produce among local government actors.

2.1.2 Types of Social Capital

As social behaviours are largely products of social interactions, social networks are imperative in the formation of social capital (Ferlander, 2007). Social capital refers to the development of collective knowledge and co-operative behaviours of communities which

are formed through the formation of social structures (Ferlander, 2007; Babaei, Ahmad & Gill, 2012; Jordan, 2015). The three main forms of social capital which exist are bonding capital, bridging capital and linking capital. **Bonding social capital** is formed through strong bonding ties between actors with close relationships and similar characteristics (Woolcock, 2001; Babaei, Ahmad & Gill, 2012). Bonding social capital is associated with actors sharing strong ties and similar values which serve to enforce the values of the node (Anagnostopoulos, Kumar & Mahdian, 2008). Bonding networks are therefore highly homogenous subgroups with inwards ties which ensures the subgroups share the same sources of information, values and practices (Wolf et al., 2010; Macias & Williams, 2014; Islam & Walkerden, 2014; Itkonen, 2015). Bonding social capital can be extremely beneficial in forming strong networks which foster community co-operation and co-ordination which benefits the actors in recovering from disturbances, such as natural disasters (Islam & Walkerden, 2014).

While strong bonded networks can be advantageous in sharing resources among actors, the homophily of these networks leads to a lack of diversity within these networks which may negatively affect the actors within these networks (Choi et al., 2011). For example, the case of strong bonded networks of senior citizens in the United Kingdom found that bonding capital exacerbated vulnerabilities by spreading coping strategies to climate risks (Wolf et al., 2010). The transmission of coping strategies in this case resulted in actors within the network maintaining current behaviours rather than seeking means to adapt to increasing climate risks.

Bridging social capital allow actors from different sub-groups and nodes to interact with each other to share different perspectives thereby diversifying the actors within a network (Macias & Williams, 2014). Bridging social capital is the result of weak ties between similar individuals from different sub-groups within a social network (Woolcock, 2001; Ferlander, 2007; Torkelsson, 2007; Babaei, Ahmad & Gill, 2012). Bridging capital is formed through bridging ties which form outward connections between different subgroups and nodes which often hold differences in sources of information, values and practices (Wolf et al., 2010; Macias & Williams, 2014; Islam & Walkerden, 2014). Thus bridging ties present key opportunities for introducing new and diverse types of knowledge into networks in order to facilitate the change in behaviours within social networks (Brass & Krackhardt, 2012). In a hierarchical sense, bridging ties

are often referred to as horizontal ties in that they are ties between actors from different subgroups but with a similar social position within their respective subgroups (Ferlander, 2007; Islam & Walkerden, 2014).

While bonding and bridging social capital is vital in the exchange of information within and between different subgroups within a social network, the third form of social capital is vital in connecting actors to power entities (Torkelsson, 2007). **Linking social capital** is created through vertical ties with individuals who maintain higher positions of power (Ferlander, 2007). In this sense linking ties connect actors to outside organisations and institutions which can provide them with informational, technical or financial assistance (Babaei, Ahmad & Gill, 2012). As these entities hold greater power they often have a dominant role in affecting the circumstances of the social network (e.g. national government determines the political environment within which local governments operate) (Islam & Walkerden, 2014). Where bonding and bridging ties are essential in spreading influence and information within social networks, linking ties are essential in providing resources from outside of the network (Torkelsson, 2007).

While social capital can provide various benefits to actors within social networks, social capital can also be viewed as a "double edged sword" (Woolcock & Narayan, 2000: 8). While the three forms of social capital can each benefit social networks, social capital is multifaceted in nature and can also negatively affect social networks. Thus resilient social networks should not be dominated by any of the forms of social capital but should rather have a mix of social capital which is flexible to new information entering networks while maintaining the ability to assimilate new information into existing values and practices (Bahadur, Ibrahim & Tanner, 2013; Wang, 2016). In order to be cognisant of the multifaceted nature of social capital, this research will consider both the benefits and pitfalls of social capital in terms of resilience at the local government level.

2.1.3 Social Networks and Climate Resilience

The importance of social networks in knowledge exchange processes and influencing behaviours around issues of CCA and resilience has been recognised by various authors (Ingold, Balsiger & Hirschi, 2010; Wolf et al., 2010; Dowd et al., 2014; Macias & Williams,

2014; Jordan, 2015; Farrell, 2016). Social networks are key to facilitating the collaboration and knowledge sharing of actors which promote the properties of system resilience (Luthe, Wyss & Schuckert, 2012). Thus, this research will examine the potential for the social networks of local governments to play a dominant role in improving capacitates to build resilience at the local level.

Effectively building resilience to climate-related risks at the local level will require a diversity of social ties between government officials, managers and scientists, in order to create shared knowledge and improve the diffusion of knowledge within the different networks (Fischer et al., 2014). Although these ties between local interest groups are vital in creating a shared goal between networks, linking ties between different levels of government also have a significant impact on the capacities of actors in a network (Wolf et al., 2010). Formal vertical (linking) ties between different levels of governments and organisations is essential to ensuring policy awareness and information regarding climate related risks is diffused across different levels of governments (Laatsch & Ma, 2016).

One of the key properties of social networks which can largely influence the diffusion of information in networks, thereby affecting CCA and resilience, is the strength of ties between actors. Strong interpersonal ties between actors act as mechanisms that spread similar knowledge thereby enforcing the values and behaviours and creating homophily within social networks (Barrington et al., 2009; Brass & Krackhardt, 2012; Leombruni, 2015). Thus it is argued that social networks with strong ties and flows of information produce social cohesion within networks (Barrington et al., 2009). This social cohesion can then positively affect properties of self-organisation to enable actors within the social networks to be more resilient to the risks associated with climate change (Dowd et al., 2014).

While strong social networks require strong bonding capital to effectively influence behaviours of actors, long-term resilience requires social networks that consist of weak and far reaching ties which facilitate bridging and linking capital within networks (Dowd et al., 2014). Social networks comprised primarily of bonding ties enforce norms between actors thereby limiting the potential to address vulnerabilities to climate change by restricting system innovation and flexibility (Luthe, Wyss & Schuckert, 2012; Fischer et al., 2014). This is evident in the study by Wolf et al (2010), where adaptation to heat

waves was inhibited by bonding capital in the networks of elderly people. Bonding capital in this case spread the notion that elderly could cope with heat waves, and did not encourage actors to make adjustment to limit the impacts of heat waves.

Therefore whereas strong ties provide vital sources of influence in networks, weak ties play unique roles in contributing to new forms of knowledge into networks which provides space for innovation and adaptive learning which can then be diffused into networks through strong ties (Brass & Krackhardt, 2012). In the previous mentioned case of heat waves and elderly people, Wolf et al (2010) suggest bridging ties between sub-groups with opposing views may be beneficial in challenging viewpoints and creating new social behaviours within social networks. However this study was carried out in a developed nation with presumably less socio-economic vulnerabilities, and social network outcomes may present themselves differently in developing countries. As developing countries face greater vulnerabilities to climate change, bonding ties may be essential not only for coping with the impacts but for mobilising networks to bring resources together and adapt to climate changes.

Similar to the case of heat waves, in a study of agricultural actors, Dowd et al. (2014) found actors with multiple strong ties were implementing incremental CCA[1] measures which failed to build long-term resilience to these groups. This was found to be the result of strong bonding ties enforcing norms between actors. In contrast, groups with weaker ties were more able to overcome the norms within their social network and demonstrated the highest potential to implement transformative CCA[2] measures (Dowd et al., 2014).In this sense strong network ties could potentially enforce practices of coping and/or adaptive strategies with limited long term benefits to overall resilience of socio-economic systems, while weak ties may be vital in allowing the flexibility needed for building resilience in uncertain conditions. However this study was again based in a developed country (Australia) with agricultural actors presumably having much greater capacities to overcome climate shocks. In developing countries transformative CCA may be heavily reliant on strong ties between actors which could encourage effective knowledge sharing. These strong ties can stimulate system transformation through social learning which can recouple society and nature, and facilitate coproduction of knowledge

[1] Incremental CCA: Adaptation measures which make adjustments to existing systems and behaviour.
[2] Transformative CCA: Adaptation measures which seek to create a fundamentally new system

between actors so that actors in developing countries are more capable of overcoming complexities and uncertainties pertaining to the impacts of climate change.

Thus while empirical studies from the developing world point towards the pitfalls of too much of one form of social capital, studies in the developing world need to be cognisant of the complex process of knowledge exchange and multifaceted nature of social capital when dealing with issues of climate change. In theory long term resilience should require both bonding ties, to create homophily and promote coping capacities, and a range of far-reaching bridging and linking ties, which allow a diversity of new information and values to enter the network and benefit adaptive and transformative capacities. However in developing countries the manifestation of social network benefits and challenges will largely be dependent on the context specific vulnerabilities, and the means to build resilience in these contexts. The concepts of vulnerability and resilience will be explored further in the following section.

2.2 Understanding Vulnerability and Resilience in the Context of Flooding

The concepts of vulnerability, adaptation and resilience have fast been gaining prominence within climate change literature and policy-making (Gaillard, 2010; Tanner et al., 2015). As the global temperatures increase in the 21st century, the climate-related risks associated with these changes increasingly threaten the stability and functioning of all socio-ecological systems. As such it is vital to understand these concepts in the context of climate-related risks, in order to understand how to mitigate the impacts of climate change.

2.2.1 Flood Vulnerability in Informal Settlements

The climate-related risks associated with climate changes vary from place to place based on the interaction between the hazards (of natural variability and anthropogenic climate changes) and the context specific socio-economic processes which increase the exposure

and sensitivities to these hazards (Field et al., 2014). Flooding is a dominant climate-related risk which is likely to occur more frequently and with greater intensity due to climate change continuing to adversely affect socio-ecological systems (Wilby & Keenan, 2012). The main causes of flooding in urban areas are the inadequate drainage systems, development within floodplains, or development on the banks of rivers (Douglas et al., 2008). The risks posed by flooding include the disruption of local development, economic activities and livelihoods, the loss of life and health impacts, and the damage to infrastructure and built structures (Tempelhoff et al., 2009; Ashley et al., 2012).

According to the IPCC definition, vulnerability refers to "The propensity or predisposition to be adversely affected" (Field et al., 2014: 39). In the context of flooding, vulnerability refers to the likelihood of a socio-ecological system to be exposed to flood related risks, and the extent to which this system will be negatively impacted by these risks (Few, 2003). In this sense one crucial aspect of vulnerability is the capacities of actors within systems to predict, withstand and recover from the impacts associated with these risks (Anderson-Berry, 2003).

As Anderson-Berry (2003) describes vulnerability as the capacity to respond to a hazard, vulnerability to flood related risks varies not only across geographical scales but across socio-economic contexts. For instance, vulnerability to flood-related risks is expected to be concentrated in informal settlements (Few, 2003; Douglas et al., 2008). In this sense, the presence of a flood hazards does not directly correlate to the vulnerability of informal settlements, but is a product of both the exposure and sensitivity of these settlements to flood related risks (Kotzee & Reyers, 2016). However these vulnerabilities refer not only to the climatic exposure and sensitivities to flooding, but the socio-economic processes, such as the historical, political, and economic contexts, which have created systems of political, social and economic marginalisation of residents in informal settlements (Smit & Wandel, 2006; Miller et al., 2010).

Informal settlements are extremely vulnerable to flooding not only because of their geographical location but due to various factors which make these settlements increasingly sensitive to the occurrence of flood events. Poverty is a large determinant of the vulnerability of these settlements because of the location of impoverished groups in areas of high flood exposure, as well as the concentration of high populations and poor infrastructure and building conditions associated with these settlements (Few, 2003;

Douglas et al., 2008; Tempelhoff et al., 2009; De Risi et al., 2013). However vulnerability may also be the result of the underlying social conditions in which poor groups are unable to access resources, information or power, which inhibits their ability to respond to flooding events (Few, 2003). According to Torkelsson (2007) the most vulnerable individuals are often excluded from social network structure, which means the vulnerabilities of these individuals is exacerbated by their inability to access resources through social networks. Hence addressing flood vulnerability in informal settlements require reducing the exposure of these settlements to flood related risks, as well as reducing the sensitivities which cultivate vulnerabilities in informal settlements.

2.2.2 Flood Resilience in Informal Settlements

The concept of resilience has become a dominant term in both the disaster risk reduction and climate change literatures with resilience-building being widely recognised as key to addressing vulnerabilities to climate change (Gaillard, 2010; Kotzee & Reyers, 2016). Resilience refers to the capacity which socio-ecological systems possess to maintain the core properties of the system while experiencing external stresses such as climate-related risks (Walker et al., 2004; Field et al., 2014). Climate resilience can either refer to specified resilience or general resilience (Walker, 2009). The former is used when referring to resilience in term of resistance of particular elements of the system to a defined risk, while the latter referring the resilience to unspecified and possibly unknown shocks (Walker, 2009). When referring to flood resilience in informal settlement, this research assumes the approach of general resilience because this research does not operate with particular harm thresholds or with defined impacts of flooding. In this sense, flood resilience is used to describe the ability of socio-ecological systems to mitigate the exposure and sensitivities of systems to the risks of flooding through measures which will ensure less flooding occurs, less harm occurs and coping capacities are improved (Schelfaut et al., 2011; O'Sullivan et al., 2012).

While moving informal settlements away from a state of vulnerability is vital for flood resilience, building long–term resilience requires an understanding of the complexities within socio-ecological systems (Walker et al., 2004). As climate change presents local

governments with various uncertainties, building resilience in informal settlements entails that local governments plan for uncertainty in the climate and in how informal settlements respond to these flood risks. Walker et al (2006) describes resilience as a property which emerges as a result of the complex interactions between system components and hazards. To this extent building flood resilience in informal settlements requires interventions which address initial conditions of vulnerability and account for complex interactions between system components (Walker et al., 2004; Brody, Kang & Bernhardt, 2010; Bahadur, Ibrahim & Tanner, 2013).

An important consideration when dealing with resilience is that resilience may not always produce desirable outcomes. For example resilience of some systems to climate risks may result in the long term corrosion of systems in a changing climate, and may maintain undesirable systems of inequality (Miller et al., 2010). In the developing world particularly this challenges conceptions of resilience, as the concept needs to acknowledge the state of resilience as dynamic and complex. Creating an understanding of how the components of socio-ecological systems manifest resistance to flood related risk establishes a basis from which local governments can build resilience to natural variability and uncertainties (Kotzee & Reyers, 2016). A review of existing literature on resilience served to highlight the main components of a resilient system, illustrated in Figure 1, to be discussed in the following section.

2.2.3 The Conceptualisation of System Resilience and the Capacities to Build Resilience

As resilience is described as an emerged system property, applying the concept to studies of municipal resilience must acknowledge the dynamic and interrelated nature of the concept. Figure 1 provides a simplified visual representation of the concept of resilience, adapted from various literature, with five main interrelated components which affect the capacities to build resilience. These main components as, explained in Figure 1, are the capacity to overcome uncertainty, inclusivity, self-organisation, effective and equitable governance, and social capital. As these components are overlapping and interrelated, various aspects of each component will be evident in the various components of the framework (discussed in section 3.2) applied to this research.

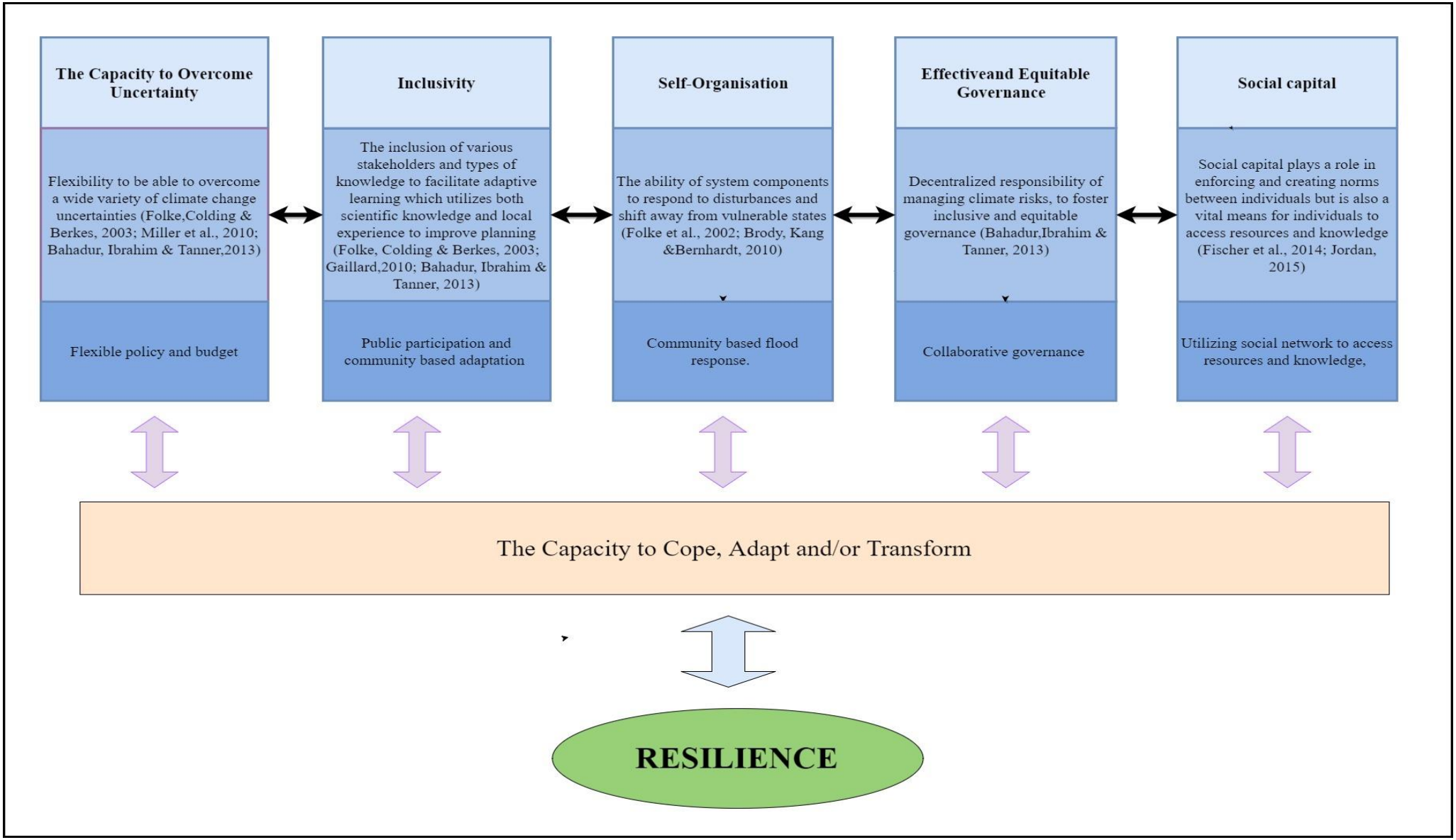

Figure 1- Illustration of the components of resilient socio-ecological systems. The figure illustrates how the components of a resilient system, influence the coping, adaptive or transformative capacity of a system to build resilience. The blue blocks list each of these components (top blocks) with a brief description of these components (middle blocks) and an example of how these components may manifest in a flood resilient system. .

The resilience of systems is not solely dependent on these five components, but is a product of the influence these components have on influencing the coping capacity, adaptive capacity and transformative capacity of the system (Folke et al., 2002; Walker et al., 2004; Miller et al., 2010).

Coping capacity refers to the ability the system has to maintain its functioning and identity and resist change under the pressure of a hazard (Bahadur, Ibrahim & Tanner, 2013) While coping capacities are vital components of resilience because they ensure the perseverance of socio-ecological systems, coping strategies neither address the cause of vulnerability nor the indirect impacts of hazards and only contribute to the short-term resilience of systems (Miller et al., 2010; Tyler & Moench, 2012).

On the other hand, **adaptive capacity** refers to the ability of the system to make alterations in attempts to reduce the vulnerability of the system and avoid the negative impacts of hazards (Smit & Wandel, 2006; Field et al., 2014). Where coping capacities are limited in their short-term contribution to the resilience of socio-ecological systems, adaptive capacities are valuable in shifting the system away from vulnerable states and limiting the impacts of climate-related risks (Smit & Wandel, 2006). Despite the increase in climate-related risks pushing the need for adaptive capacity to drive resilience within socio-ecological system, adaptation strategies have been criticised for not addressing the root causes of vulnerability (Magnan, 2014). This means adaptation strategies may possibly have a limited contribution to long-term resilience and could possibly shift the burden of vulnerability onto other systems (Magnan, 2014; Dowd et al., 2014).

Transformative capacity refers to the ability of a system to shift the nature of the entire system to create a fundamentally new system (Walker et al., 2006). When a system faces disturbances associated with climate-related risks, aspects of resilience which promote innovation, reorganisation and transformation opens the door to transformational sustainable development which allows socio-ecological systems to be resilient to a range of uncertainties (Folke, 2006). Ziervogel et al. (2016:955) describe transformational capacity as being supported by the recoupling of "life-support systems, agency, and social cohesion." Therefore transformative capacities exercise creativity capacity and innovation to address the underlying causes of vulnerability (both social and environmental) to avoid harm under various climate uncertainties (Folke, 2006; Tyler & Moench, 2012).

These three capacities refer to the amount of natural, physical and social capital which systems possess, and the ability of systems to access and utilized this capital in order to prevent undesirable affects in the face of hazards (Smit & Wandel, 2006; Gaillard, 2010). The resilience of socio-economic systems depends largely on a mix of these capacities to ensure systems can face climate risks without detriment but also so systems can adapt and transform in order to address the vulnerabilities of the system. This research will focus primarily on the social capital property (in terms of the social networks of local governments) and its effect on adaptive and inclusive governance (which includes aspects of flexibility, inclusivity, collaboration and effective governance).

2.3 The Role of Local Government in Building Resilience against Climate-Related Risks.

As resilience refers to the dynamic properties of socio-ecological systems, the governance of these systems has a considerable role in limiting or promoting resilience against climate-related risks. The decentralisation of governmental roles in building resilience is vital for redistributing power and resources to the local level, to enable flexible context-specific decisions that address local vulnerabilities to climate change (Miller & Douglass, 2016). As the impacts of climate-related risks will be experienced on the local level, local governments have a key role to play in building the capacities to respond to local climate-related risks (Roberts, 2008; Pasquini et al., 2015). The direct roles which municipal councillors and managers have in planning and managing risk reduction at the local levels means these actors hold great potential to build resilience at the community level (Brody, Kang & Bernhardt, 2010; Pasquini et al., 2015).

While local governments are vital in building resilience, the ability for governments to effectively build resilience is largely dependent on the availability of resources and the capacity to effectively access these resources (Smit & Wandel, 2006; Brody, Kang & Bernhardt, 2010). Financial capital in particular can constrain the building of resilience, as effective CCA strategies often carry a high price which is constrained by the budget of local governments to implement these strategies (Tempelhoff et al., 2009; Pasquini et al., 2015). However these budget constrains can be effective in stimulating creative and

adaptive management, especially to avoid the cost of the impacts of climate-related risks, which could benefit local resilience (Lowndes & McCaughie, 2013; Pasquini et al., 2015).

While financial capital is a vital component for local governments in implementing strategies to build resilience, social and knowledge capital also have a key role in enabling the capacities of local governments to build resilience. The potential for local governments to effectively address vulnerabilities is often dependent on collaborative governance which includes various stakeholders, disciplines and types of information in order to strengthen institutional and organisational capacity to respond to climate-related risks (Pasquini et al., 2015; Miller & Douglass, 2016). Government managers often possess strong bonding capital between subgroups in the government with very little bridging capital between other disciplines (Stein, Ernstson & Barron, 2011). With limited bridging and linking social capital as well as cognitive constraints to resilience, the political environment of local governments is likely to hamper resilience by inhibiting the ability to deal with uncertainty and harness creative and transformative capacities (Folke et al., 2002).

In addition to the financial and social capital needs for local resilience building, the ability of local governments to build resilience to climate-related risks often depends on the political context of local governments. For example the cognitive values and practices of decision making bodies, as well as the stability of municipal political actors can largely influence the management policies of local areas (Lowndes & McCaughie, 2013; Pasquini et al., 2015).

The ability of local governments to build resilience can also be a result of the structure of local government systems. Metropolitan municipalities[3] have a much higher concentration of resources and capital to facilitate resilience building whereas local and district[4] municipalities are likely to have less stakeholders and less resources (Pasquini, Cowling & Ziervogel, 2013; Pasquini et al., 2015). However larger government sizes may also work against local governments, as institutional silos may inhibit collaboration between different departments (Pasquini, Cowling & Ziervogel, 2013). This research thus seeks to explore how patterns of social interaction vary across different types if local

[3] Metropolitan Municipalities are usually local governments which oversee the governance of large cities.
[4] Local municipalities are local governments which do not encompass large cities, while district municipalities oversee the governance in a conglomerate of local municipalities.

governments, and how these social interactions affect the ability of the local governments to build resilience. Brief overviews of the profiles and governance structures of these two municipalities, and the theoretical framework for this research will be provided in the subsequent chapter.

3 Context and Methodology

This chapter provides an overview of the study sites and methodology utilized to carry out this research. The first section of the chapter provides a brief profile and governance overview for each of the local municipalities examined throughout the thesis. This is followed by an overview of the theoretical framework applied to the research. Following the framework are sections on data collection and analysis, and the chapter is concluded by outlining the limitations and ethical considerations for this research.

3.1 Study Sites:

3.1.1 The Nelson Mandela Bay Metropolitan Municipality

The NMBMM, located in the Eastern Cape of South Africa (as illustrated in figure 2(a)), is one of the eight metropolitan municipalities (or category A municipalities), representing the biggest cities in South Africa (Pasquini, Cowling & Ziervogel, 2013). The municipality covers an approximate administrative area of 1 950 km^2 and has the 6^{th} largest population in South Africa, with a population of approximately 1.2 million people (Statistics South Africa, 2012). The Metro acts as the economic centre for the Eastern Cape of South Africa, with the multimillion dollar Coega Industrial Development Zone, and the Port of Port Elizabeth and the deep water Port of Ngqura making the municipality highly desirable for industrial activities (Statistics South Africa, 2012; Nelson Mandela Bay Metropolitan., 2016). Despite making up more than 40% of the Eastern Cape's economy, poverty remains an issue for the metro with a 36.6% unemployment rate and 9 informal settlements with more than 30 000 informal households (Nelson Mandela Bay Metropolitan., 2016).

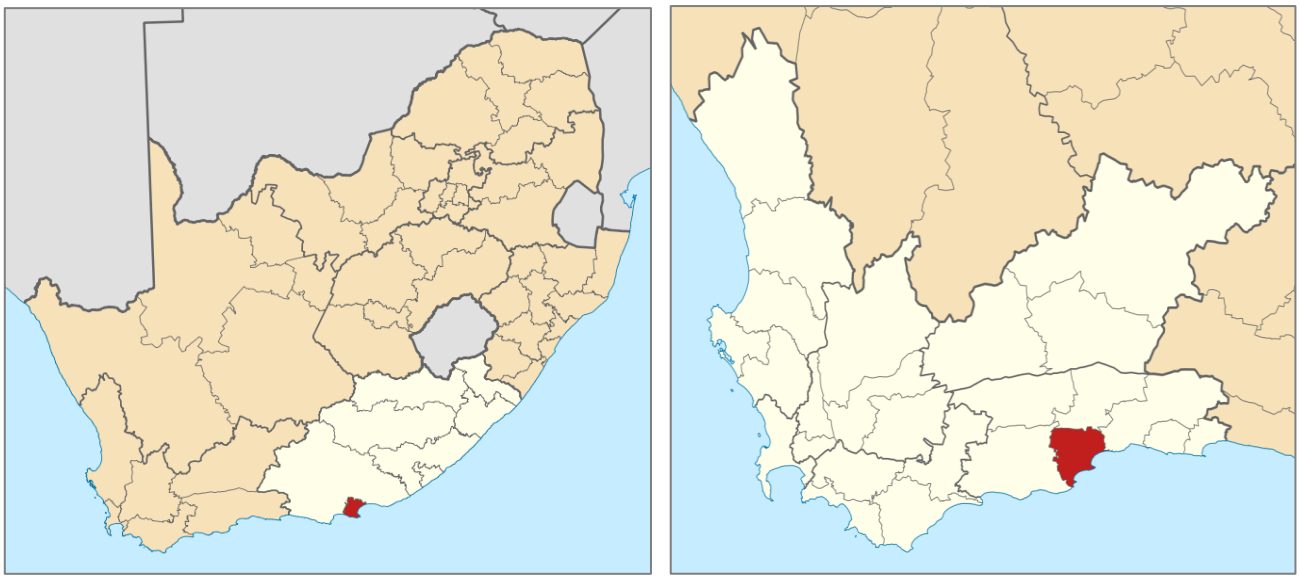

Figure 2(a) Map of South Africa with the Eastern Cape shaded in pale yellow and the Nelson Mandela Bay Metropolitan Municipality shaded in red. (b) Map of the Western Cape shaded in pale yellow with the Mossel Bay Local Municipality shaded in red. Source: http://en.wikipedia.org

The governance structure of the NMBMM, as other municipalities in South Africa, is divided into a political and an administrative branch of government. The structure of governance is illustrated in Figure 33. The political governance structure consists of a council comprised of 60 ward councillors, 60 proportional representative councillors[5], and the executive major and the mayoral committee (Nelson Mandela Bay Metropolitan., 2016). This mayoral committee consists of the executive mayor, the deputy mayor and chairpersons from nine portfolio committees[6], and represent the elected officials responsible for decision-making in the municipality (Nelson Mandela Bay Metropolitan., 2016), as is the case in all South Africa municipalities. The administrative governance of the municipality is headed by the city manager, the chief operating officer, the chief financial officer and directors from nine directorates[7] (Nelson Mandela Bay Metropolitan., 2016). The administrative branch of governance is responsible for

[5] Councillors are elected officials in local governments; ward councillors refer to councillor elected to represent local wards and proportional councillors reflect the proportion of votes received by each party in elections.
[6] Portfolio Committees: committee which form part of council. Each portfolio committee is responsible for decision making for a particular subdivision or directorate within a local government.
[7] Directorate: A subdivision of local governments mandated to carry out particular administrative duties. Directorates can be divided into sub-directorates which carry out key mandates of the directorate.

implementing the decisions made by council as well as achieving the goals outlined in the Integrated Development Plan (IDP), in NMBMM as in all South African municipalities.

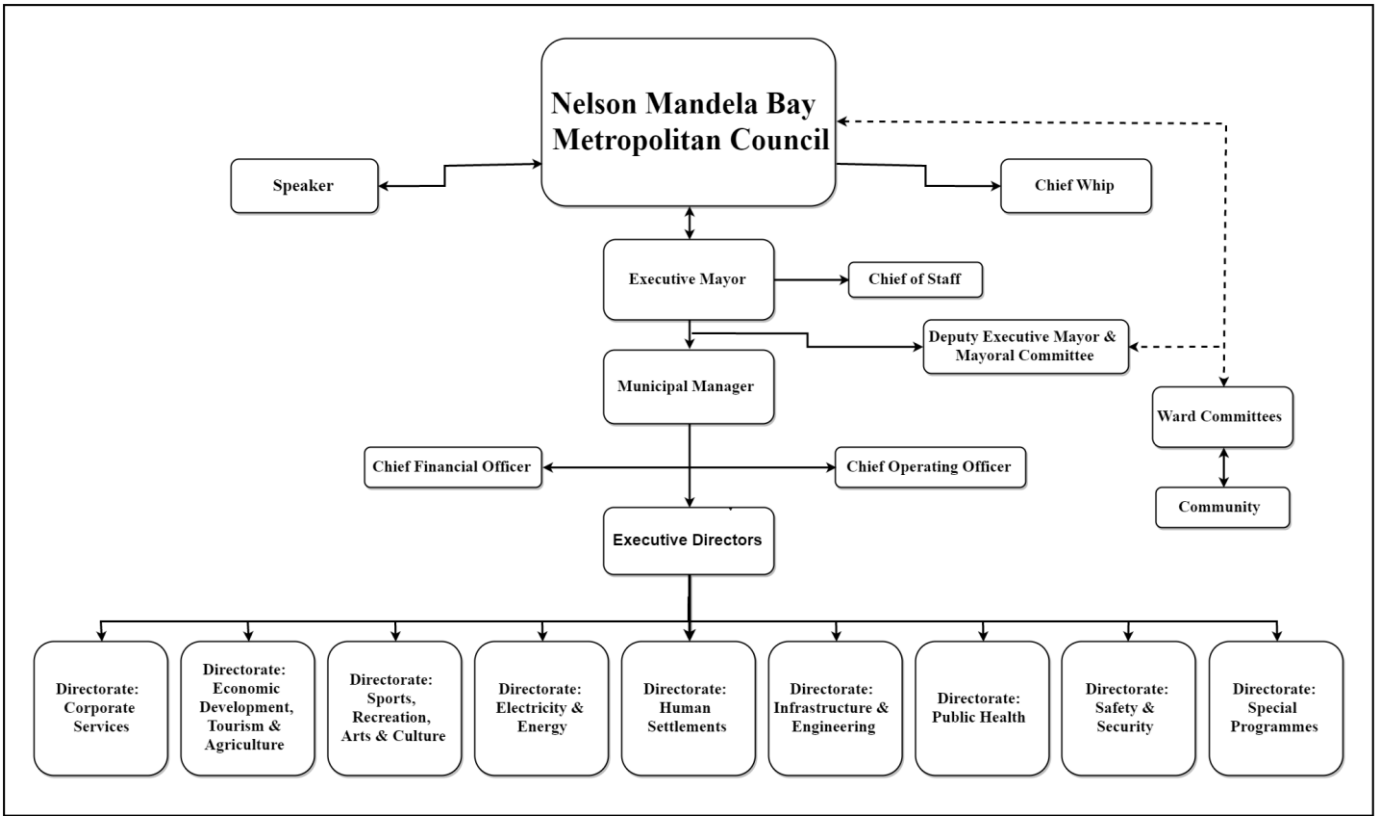

Figure 3 - The Structure of Governance in the Nelson Mandela Bay Metropolitan Municipality. (Adapted from (Nelson Mandela Bay Metropolitan. 2016))

In terms of disaster risk management, NMBMM has a specially mandated Disaster Management Centre (DMC), under the Safety and Security Directorate (Nelson Mandela Bay Metropolitan., 2016). The DMC is responsible for identifying areas at risk from flooding exposure and develop contingency plans for these areas. The Municipal area consists of four river and river estuaries, these being the Sundays, Swartkops, Maitland and van Stadens Rivers (van der Linde et al., 2010). While large portions of the municipality consists of conservation and protected areas, the natural ecosystems of the area are strained by urban growth (van der Linde et al., 2010). The climate of the municipality is considered temperate and warm with rainfall throughout the year (van der Linde et al., 2010). According to the municipality's risk assessment report, floods and fires are ranked as top priority hazards for the municipality (van der Linde et al., 2010).

The area has a history of flooding, with regular seasonal floods occurring in Port Elizabeth due to poor drainage in the city (van der Linde et al., 2010). The informal settlements of

the municipality have been noted as carrying the highest socio-economic vulnerability in the municipality (van der Linde et al., 2010).

3.1.2 Mossel Bay Local Municipality

The Mossel Bay Municipality is a local municipality (or category B municipality) in the Western Cape province of South Africa (as illustrated in figure 2(b)). The municipality is one of seven local municipalities which form the Eden District Municipality[8] (Mossel Bay Municipality, 2015). The municipality has an approximate area of 2007 km^2 with an estimated population of 117 000 people (Mossel Bay Municipality, 2015). The municipality has considerably less stakeholders in disaster risk management than major metropolitan municipalities such as NMBMM, with a smaller economy, fewer institutions and a much smaller population size than metropolitan areas (Mossel Bay Municipality, 2015). In terms of service delivery the municipality has been recognised as having an excellent track record with high proportions of the population having access to water, sanitation, electricity, education and housing (Mossel Bay Municipality, 2015). However, despite this track record, the municipality still experiences issues related to population growth and socio-economic inequality.

During the period 2001 – 2011 the municipality experienced a population growth of 2,24% accounting for an additional 17 935 new residents placing strain on current infrastructure as well as housing and service backlogs in the municipality (Mossel Bay Municipality, 2015). Approximately 5 588 households or 19% of all households in the municipality are classified as being informal or overcrowded dwellings with the majority of inadequate housing needs being concentrated in the urban areas of the municipality (Western Cape Government, 2015).

[8] South African Municipalities are categorised into 3 categories: Category A, B & C. Category A represent metropolitan municipalities, Category B represent local municipalities & category C represent district municipalities. Category C municipalities encompass a conglomerate of category B municipalities and are responsible for overseeing development within these category B municipalities.

The structure of governance of MBLM is illustrated in Figure 4. The political governance consist of the executive mayor, the deputy executive mayor and the mayoral committee (consisting of five committee portfolios). The political governance also consists of 14 ward councillors and 13 proportional representative councillors (Mossel Bay Municipality, 2015). The Administrative governance consists of the municipal manager, the strategic support executive and the directors from 5 municipal directorates.. As a local municipality, MBLM falls under the Eden District Municipality (EDM) which is also responsible for coordinating and overseeing regional development between MBLM and six other local municipalities (Eden District Municipality, 2015). Disaster management in EDM falls largely on the district, with a district DMC located in George, with key responsibilities being delegated to a specific department within each local municipality. The delegate department responsible for disaster management in MBLM is the Fire and Disaster Management Services, under the Social Services Directorate.

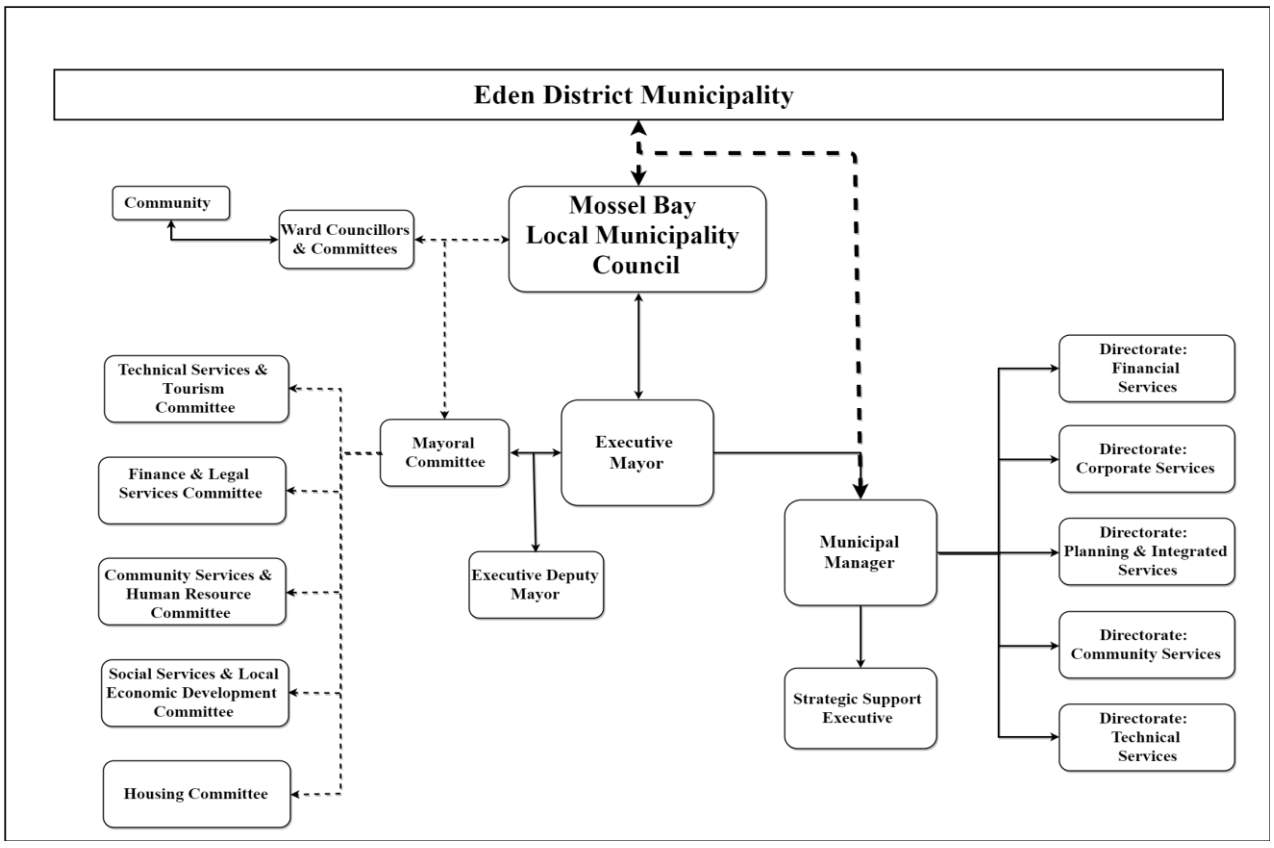

Figure 4 - The Structure of Governance for Mossel Bay Local Government (Adapted from (Mossel Bay Municipality, 2015))

The Eden District has been identified as being one of the most vulnerable areas to disasters, especially flash flooding, in South Africa, with the informal settlements of the area possessing very low resilience to the impacts of flooding (Kotzee & Reyers, 2016).

The close proximity to rivers, and their location within low-lying areas, make settlements within EDM extremely exposed to flooding risk. This flooding exposure is paired with flooding sensitivity attributed to poor infrastructure and a lack of warning systems, making these settlements extremely vulnerable to flooding (Faling, Tempelhoff & Van Niekerk, 2012; Eden District Municipality, 2013). The observed impact of flooding within EDM is believed to be increasing with each flood event, as development and climate changes continue to exacerbate the intensity of flooding events thereby diminishing coping capacities (Faling, Tempelhoff & Van Niekerk, 2012). Despite the risks posed by flooding to the area, flood prevention and preparedness are not high priorities on local government agendas and poor recovery strategies, ineffective infrastructure, budget constraints and flood line settlements have limited the development of resilience in the area (Tempelhoff et al., 2009; Raju & Van Niekerk, 2013).

3.2 Applying a Social Networks Framework to the Study of Municipal Resilience

According to the components of socio-ecological resilience in Figure 1, social capital is a vital component of resilient systems. As social capital is defined by Fischer et al. (2014: 674) as "the stock of informal and institutionalised relationships", applying a social networks framework is beneficial in examining the influence social interactions have on the resilience of socio-ecological systems. In order to examine the role social ties have on improving the capacity of local governments to build resilience, this study will follow the framework outlined in Figure 5. This framework represents the theoretical flow of this research, and was adapted from the conceptualisation of resilience as illustrated in figure 1. As such the framework utilised elements of the five main components of system resilience (as outlined in figure 1) in the main components of the framework (to be discussed below).

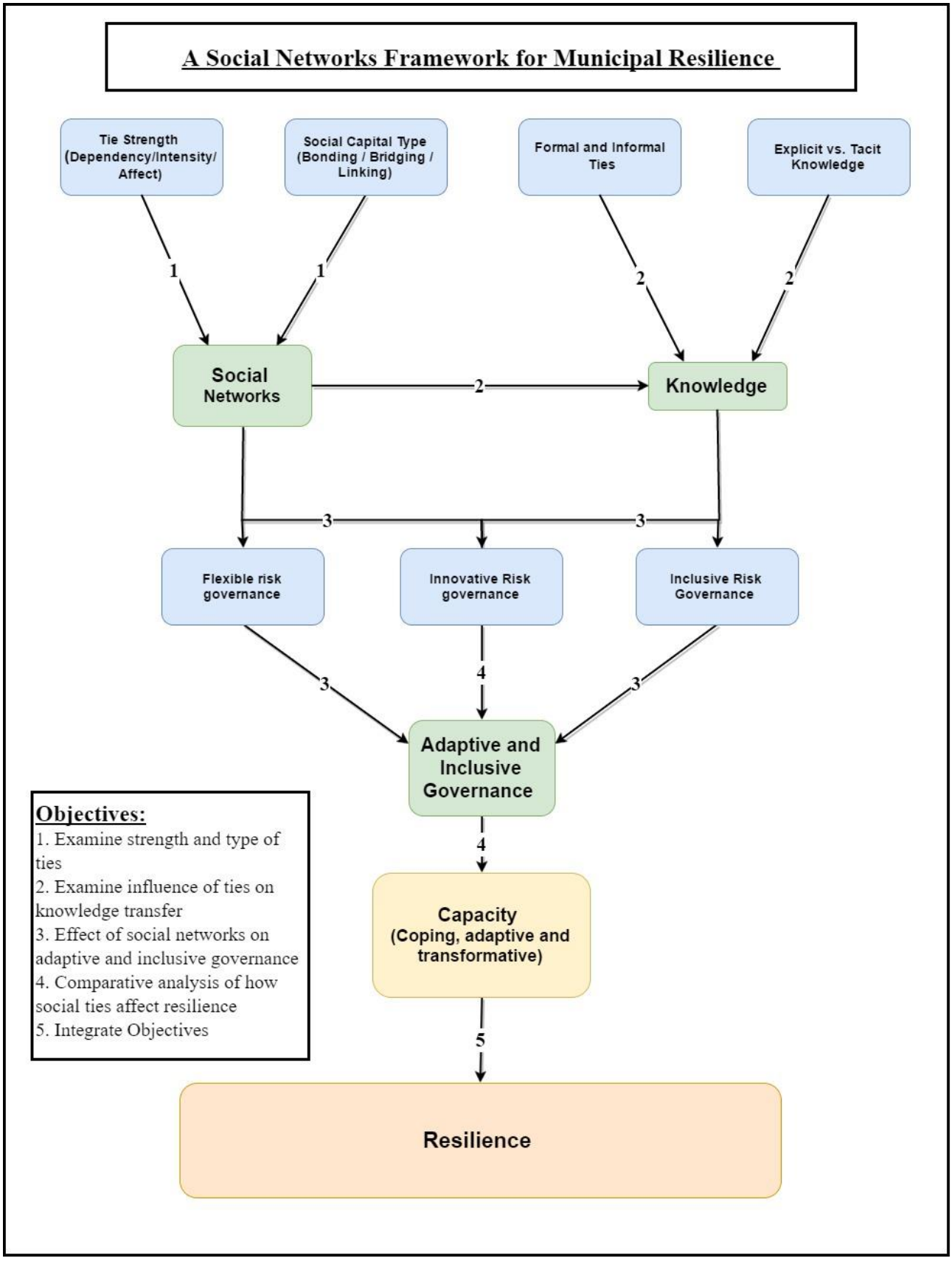

Figure 5 - Social Network Framework for Municipal Resilience. The framework illustrates the theoretical flow for this research with each of the three main components of the framework shaded in green. Key Parameters for data collection are shaded in blue, with expected outcomes shaded in yellow and orange. Arrows indicate the flow of data collection and analysis with numbers indicate the key objectives fulfilled by examining each component and parameter.

3.2.1 Social Network Ties

Drawing on social network analysis, the first objective of this research will be achieved by examining the strength and type of ties within the municipal networks of respondents. The strength of ties between municipal actors will be assessed using the model for network processes described by Krackhardt (2003), considering the dependency, intensity and affect of ties. Dependency will be utilised as a measure of the extent to which actors are dependent on social ties as sources of knowledge, and whether the functions these ties play can be replaced by different social actors (Brass & Krackhardt, 2012). Intensity can be utilised as a measure for the strength of the relationship held by two actors sharing a tie, determined by the frequency and nature of interactions between the actors (Brass & Krackhardt, 2012). Lastly the affect of ties refer to the perceptions social actors sharing a tie have towards each other. Affect is often referred to as the emotional and cognitive closeness of a relationship which aid in the development of trust between actors (McAllister, 1995). Brass and Krackhardt (2012: 368) suggests the affect of ties often relates to the "homophily and balance" between actors. Thus examining the homophily, in terms of values, attitudes and goals, between actors can be paired with indicators of dependency and intensity to inform the strength of social ties.

In addition to examining the strength of ties using the model described by Krackhardt (2003), the role these ties play in bonding, bridging or linking social capital will also be examined. Bonding ties shape homogenous sub-groups by connecting actors with similar social positions that have immediate and frequent interactions (Hampton, 2011; Islam & Walkerden, 2014). While bridging ties connect actors from these sub-groups with similar actors from different sub-groups, and linking ties connect actors from these sub-groups with actors on different levels of authority (i.e. different levels of government) (Ferlander, 2007; Islam & Walkerden, 2014). Thus identifying the types of ties between municipal actors will establish the prevalence of sub-groups within the social networks. As each sub-group will represent a bonded network core, these sub-groups will indicate areas of homophily in terms of shared values, attitude and goals within social networks.

3.2.2 Knowledge

The second objective of this thesis will be achieved through the examination of knowledge sources and transfers within the networks of municipal actors. As the global climate changes it is vital for knowledge system to be open, to include diverse forms of knowledge and to foster the co-production of knowledge (Cornell et al., 2013). According to organisational learning theory, knowledge exchange at the institutional level is a product of social processes and interactions which involves learning from two types of knowledge, these being tacit and explicit knowledge (Fischer et al., 2014). Explicit knowledge refers to formal knowledge which can be easily communicated via formal learning channels, whereas tacit knowledge refers to informal knowledge which is gathered from shared experiences and observations at the local contexts (Fischer et al., 2014). Tacit knowledge is thus gathered through experience, and then transferred within communication networks, where it gains recognition and is developed into explicit knowledge, which can then be modified and communicated to feed back into tacit knowledge (Fischer et al., 2014). Identifying types of knowledge being exchanged within networks were done by examining the types of sources of knowledge (e.g. academic, policy, experience, etc.) and examining the kind of knowledge which is primarily used when making decisions.

As complex knowledge systems can be perceived as being participatory and dynamic, the knowledge available should constantly be evolving (Cornell et al., 2013). Therefore, local governments can gain flood-related knowledge from formal sources as well as shared experience at the local context. This should entail a mixture of formal and informal opportunities to transfer knowledge. Explicit knowledge refers to verified information which can be produced and communicated from institutions and organisations (such as universities, governmental entities or international entities) (Wenger, 2011). This type of knowledge is often transferred by compulsory ties which have been laid out by governance and organisational structures (Allen, James & Gamlen, 2007). However, the uncertainty of climate change requires decision-makers to have a diversity of knowledge sources and stakeholders to address increasing climate-related risk (Bahadur, Ibrahim & Tanner, 2013). Thus informal ties will become increasing important for municipal actors. These informal ties refer to interactions and collaboration between actors or entities which are not bound by organisation structures, but rather form through organic

relationships (Allen, James & Gamlen, 2007). Thus informal ties include ties between municipal actors and local organisations, universities, experts and NGOs who have shared experiences of the local context. Identifying the types of exchanges occurring was done by examining whether ties were based on governance or organisation structures or whether they had emerged organically.

3.2.3 Adaptive and Inclusive Governance

The components of resilient systems, illustrated in Figure 1, outline the components which enable the capacities of systems to build resilience and address vulnerabilities. In order to assess the impact of social network ties on adaptive and inclusive governance (objective 3), this framework will examine their impacts on the flexibility, innovation and inclusivity aspects of risk governance.

Adaptive and inclusive governance is a vital measure of resilience because local governments play a critical role in building resilience at the local level (Field et al., 2014). Effective risk governance under climate change entails the inclusion of various stakeholders, innovative governance, and flexibility in the management of socio-ecological systems (Bahadur, Ibrahim & Tanner, 2013). As the impacts of climate-related risks on complex socio-ecological systems will vary greatly over temporal and spatial scales, flexibility, innovation and inclusivity directly relate to the principles of adaptive co-management which are essential for addressing vulnerabilities to these impacts (Armitage et al., 2009).

Flexibility is a vital component of local governments' capacity to effectively manage flood risks in informal settlements under various uncertain conditions (Bahadur, Ibrahim & Tanner, 2013). Flexibility can be measured by examining the features of structured decision-making outlined by Nichols et al. (2011). These features include objectives (assumed to be building flood resilience in this case), current management resources and budget, the use of various models, monitoring and solutions (Nichols et al., 2011). The integration of these features into the management of socio-ecological systems allows local governments to exercise flexibility in planning and decision making under uncertain

conditions. This research will focus mainly on features of use of models, solutions and management resources

The flexibility of local governments is also largely dependent on system innovation. Innovation is a large component of self-organisation, whereby human agency allows socio-ecological systems to respond to natural hazards in fundamental new ways (Ziervogel, Cowen & Ziniades, 2016). Innovation thus reflects the creative capacity of municipal actors under uncertain and changing conditions (Folke et al., 2002).

In addition to flexibility and innovation, the inclusion of various types of knowledge, stakeholders and flood mitigation strategies is essential in effective and locally relevant risk governance (Bahadur, Ibrahim & Tanner, 2013).

3.2.4 Capacities to Build Resilience

According to the framework for urban resilience outlined by Tyler and Moench (2012), building urban resilience requires building resistance and addressing the sensitivity of socio-ecological systems to climate risks, while also improving the capacities of actors and institutions to plan for and respond to these risks. In this sense building flood resilience in informal settlements entails addressing the vulnerabilities within these settlements while also improving the capacity of local governments and stakeholders to predict, plan for and respond to flooding-related risks. Thus objective 4 and 5 will be achieved through examining the role adaptive and inclusive governance (as a product of social and knowledge networks) play on building flood resilience, by examining the implications of these factors on coping, adaptive and transformative capacities . The framework for this research will then be used to explore the implications for building flood resilience in the most vulnerable communities, being informal settlements.

3.3 Data Collection

In order to achieve the aim and objectives of this research project data collection occurred within the NMBMM and MBLM from the period October 2016 to December

2016. Respondents from these municipalities were selected using purposive sampling. Purposive sampling is a non-random sampling method, where respondents are purposely chosen due to the presumption that these respondents would process the most relevant information regarding the topic (Tongco, 2007). This form of sampling is appropriate in studies of municipal resilience because rather than seeking to gain insight into governance processes in general, these forms of research are usually particularly focused on aspects of risk governance which may not be applicable to all municipal actors in the network. Thus Purposive sampling was used to identify the relevant authorities and stakeholders involved in local development, flood risk reduction, and disaster management in the two municipalities.

The criteria for selecting participants involved analysis of the governance structures of each municipality according to each municipality's annual report. From these governance structures, councillors and officials were selected based on their position within committees, directorates, or departments which were mandated with either decision-making or the management of flood related risks. This included individuals involved in disaster management, human settlements, environmental management, storm water systems, and planning. The selection of relevant stakeholders was aided by telephone calls and email correspondence with government officials and local experts, who provided advice regarding the correct individuals to contact. Once these relevant stakeholders had been identified, they were contacted by phone calls and emails, given a brief overview of the study and requested to participate in the study. In the case of stakeholders feeling ill-suited to participate in the study, stakeholders were asked to recommend a more suited colleague.

Table 1 lists the sub-directorates and directorates (and numbers) of the stakeholders who consented to participate in this research, 18 in total (more detailed information regarding the job title of respondents is withheld for confidentiality purposes). Once stakeholders consented to participation, semi-structured interviews, with some structured questions included, were conducted with these stakeholders. All interviews were recorded using a digital voice recorder with the respondent's permission. All participants were informed about confidentiality and ethical considerations for this study. All interviews took place in the offices of the respondents, were conducted in English, and lasted between 30 minutes and 90 minutes.

Table 1- List of sub-directorates and directorates of respondents from two study sites. Columns 1 & 3 indicate the sub-directorates of respondents. Column 2 & 4 indicating the relevant directorates of respondents. Respondents from MBLM included respondents from EDM's disaster management centre, due to the strong involvement of the district in local disaster management. NMBMM respondents also included one ward councillor who falls under political governance. .

Nelson Mandela Bay Metropolitan Municipality		**Mossel Bay Local Municipality**	
Sub-directorate	**Directorate**	**Sub-directorate**	**Directorate**
Disaster Management Centre (3 respondents)	Safety and Security	Fire and Disaster Management Services (1 respondent)	Community Services
Environmental Management (2 respondents)	Public health	Environmental Management (1 respondent)	Planning and Integrated Services
Roads and Stormwater (3 respondents)	Infrastructure and Engineering	Roads and Storm Water (3 respondents)	Planning and Integrated Services
Council (1 Ward Councillor)		Human Settlements (2 respondents)	Planning and Integrated Services
		EDM	
		Disaster Management Centre (1 respondent)	Community Services

These interviews explored the relevant measures pertaining to social ties, knowledge and resilience. Appendix 1 outlines the interview guide for data collection for the first component of the framework (social network ties). In order to attain information regarding social ties, interviewees were asked firstly to identify their five main social ties which provide them with the most information in regards to flood risk related knowledge. Interviewees were then asked questions regarding the tie dependency (i.e. how dependent the interviewee is on each social tie for access of information), tie intensity (i.e. frequency and nature of interactions between actors) and tie affect (i.e. do the actors in social network share similar social characteristics and backgrounds). The interviewees were also asked whether they perceive each of the identified ties, to fall within their immediate social group (colleagues in the same department, field, or position that share the same approaches and interact frequently), in order to determine whether the ties can be classified as bridging, bonding or linking ties.

The second section of these semi-structured interviews aimed to ascertain the types of knowledge (tacit or explicit) which are transferred by these social ties. Appendix 2

provides the interview guide for data collection for this section of the framework. Data collection in this section entailed questions regarding sources of information on flooding risk-related information for interviewees. Interviewees were also asked to reflect on the effect these different types of knowledge have on their own decision making.

The final section of the interviews consisted of questions regarding measures of adaptive and inclusive governance, and the interview guide pertaining to this section is provided in Appendix 3. In this section interviewees were asked whether they felt they are able to plan and respond to various flooding risk related scenarios. Interviewees were also asked whether the policy tools, and resources at hand (budget and knowledge) allows decision making and planning for flood related-risk to be flexible to various different outcomes. In order to gauge measures of inclusivity, the interviewees were asked about their engagement with various types of stakeholders, the types of knowledge and solutions which are considered in decision-making processes, and which of these stakeholders and types of knowledge carry the most influence.

3.4 Data Analysis

Interview recordings were transcribed, and the transcripts were coded and qualitatively analysed using thematic analysis. The main themes which emerged from the analysis were strong interpersonal ties, weak and strained ties (social networks), sources of explicit knowledge, value of tacit knowledge, types of knowledge exchanges (knowledge), flexible governance, innovative governance, and inclusive governance (adaptive and inclusive governance). In order to maintain respondents' anonymity, in the following chapters each respondent is assigned a key according to their municipality (NMBMM/MBLM/EDM), a randomly assigned number (e.g. respondent 1) and a randomly assigned letter for the sub-directorate they fall under (dept. A/B/C, etc.)

Information gathered regarding the social network ties of respondents was analysed to examine the sources of information as well as the strength and types of social ties held by respondents. Strength of ties was determined through qualitative analysis of tie dependency, intensity and affect. Ties with high dependency (i.e. ties where information flows would not be maintained if an actor left the network) indicated strong bonding

relationships. However when the dependency was not reciprocal (i.e. dependency was not shared by both actors) ties were considered weak. Ties with high intensity were ties which occurred frequently (i.e. on a regular basis) and were considered to have greater social closeness (i.e. the nature of the relationship). Relationships could be classified as either strained professional (i.e. will work together but face some conflict), strictly professional (i.e. the relationship is solely work-related), more than just professional (i.e. friendly, but does not mean being friends), or friends (i.e. friends also outside of the work context). Therefore ties which were classified as strained or strictly professional were deemed low intensity, while ties classified as more than just professional and friends were deemed high intensity. Ties between actors in a network or sub-group with homophily in values, attitudes and goals were considered to have a high affect. These ties between actors with similar values, attitudes and goals were considered to represent strong ties between actors.

From this it was possible to identify different subgroups within the social networks of local governments. Once these different subgroups were identified, the types of knowledge and the transfer of this knowledge between actors was examined. A qualitative analysis of the measures of adaptive and inclusive governance then examined the different types of knowledge and individuals which were incorporated into decision making and flood management. This informed the flexibility, innovation and inclusivity of flood management at the municipal level. This was followed by a comparative analysis between results from the NMBMM and MBLM to examine how the expected variance in governance structures and sources of knowledge affect these measures of resilience. The framework, outlined in Figure 5, was then applied to integrate all the objectives in order to examine the role that social ties play in transferring different types of knowledge, and how this influences the adaptive and inclusive governance of flood risk management in local governments.

3.5 Limitations

The project was affected by the occurrence of the 2016 local government elections, which were held in August 2016. The election process entails political campaigning and shuffles

in local councils which meant that local governments faced time constraints both before and in the period following the elections. In the NMBMM, a shift in political leadership occurred as a result of a new political party coming to power and a new mayor being elected (The Local Government Handbook, 2016). This change resulted in slight shifts to the political branches of governance as well as to uncertainty within the administrative branch. In order to overcome these challenges, the interview with the political councillor was conducted with a councillor who had served the municipality for more than one term. As newly elected councillor would likely have limited institutional knowledge and experience of the decision making process, interviewing longstanding councillors accounted for insight from both the previous and past political administration of the municipality. However interviews were mostly conducted with municipal officials as councillor did not wish to participate. This may impact findings by offering little insight into decision-making processes, however when applicable municipal managers were asked about their experience with these processes.

3.6 Ethical Considerations

Before the commencement of fieldwork, an application for ethical clearance was submitted to, and granted by, the Faculty of Science at The University of Cape Town (see Appendix 4). All participants of the study took part in the research on a voluntary basis and were offered the opportunity to withdraw their participation at any point in the research. All participants were also assured of full anonymity. Because their position within a public governmental institution might have made it possible to identify them, participants are referred to by respondent key (outlined above in section 3.4) in the following chapters.

4 The Social and Knowledge Networks of Local Governments.

Social networks and the social ties held by individuals have a dominant role in the transfer of information, and how information is used by individuals in the network (Crona et al., 2011). According to the social networks framework (figure 5) applied in this research, social ties have the potential to play a role in creating knowledge networks that can aid adaptive and more inclusive governance, to increase the capacities of local governments to build resilience. This chapter firstly examines the structure of social networks of local actors in flood management by examining the strength of social ties and the types of social capital in municipal networks. This chapter then goes onto examine how these networks influence knowledge exchanges in the two case studies.

4.1 The Strength of Social Ties in Municipal Networks

4.1.1 Dependency

Examining the dependency of respondents on their social ties informs the extent to which interactions are valued and whether these interactions can be replicated (Krackhardt, 2003). The findings regarding tie dependency in each municipality will now be examined, with Table 2 at the end of the section providing a summary of these findings. In general, respondents from the NMBMM demonstrated a very low dependency on actors within their social networks. Often respondents stated being extremely dependent on particular directorates and sub-directorates, however this dependency was based on the roles of the actors rather than the actors themselves. In this sense respondents firmly believe that there would be little loss if an actor were to leave the municipal network. One respondent clarifies that the dependency is based on the function rather than the social relationship and states:

> *"It's not the person, but the department."* (NMBMM, respondent 2, Dept. A)

This quote suggests that granted an actor has a replacement when they leave a network, the loss of social relationships would have little effect. The lack of concern for the loss of social contacts suggest weak ties between these actors. While the majority of respondents (66%, n=6) believe the loss of actors may result in some loss of experience, other respondents (22%, n=2) believed that the rapid employee turnover doesn't allow dependency on specific individuals. Respondents from the latter group state the high number of interns creates uncertainty about the presence of these actors in the network in the future. This regular turn-over of actors within the network results in a hesitance from the respondent to form strong bridging relationships (ties between different sub-groups or networks). According to Lewicki and Brinsfield (2009) beneficial ties require continuous relationships with the ability of actors to overcome mistrust. As the NMBMM features various actors which are new and considered to only be present in the network for a short period, actors are hesitant to form new ties and dependencies on actors from other sub-directorates because of the lack of these continuous relationships.

These findings are in contrast to the situation encountered in the MBLM network, as respondents expressed a high dependency on their social network ties. Most respondents (77%, n=7) stressed the importance of social ties within a small municipality, because of the vital role each of their ties play in fulfilling different line functions. One responded stressed the importance of cooperation between departments of the municipality to ensure that municipal objectives, such as service delivery, are met. His view is evidenced in the following quote:

> *"I'm fully reliant on each of those departments doing what they supposed to do, but what we have found before… because housing for example* […] *if the municipality hasn't got their ducks in a row, to implement the emergency housing programme* […] *then nothing happens."*(EDM, Respondent 1, Dept. A)

Another respondent emphasised the need to maintain these social ties which enable collaboration in order to avoid the loss of vital information sources, stating:

> *"Eventually you must go and humble yourself to that* [person] *if you want that information and you want to keep that relationship."(MBLM, respondent 5, Dept. D)*

The two quotes above demonstrate the dependency that actors in the municipality have on their social ties, for coordinating responsibilities (quote from respondent 1) as well as

for accessing information held within the network (quote from respondent 5). Unlike the NMBMM which regularly has actors entering and leaving the network, respondents from MBLM reported a high dependency on actors within the network because of the actor stability within the network.

In terms of administrative governance in particular, actors at the municipal level are viewed by all respondents as being quite "stable", often maintaining certain positions for long periods of time. These actors thus gain unique value due to their experience within the municipal network, making it essential for these actors to be able to share knowledge should they leave the network. More than half of respondents (55%, n=5) stated that the loss of some actors and their experience would negatively affect the management of the municipality. The following respondent provides an example of such an instance, outlining some of the issues in regards to a municipal official that had recently left the network:

> *"He's an example because he left recently, so* [in terms of] *the communication with his* [successor] *that line is still open, but in terms of the experience that we lost that is quite a big one… it has had an impact."*(MBLM, respondent 3, Dept. C)

In this case, actors within the MBLM network indicate strong dependency on their social ties. While actors leaving won't necessarily affect the presence of social ties between actors, a transfer of knowledge from old to new actors is necessary to maintain the dependency of these ties. A similar concern arose from the actors who had recently entered the social network in NMBMM. Despite the low dependency from the majority of respondents (66%, n=6), the respondents who had only recently entered the network (33%, n=3) revealed a much higher dependency on actors who had been active in the network for longer periods of time. While these newer actors were less dependent on their closest social ties, they were very dependent on the actors who formed the bridging ties between different sub-directorates. One of these respondent states:

> *"if someone like* [Mr. X] *had to leave then it would be a problem, nothing would* [get done]*"* (NMBMM, respondent 4, Dept. B)

This quote demonstrates how the loss of a bridging tie (which Mr. X is, in this context) would make it challenging for the respondent to maintain the same vital ties to a different sub-directorates. This suggested a slightly higher dependency on ties in this case,

however this dependency is not reciprocal indicating weak ties. This finding is similar to past studies which found that actors in new settings (such as immigrants and start-up businesses) are extremely dependent on social ties for initial support (Sanders, Nee & Sernau, 2002; Oviatt & McDougall, 2005).

Table 2- Summary of tie dependency results. The table highlights some of the key themes, subtopics and examples from the findings for the Dependency of social ties and demonstrates whether the point indicates high or low dependency, and weak or strong ties. The table also identifies whether the finding was evident in the Nelson Mandela Bay Metropolitan Municipality (NMBMM) or the Mossel Bay Local Municipality (MBLM).

Theme/Subtopic and examples	**Indicator**				**Case study**	
	Dependency		**Strength of ties**			
	Low	**High**	**Weak**	**Strong**	**NMBMM**	**MBLM**
Perceived level of dependency						
Little dependency on individual actors	x		x		x	
High dependency on each actor		x		x		x
Perceived loss if actor leaves network						
The loss of an actor would result in detrimental loss of experience		x		x		x
Stable actors with individuals maintaining their position for multiple years		x		x		x
Multiple temporary actors – respondents avoid becoming dependent on these actors	x		x		x	
Actors in network for short periods struggle to replace bridging ties if other actors had to leave.		x	x		x	

4.1.2 Intensity

The intensity of social ties indicates tie strength through the parameters of frequency of interactions and the nature of the relationship between actors (Krackhardt, 2003). Findings regarding tie intensity from each municipality will be discussed in the section below, and Table 3 provides a summary of these findings. In terms of the frequency of interactions between ties, in the NMBMM network most interactions did not occur on a frequent basis. Many respondents (55%, n-5) reported only interacting with their ties during specific events (such as disasters), for specific projects which required multiple inputs, or when the other actor initiated contact. Often interactions between sub-directorates were limited to once every few months (usually quarterly), at forum meetings specifically intended to facilitate collaboration, however many respondents

reported these meetings to be poorly attended. Similarly all respondents reported a low frequency of interactions with provincial and national departments, often limiting these to quarterly forum meetings. The lack of frequent interactions and poor commitments to committee meetings indicates a significant trend of low-intensity ties.

The only exception to this general trend of infrequent interactions was evident in one specific sub-directorate, which held long-standing relationships with the others sub-directorates (existing for a period greater than 10 years). Respondents from this sub-directorate stated the following:

> *"We have a very good relationship with* [department X]. *We actually have a monthly meeting, we have a committee that was established in the 80's - and the meetings have been monthly since then. So, there is a very good formal and informal relationship between* [us]*."* (NMBMM, Respondent 2, Dept. A)

> *"I think* [our sub-directorate and Department Y] *are perhaps more than just professional, sort of on a friendship basis* [...] *we even make provisions for* [the other sub-directorate] *to come here and sit in our JOC* [joint operation center[9]] *so they would then be physically here to advise us on, you can almost say minute-by-minute updates"* (NMBMM, Respondent 1, Dept. A)

The two quotes above demonstrate how the long history of social interactions between the respondents in Dept. 1 and the other sub-directorates have not only resulted in more frequent interactions (quote 1) but have facilitated much closer relationships as well (quote 2). Thus it is likely that social cohesion and collaboration in the municipal network requires relationships to be sustained over a relatively long time in order to strengthen ties between actors. This suggestion is supported by Reagans and McEvily (2003) who emphasise how long-standing ties positively influence the frequency and strength of interactions between actors.

In terms of maintaining relationships, respondents from MBLM reported much higher frequency of interactions between ties. All respondents reported weekly interactions with ties from within their own directorate, except one respondent in a senior position who reported daily interactions with ties. In terms of bridging ties between political and

[9] Joint Operation Centres: are assembled during times of disaster to facilitate co-operative emergency responses

administrative government, one administrative respondent (who held multiple ties with ward councillors), while reporting some challenges with interactions, reported almost daily interactions occurring. The respondent explains:

> *"I meet the councillors almost every day and I meet with them at* [weekly] *council meetings. […] If I don't meet with them at least once a week then there's something wrong between us* [the directorate] *and the councillors." (MBLM, respondent 5, Dept. D)*

This response suggests that the high dependency of this respondent on his ties with councillors, drives the high frequency of interactions in order to maintain good relationships with these ties.

In cases of inter-directorate interactions, the frequency ranged during times of the year occurring anywhere between daily and quarterly based on need. Interactions between district and local government officials were less frequent than the intra-municipal interactions, with respondents claiming to only interact on a monthly basis. Similarly, respondents with ties in provincial government (33%, n=3) also reported that they have monthly interactions with these ties. Interactions with national departments occurred less frequently, at quarterly forum meetings. Therefore, while respondents from NMBMM reported low frequencies of interactions between different directorates (with the exception of the long-standing ties held by Department 1), the respondents from MBLM shared high frequency ties within the municipality with lower frequency ties to higher levels of government.

In terms of the relationships between respondents and their social ties, the low frequency of interactions in the NMBMM was reflected by most respondents (66%, n=6) reporting only having "strictly professional" or "strained professional ties" with colleagues in the municipality. While all respondents reported having more than professional relationships with colleagues within their own sub-directorates, respondents reported having strictly professional relationships between sub-directorates and political governance. When asked to classify their relationship with a tie one respondent replied:

> *"Yes professional, I wouldn't say that we are in contact with them daily or even weekly, but I think all of us know the people."* (NMBMM, respondent 1, Dept. A)

The above quotes demonstrate that interactions between sub-directorates (and between administrative and political governance) seldom extend beyond professional duties. One of the reasons for the weak intensity of relationships between actors could be due to the relatively recent formation of interdepartmental ties: many respondents (66%, n=6) reported only forming ties after a flooding event in 2012. As indicated in the two exceptions of dept. A in terms of frequency, ties formed prior to recent disaster events demonstrate have much higher intensities than those that have been created recently.

As environmental legislation increasingly emphasises the need for co-operative governance, relationships between sub-directorates should be increasing in intensity as interaction is becoming mandatory in municipalities. However, this does not appear to be the case in NMBMM where respondents reported that relationships between sub-directorates were often strained. These respondents cited conflicting departmental priorities as the main reason for these troubled relationships. One responded states:

> *"Infrastructure and engineering is usually … a very development-intensive service. You have to transform patches of land, you have to do excavations, you have to do building structures,* [...] *And when it comes to developments you are looking immediately at environmental impact assessment regulations. So there the relationship* [between environmental management and infrastructure and engineering] *is strained because of the legislation.* [...] *There have been instances in the past where environmental developments were deemed illegal. And those are transgressions that occurred and it obviously brings the municipality into disrepute.* [...] *So those have been issues that have created strained relationships* [between environmental management and infrastructure and engineering]*"* (NMBMM, respondent number and department letter withheld for anonymity).

The above quote demonstrates how actors within the municipal network are often required to work with other sub-directorates with opposing mandates, which can stimulate conflict and low-intensity ties. The quote illustrates how conflicting priorities created strained relationships between environmental management, who are mandated to manage and protect the natural environment, and infrastructure and engineering, who are mandated to develop urban infrastructure, and in so doing may impact the natural environment.

This issue of conflicting and contradicting priorities is not clearly evident, or recognised, by respondents from the MBLM. While all respondents from MBLM insisted their relationship with other actors was strictly professional, many (55%, n=5) respondents suggested that the interactions often go beyond the formal work place environment, often occurring in an informal setting. Due to the size and constancy of the local municipality's network, many respondents feel that a mutual trust and understanding has developed. Actors have strictly professional relationships, but recognize that their job requirements often require them to go beyond professional duties. One respondent explains:

> *"I wouldn't say we are friends but there is an understanding that everybody will go a bit more out of their way because we accept the importance of what we are trying to accomplish. It's a confusing mix between formal communications through formal channels, and the informal stuff we need to do to make the formal stuff work."* (MBLM, respondent 3, Dept. C)

Another respondent provides an example of such interactions, stating:

> *"If* [Mr. Y] *knows something bad, he can see the predictions and he can see everything from weather services,* [and] *he will phone me even if its four o'clock in the morning."*(EDM, Respondent 1, Dept. A)

The above quotes demonstrate how despite the fact that relationships exist in the professional domain, actors are often willing to maintain relationships outside of these professional domains. Another respondent also reported often needing to go beyond his professional obligations (for example, visiting informal settlements experiencing flooding after working hours) in order to maintain good relationships with ward councillors. In this case, the former respondent explained that in order to maintain good relationships, he often had to earn trust and loyalty of councillors by demonstrating his personal commitment to the problem of flooding.

As respondents from MBLM emphasised often going beyond simple professional relationships, the social ties of these respondents demonstrate higher intensities than those of the NMBMM. The "strictly professional" and sometime strained relationships of NMBMM respondents suggest ties of much lower intensities. Roberts et al. (2011) describe how frequency and emotional closeness positively influence the formation of strong ties and social cohesion, suggesting the more frequent and better professional relationships in the MBLM network is likely to positively influence cooperation for flood risk management in the municipality.

Table 3 - Summary of intensity results. The table highlights some of the key themes, subtopics and examples from the findings for the Intensity of social ties and demonstrates whether the point indicates high or low intensity, and weak or strong ties. The table also identifies whether the finding was evident in the Nelson Mandela Bay Metropolitan Municipality (NMBMM) or the Mossel Bay Local Municipality (MBLM).

Theme/Subtopic and examples	**Indicator**				**Case study**	
	Intensity		**Strength of ties**			
	Low	**High**	**Weak**	**Strong**	**NMBMM**	**MBLM**
Frequency of interactions						
Only in disasters, for certain projects, or when contacted	x		x		x	
Weekly within directorate (daily for seniors)		X		x		X
Monthly (District and provincial)		x		x		x
Quarterly committee meetings (poor attendance)	x		x		x	
Quartly (Inter-directorate)		x		x		x
Quarterly (National)	x		x		x	x
Nature of relationships						
Friends		x		x		
More than just professional		x		x		x
Strictly professional	x		x		x	
Strained professional	x		x		x	

4.1.3 Affect

As individuals tend to share close ties with people who share their own values, attitude and goals, the homophily between actors in a network indicates the social cohesion (collective co-operation between social groups) within a social network (Brass & Krackhardt, 2012). The following section examines the homophily in values, attitudes and goals between actors, which should thus provide an indication of the type of relationship held between ties. Table 4 at the end of the section provides a summary of tie affect in each municipality.

In the NMBMM network various sub-groups existed, each having different values, attitudes and goals. The separation of sub-groups with different values, attitudes and goals leads to the prevalence of institutional silos, in which interdepartmental interactions are inhibited by the separation of responsibilities and lack of collaboration (Mitchell, 2005). Despite various efforts to facilitate co-operative governance and collaboration between these different sub-groups (e.g. forum committees, advisory meetings, etc.), conflicting priorities and goals often placed strain on these interactions. One respondent believed that all the directorates within the municipality shared a similar core objective of service delivery, however once priorities were broken down the values and attitudes came into conflict. This respondent goes on to explain how varying priorities create conflict between actors:

> *"Overarching, everyone's goal is the same, but if you break it down further we have got competing mandates and functions that often clash. Especially when it comes to the regulatory process."*(NMBMM, respondent 7, Dept. C)

Other respondents (55%, n=5) reported similar views, believing other directorates were not cognisant of the worth of their different priorities and were *"not coming on board*" in terms of collaborative decision-making. In particular respondents from the disaster management sub-directorate stated:

> *"I'm not certain that* [other sub-directorates] *understand the value of preparedness.* [Or] *rather prevention. I don't think they share the same values that we really want them to share.* [….] *We have been trying for years to have this a local disaster committee and the community* [based] *flood response plan* […] *And the other* [sub-directorates]*… I don't know if they see a disaster risk reduction as a priority."(*NMBMM, respondent number and department letter withheld for anonymity)

Thus the quote demonstrates the evidently different values in operation between directorates, which likely results in a failure to collaborate even where it was necessary, such as in cases where risk reduction comes into play. Various respondents (55%, n=5) described attempts to facilitate cooperation through the formation of various committees and meetings, however these were poorly attended. Respondents (55%, n=5) suggested that the lack of participation from other directorates demonstrates the poor recognition

of shared responsibilities. When asked about their sub-directorate's participation in committee meetings, one respondent stated:

> *"*[when we participate] *is dependent on* [the disaster management sub-directorate] […] *because you must remember not every* [disaster] *might affect us* [or require our sub-directorate's function]*."* (NMBMM, Respondent 5, Dept. B).

The respondent was explaining how participation in committee meetings (set up for risk management) is dependent on the other sub-directorates, and went on to point out later in the conversation that such participation was poor, which he attributed to other departments having different responsibilities and priorities. The institutional silos which arise due to differing values, attitudes and goals results in low levels of homophily within the NMBMM network. The poor homophily could be attributed to choice homophily as described by Louch (2000), whereby actors choose to form strong ties with actors who share their own values, due to the expectation that these actors will have a better relationship. Therefore, the lack of shared values could presumably be inhibiting the formation of strong ties within the NMBMM.

In terms of the shared values, attitudes and goals within the network of MBLM, the homophily within the municipal network was much higher than that of the NMBMM. While all respondents have different responsibilities and professional priorities, all the respondents felt the local policies and management plans ensured that all actors were working towards a common goal of service delivery. Respondents used phrases such as: "same problem", "same obstacles", "same goals", and "same policies" when describing their similar values. One respondent clarifies his definition of shared values as following the correct procedure by stating:

> *"Same values for me means quick response time, follow the necessary procedure, don't procure if you don't follow the procedures, make sure the budget is in place. All those cross cutting values and morals, that is what I meant when* [I said that] *we share the same values."*(MBLM, Respondent 6, Dept. E)

This quote demonstrates how despite each actor holding different responsibilities and line functions, there is agreement regarding the procedure for flood management. This means each actor works towards fulfilling their own responsibility, in order to work with other actors to achieve a shared goal. Even in cases where the most noticeable conflict

surfaced in the NMBMM (between environmental management and engineering), actors in these departments in the MBLM network believed they shared the same values and attitudes and collaborated regularly to achieve a shared goal.

The most significant disparity in values existed between the disaster management departments at the local and at the district level. While the EDM has a dedicated DMC, disaster management in MBLM is the responsibility of the local fire chief. In this sense, the dual responsibility of the fire chief results in disaster management at the local level having different priorities to disaster management at the district level. This is evident in the following response:

> *"at local level you don't have dedicated disaster risk management staff or disaster management staff. The guys that are in charge have got a dual function – he's also traffic chief or also the fire chief. So his focus is not … always* [on] *the wider spectrum. It depends on what line function he comes from, and what he will drive. For example if it's the fire chief he will drive the* [fire management] *response very well"* (EDM, Respondent 1, Dept. A)

This quote illustrates the nature of differing values of preparedness and prevention from district and from local levels. While the homophily between municipal actors is high, the above quote suggests that there may be lower levels of homophily between local actors and actors from higher levels of government.

Despite the greater disparity between local and district disaster management, in general there is high homophily in the MBLM network. This homophily, along with the frequency of interactions, good professional relationships, and high dependency of actors, indicate a high affect of ties between actors in the MBLM. This is not the case in the NMBMM, as actors had conflicting values, infrequent interactions, often strained relationships, and low levels of dependency. This indicates a low affect of ties in the NMBMM. McPherson et al. (2001) describe how homophily creates strong sustained ties between similar actors, while interactions without homophily often disband over time. Thus, the high homophily between actors in MBLM is more likely to result in actors continually working towards common flood management goals.

Table 4 - Summary of affect results for each municipality. The table highlights some of the key themes, subtopics and examples from the findings for the Affect of social ties and demonstrates whether the point indicates high or low affect, and weak or strong ties. The table also identifies whether the finding was evident in the Nelson Mandela Bay Metropolitan Municipality (NMBMM) or the Mossel Bay Local Municipality (MBLM).

Theme/Subtopic and examples	**Indicator**				**Case study**	
	Affect		**Strength of ties**			
	Low	**High**	**Weak**	**Strong**	**NMBMM**	**MBLM**
Homophily between actors						
Shared values, attitudes & goals		x		x		x
Few shared goals and poor collaboration	x		x		x	
Defined sub-groups resulting in institutional silos	x		x		x	
Differing values between local and district disaster management	x		x			x

4.2 The Effect of Governance Structures on Social Capital in Municipalities

Social capital refers to the structure of social interactions, and their effect on social cohesion and cooperation (Ferlander, 2007). Fischer et al. (2014: 674) refers to social capital at the "stock" of social networks, describing how different types of ties facilitate social learning and cooperation. While the size of a municipality influences the amount of actors in the network, the structure and strength of ties between these actors has a dominant effect on forming the social capital within the network. This results in the emergence of three dominant forms of social capital in municipal networks (as in other networks), these being: bonding, bridging and linking social capital.

4.2.1 Bonding Social Capital

Bonding social ties are referred to as the ties which connect individuals which share close relationships within a sub-group (Islam & Walkerden, 2014). In the NMBMM, the social networks of role players in flood risk management are comprised of strong bonded sub-groups which form specific sub-directorates with the municipality. Respondents from NMBMM reported having very strong bonding ties with actors within their own department, sharing high levels of homophily within these sub-groups. One respondent describes the strong relationship in their sub-directorate with the following statement:

> *"We are a very small staff contingent. So we know each other, it's almost like a family"* (NMBMM, Respondent 1, Dept. 1)

This response indicates the subgroups are comprised of close intimate relationship typical of bonding social capital. The formation of these clearly defined bonded sub-groups is likely the result of the large size of the metropolitan network. This is not the case for the MBLM.

As a local municipality, MBLM has considerably less role players in flood risk management than metropolitan municipalities such as NMBMM. Pasquini et al. (2015) attributes larger governance networks in Category A (metropolitan) municipalities to population size and resource concentrations, with the reverse being true for category B (local) municipalities. This suggestion of smaller governance networks in local municipalities is evident in MBLM, which has considerably smaller political and governance structures than the NMBMM. For example the NMBMM council consists of 120 members, whereas the MBLM council consists of 27; the NMBMM has 9 administrative directorates with multiple sub-directorates, whereas the MBLM has 5 directorates (Mossel Bay Municipality, 2015; Nelson Mandela Bay Metropolitan., 2016).

While the most dominant form of social capital in the MBLM municipality was also bonding social capital, there were less clearly defined bonded sub-groups within the network as compared to the NMBMM. Respondents from MBLM still maintained the strongest ties with others actors in the same directorates, however the size of the municipality often requires these different directorates to work together to achieve common objectives. One respondent elaborates how the size of the municipality assists in shaping the strong bonding capital across the entire municipality in the following statement:

> *"Mossel bay is a small municipality so everyone knows everyone. And with JOCs we have large events and it's the same people so you build up a relationship. Everybody knows everybody* […] *it's usually the same faces that come and assist so you eventually form a relationship with these people."* (MBLM, Respondent 2, Dept. 1)

The response provided by the aforementioned respondent indicates that despite the existence of different directorates, the constant collaboration between directorates leads to the formation of one large bonded network rather than clearly defined bonded sub-

groups. The strong bonding social capital in the MBLM can thus benefit flood management in the municipality by facilitating the sharing of resources and responsibilities. Similar findings were found in regards to hurricane recovery in New Orleans, where bonding capital assisted disadvantaged communities in sharing resources to aid disaster recovery (Elliott, Haney & Sams-Abiodun, 2010). However this bonding capital can also negatively affect flood management in networks that don't suffer resource constraints, i.e. networks which are able to overcome floods with the resources immediately available to the network. According to Beggs et al. (1996), bonding capital may limit the need for actors to seek external assistance, which could possibly be an inhibiting factor for flood management in the NMBMM network, as strong bonded sub-groups result in actors failing to form bridging ties to facilitate co-operative flood management.

4.2.2 Bridging Social Capital

Bridging ties are describe as the ties which connect similar entities from different sub-groups and networks (Torkelsson, 2007). In the NBMMM, the vast majority of respondents (88%, n=8) reported few cases of bridging ties from outside the municipality. Additionally, the large network size of NMBMM appears to have resulted in various bonded sub-groups with weak bridging ties between these subgroups. As NMBMM has multiple officials within each sub-group, there is less urgency for actors to collaborate in order to meet municipal service delivery goals, because each sub-directorate is well-staffed. While various attempts are made to facilitate collaborative governance within the municipality (as described below), the political and administrative priorities of the different actors within the social networks were often cited by all respondents as obstacles to effective knowledge sharing and collaboration.

Many respondents (55%, n=5) from NMBMM revealed that their sub-directorates had made attempts to create forums to facilitate cooperative municipal governance for the mutual benefits of participants. Despite this, respondents reported that these forums were poorly attended due to the disjuncture of priorities between different directorates. One respondent stated:

> *"We have the advisory forum which has not been attended yet. And again that comes back to that question of shared values. Because I believe that if there was shared values, and people saw the importance of disaster management, they would attend the advisory forum, because that creates a forum where we can discuss disaster issues, which should be of interest to them, and they should see the benefit, but it's a bit of a challenge to get people to attend meetings. It is better attended by* [provincial sector departments] *than by our own metro departments."*(NMBMM, respondent number and department letter withheld for anonymity)

The quote highlights a couple of the key themes that have been discussed so far, these being the poor participation in collaborative governance meetings, and the existence of different values between municipal departments (and the barriers they create to collaborative governance). The quote further implicitly suggests the existence of institutional silos, described as the failure of intra-institutional departments to collaborate (Pasquini et al., 2015). Such weak bridging ties between different directorates/departments result in various instances of conflict due to the lack of shared principles and attitudes between sub-groups. The sentiment of poor collaboration between groups with differing attitudes is similar to studies of social networks of climate deniers. Such studies show how actors tend to share strong ties with actors similar to them. These strong ties aid in filtering out information which does not correlate with their own values (Itkonen, 2015; Leombruni, 2015). Additionally Pasquini et al. (2015) describe how the small size of local municipalities can be an advantage for CCA because of its effects on building collaborative networks. Thus, the size of the NMBMM network appears to be having a negative impact on knowledge-sharing and collaboration between municipal officials.

Whereas interactions between different directorates in NMBMM constitutes bridging social capital, In MBLM stronger relationships between directorates form bonding social capital. Thus, sources of bridging social capital in MBLM comes from outside of the municipal network. Some of these instances of bridging ties existed between respondents and individuals in similar positions from different municipalities, however these ties were found to be very weak ties. One respondent suggests a physical isolation from similar municipalities as a main contributor to the lack of more bridging ties within the municipality. This respondent explains:

> *"they are too far away* [...] *If Plettenberg Bay* [Bitou Municipality] *was just next to us then maybe we would interact a bit more, but we are isolated by the coast, and then it's inland again*." (MBLM, respondent 8, Dept. F)

The above quote suggest actors recognise the potential to interact with actors from different municipal networks, but the lack of geographical proximity inhibits strong collaboration.

As strong bridging ties between actors can be beneficial not only in knowledge and resource sharing but also in helping to shape and change behaviours in a changing climate, these ties are vital in municipal networks (Leombruni, 2015). Although the large size of metropolitan networks equates to the presence of more stakeholders, smaller networks of local municipalities may be much more beneficial for collaboration and shared values. The MBLM's network consisted of far fewer actors with different structures of interactions. With fewer directorates, less conflict appears to exist between directorates and sub-directorates. However bridging ties are also vital for introducing actors to new information, and thus to challenge norms (Woolcock, 2001; Macias & Williams, 2014). The strong bonding capital of MBLM may therefore limit the influence of new information by working to enforce norms in the network (Dowd et al., 2014) and thus could work to maintain both ineffective flood management and social structures which exacerbate flooding vulnerabilities in informal settlement.

In comparison, NMBMM has more of these bridging ties than MBLM, but its weak inter-departmental ties and the conflicting priorities between sub-groups potentially results in any new information brought in by the bridging ties being poorly dispersed within the municipal networks (because, as mentioned above, strong ties are necessary for information and knowledge sharing). The conflict occurring between the municipal sub-groups exist not only in terms of their administrative priorities, but also in the political affiliation and political alignment of actors. Respondents revealed that the recent shift in political leadership within the municipality has spurred a slow shift in priorities. These respondents believed that there were individuals in both political and administrative branches of governance which are loyal to the previous political leadership and are therefore resisting these shift. This is reflected in previous research by Pasquini &

Shearing (2014) who suggest that political instability can act to disrupt the networks which enable the effective institutionalization of environmental issues at the municipal level. This resistance to political shifts leads to actors within the network being reluctant to cooperate with actors from other sub-directorates or actors sharing different values.

Despite these challenges to forming strong bridging ties within the NMBMM network, respondents did report instances where it became essential to work with other sub-directorates. Certain areas of municipal management required interaction between different sub-groups. In particular, disaster response triggers the formation of a JOC, which requires strong collaboration. Respondents (66%, n=6) reported that without the co-operation and participation of certain sub-directorates in these instances, it would be difficult to effectively implement decision-making. Thus indicating that despite a need for collaboration between departments, these bridging ties are often limited to emergency responses rather than sustainable flood management in the municipality. These findings can be compared to findings from Hansen et al. (2001), who found that despite strong bridging ties being essential for social networks, maintaining the strength of these ties is inhibited by the differences between actors, the lack of commitments to collaboration and the costs of maintaining networks. The poor formation of strong bridging ties in NMBMM can likely be attributed to these inhibiting factors.

In conclusion, despite varying forms of bridging social capital, both municipalities seem to have weak bridging social capital. While MBLM has the collaboration needed for the dispersal of new information, actors lack strong bridging ties from outside the municipal network which could act as vital sources of novel information. Unlike in MBLM, the NMBMM network has the bridging ties needed to facilitate flows of information, however the weak and strained relationships of these ties prevents adequate exchanges of knowledge.

4.2.3 Linking Social Capital

In addition to the importance of strong bonding and bridging ties, linking ties are essential in accessing knowledge and funding from different levels of government (Torkelsson, 2007). While both municipalities shared ties with certain state entities, the network of MBLM features much more linking ties than that of the NMBMM.

The coordinating function of the EDM in MBLM is a vital source of this linking social capital for the municipality. This governance structure means the EDM is able to oversee and inform local disaster management within the seven local municipalities falling within its district, but is also able to facilitate the sharing of resources in times of crisis. One respondent from the EDM explains how the district is able to shift resources between local municipalities during flood events in the following response:

> *"We can deal with* [resource constraints in local municipalities]*. By taking resources* [allocated to one] *municipality and moving* [these resources] *to the affected municipality. Because we know that the* [weather] *system only affected Hessequa* [Local Municipality] *and not* [Bitou Local Municipality] *then we can move resources around."(EDM, Respondent 1, Dept. 1)*

As the district municipality is not directly responsible for the implementation of local disaster management, the district is also likely able to focus more time on creating ties with provincial and national departments. The district's role thus plays a vital role in acquiring support to the local municipalities which are often constrained in terms of budget and knowledge availability. In addition to these ties at the district level, within the MBLM respondents (66%, n=6) reported linking ties with various provincial departments. These ties were often being created out of instances of shared responsibility between provincial and local government, such as the provision of housing and water governance. For example in terms of housing provisions, provincial administration funds the construction of houses, but local governments are responsible for providing land, town planning and service provisions for the newly developed housing.

As a category A (metropolitan) municipality, the NMBMM is expected to have a greater resources base which should entail less need for financial and technical support (Pasquini et al., 2015). However, despite its presumed greater resource base, various linking ties existed between the municipality and provincial and national departments. Respondents (33%, n=3) reported having regular interactions with the South African Weather Services, which acts as a vital conduit of forecasting information. While the majority of respondents (88%, n=8) also reported relationships with provincial departments as a means of financial and technical assistance, the occurrence and dependency on these relationships was much less than that of respondents from MBLM.

However, a small majority of respondents in NMBMM (55%, n=5), believed that some of the interactions between the provincial and local levels resulted in negative outcomes, with local governments facing fines for not abiding by provincial procedures. One respondent gave the example of a bridge which needed urgent repairs after a previous flooding event. Once work had commenced on the bridge the municipality faced fines from provincial departments for not obtaining relevant environmental authorisation. This finding indicates that although linking social capital is a vital source of assistance for the municipality, the difference in values between actors may be a source of conflict between these actors. It should however be noted that this source of conflict may extend beyond differing values, into the power dynamics between local and provincial governments. While local governments have the authority to make decisions within municipalities, they are subject to the policies and legislature of provincial government. In this case it is possible that conflict may arise from linking ties because of the power dynamics and political conditions of this form of governance, especially in NMBMM where the provincial and local governments are held by opposing political parties.[10] However this aspect of linking social capital in terms of CCA at the local level is still relatively unexplored and could potential be explored in future research.

Thus the NMBMM features much weaker linking social capital than that of the MBLM. The greater resource availability and the occurrence of institutional silos in metropolitan municipalities could possibly explain the fewer occurrence and weaker strength of linking ties as less support is needed. Whereas, local municipalities and is likely to need more access external resources in times of a crisis, more and stronger linking ties within MBLM could assist in improve the capacities of actors within the network.

4.3 The Role of Social Capital and Social Ties in Knowledge Dispersal

The social capital and social ties of actors within a social network play a large role in the formation and dispersal of knowledge with a network. Findings from Fisher et al. (2014) demonstrate how bridging social capital can expose actors to new information which

[10] As of the 2016 local government elections the Nelson Mandela Bay Metropolitan Municipality was held by the Democratic Alliance (DA), while the Eastern Cape provincial government was held by the African National Congress (ANC),

guides the co-produciton of new knowledge, while bonding capital enables sharing and coordination in order to disperse knowledge in the network. This form of institutional learning creates two forms of knowledge, explicit and tacit knowledge (as covered in section 3.2). These forms of knowledge are often dispersed via formal and informal social interactions (Allen, James & Gamlen, 2007), where formal interactions are created from organisation structures and informal ties occur organically. As will be discussed below, metropolitan and local municipalities have distinctly different availability of information sources, and the different social structures within the municipal networks further diversely impact the use and dispersal of these different types of information.

4.3.1 The Availability and Dispersal of Explicit Knowledge

Explicit knowledge is defined as knowledge which is recognised and accepted information that can be easily communicates through formal communication channels (Fischer et al., 2014). In this sense, explicit flood risk-related information should include knowledge from experts (scientists, engineers, consultants, etc.) as well as government and international entities (Allen, James & Gamlen, 2007). As demonstrated in the case of New York City by Rowenzweig and Solecki (2010), local municipalities can benefit from ties with these sources of knowledge because they can assist in making informed CCA decisions. However, despite NMBMM having a much larger social network and pool of stakeholders than the MBLM, the former municipality did not demonstrate a greater diversity of explicit flood risk-related knowledge than the latter. While higher learning institutions and multi-national consulting firms were present within the municipality, the lack of bridging ties and the effect of institutional silos meant these sources of information were often underutilized.

While all respondents reported having no ties to academic or research institutes, the majority of respondents (88%, n=8) reported being heavily reliant on explicit information from experts such as consultants for decision-making. However as a result of poor bridging ties within the network, actors often had singular sources of this explicit knowledge (e.g. engineers were in contact with only one consultancy, weather and climatic information was only gained from SA Weather services, etc.). One respondent states:

> *"we are so reliant on the weather services when it comes to looking at what we can expect, how the weather situation is going to develop. Maybe it's a cut off low* [so] *we can expect severe flooding - that information is critical,* [and] *that is information that we can't generate amongst ourselves, so we are very dependent* [on the Weather Services], *and we rely quite heavily on that information."* (NMBMM, Respondent 2, Dept. A)

The above quote indicates that municipal directorates are heavily dependent on their own few bridging ties which do provide them with explicit knowledge. The findings suggest that although there may be a large pool of expert knowledge outside of the municipality (by virtue of NMB being a metropolitan area), the few bridging ties between the municipality and expert knowledge sources means that the municipal actors are (a) not making use of all the potential sources of knowledge that are likely to be within the municipality, (b) very heavily dependent on those few bridging ties because they bring in knowledge the municipality cannot provide for itself. Furthermore, the poor bridging ties which exist between directorates within the municipality, is likely to result in poor dispersal of the few forms of explicit knowledge that come into the network.

This potential of a wide spectrum of sources of formal knowledge is not the case in the MBLM. As a local municipality, actors have much smaller networks and are typically physically distant from major higher learning institutions and public entities which create explicit knowledge (Pasquini et al., 2015). Despite the limited available sources of explicit knowledge, actors were dependent on the few bridging and linking ties they held with external actors (such as engineers, scientists, consultants, and provincial departments) for explicit knowledge. This knowledge was communicated via disaster risk assessments (undertaken by private consultants), weather forecasts (sent from SA Weather Services and accessed from weather websites), stormwater masterplans (undertaken by engineers) and policy frameworks.

Despite the presumed variance in source of explicit knowledge between the two municipalities, there did not appear to be a distinct difference in the use of explicit knowledge between the two municipalities. Unfortunately the data collected for this research does not provide any significant insights into the mechanisms which may hinder or promote the use of these types of knowledge. However, as strong bonding social capital has been found to facilitate the transfer of information (Wolf et al., 2010), the bonded

network in the MBLM should allow this information to be shared effectively between actors. However, the low presence of local producers of explicit knowledge resulted in actors being much more reliant on tacit forms of knowledge, as will be discussed in the next section.

4.3.2 Tacit Knowledge and the Development of Locally-Relevant Knowledge

Tacit knowledge or informal knowledge refers to the knowledge which actors gain from observations of reality and shared experiences (Fischer et al., 2014). As tacit knowledge cannot be easily recorded and distributed, social interaction is vital for the dispersal of tacit knowledge (Fischer et al., 2014). Therefore the use and value assigned to tacit knowledge will often be a product of the structure of the social networks of actors.

As NMBMM lacked strong ties and social cohesion between directorates, explicit knowledge-sharing was likely to be inhibited. This meant each sub-group in the network utilized their own external source of explicit knowledge. In addition respondents (88%, n=8) reported using weak inter-departmental bridging ties when they needed the explicit knowledge of another sub-group. But while these weak ties transferred explicit knowledge, respondents (88%, n=8) recognised the importance of tacit knowledge within each sub-group in informing this explicit knowledge. When asked whether they felt the two forms of knowledge differed in value and influence one respondent stated:

> "[The two] *are different because it's a different environment. You get through all the policies and stuff at school. But now when you really have to implement* [projects] *it's a different case, because you have to apply your mind" (NMBMM, Respondent 6, Dept. B)*

In the following quote another respondent also emphasised the value of recording tacit knowledge in order to highlight the differences between tacit and explicit knowledge:

> *"To have something recorded is very important even if it's just your own knowledge.* […] *So on the job, knowledge is highly valuable. It informs the academic knowledge, I would say. You know what it works like in real life, versus what is on paper"* (NMBMM, Respondent 7, Dept. C)

The first quote indicates a recognition that tacit knowledge affects the use of explicit knowledge and the second quote emphasises the importance of transforming tacit knowledge into explicit knowledge. This recognition of the value of tacit knowledge in improving explicit knowledge represents organisational learning as described by Fischer et al. (2014). However the weak ties between departments results in actors within NMBMM failing to share tactic knowledge between departments. This is reflected by one respondent from the Disaster Management sub-directorate, who suggests that they do not use their social ties to access to gain tacit knowledge. This respondent explains in the following quote:

> *"I think on a practical level as* [Disaster Risk] *management, in managing the situation, in reacting to the situation, I think we are quite comfortable with that. We don't need outside intervention to tell us what to do."* (NMBMM, respondent & department identifiers withheld for anonymity)

The above quote indicates that the respondent values their own tacit knowledge, stating they are comfortable carrying out their duties because of their experience, but also suggests that tacit knowledge is not shared between actors in NMBMM. This poor transmission of tactic knowledge could possibly be attributed the poor stock tacit knowledge due to the constant arrival and departure of new actors in the network. These actors (being inexperienced) likely bring very little tacit knowledge into the network with them, and their short duration within the network likely does not allow them to gain significant experience of the local reality.

This high actor turnover was contrasted in the MBLM, as actors were found to be relatively stable within networks. Officials within the municipality had held their positions for many years and demonstrated commitments to retain these positions. All respondents from MBLM reported their years of experience in the municipality to have contributed to a large stock of tacit knowledge. Additionally, all these respondents believed the frequency of flooding events in the area to be a large contributor to the development of tacit knowledge within the municipality. As tacit knowledge is developed through shared experiences and observations, the continued presence of the actors within the network and high exposure to flooding results in municipal actors having a much higher level of tacit knowledge than their counterparts in the NMBMM, who also experience high levels of flooding but lack actor stability.

While explicit knowledge plays a role in creating a framework for decision-making, all respondents emphasized the value of experience and tacit knowledge in the management of flooding. In many instances, respondents in MBLM reported experience and tacit knowledge to carry much greater influence over explicit knowledge. This sentiment was emphasised by various respondents (88%, n=8) who stated that the loss of actors within the network would be more detrimental in terms of the loss of experience than the loss of sources of explicit knowledge. One respondent emphases the value of experience in decision-making in the following statement:

> *"You also rely on the experience of others, so part of what you learn on the job is how to tap into other people's experience and if we have to make a quick decision who are you going to rely on for a decision."* (MBLM, Respondent 3, Dept. C)

This quote demonstrates how the respondents assign high value to the tacit knowledge of their social ties, and reflects that strong ties between actors facilitates these exchanges of tacit knowledge.

In addition to the vital role of experience, local observations are major sources of tacit knowledge within the MBLM network. Local observations play a significant role in guiding on-the-ground decision-making, and various respondents (77%, n=7) reported that it was vital for factual information to be grounded in local realities. In this sense, local residents, ward councillors and emergency service personnel were important sources of local knowledge because their observations provided up-to-date information. Two respondents reported local community-based risk assessments as a significant means by which the municipality transformed vulnerability and risk observations and experiences into explicit risk assessments. The development of this tacit knowledge into explicit knowledge is vital in guiding locally relevant-decision making in the MBLM.

The same evidence of local tacit knowledge being transformed into explicit knowledge to guide actor's decision making was not reported in the NMBMM. Respondents (55%, n=5) from the NMBMM reported opportunities for community engagement during public participation phases of projects, however no respondents reported knowledge gained from these public meetings as contributing to their own knowledge. The importance of transforming tacit knowledge into explicit knowledge was highlighted in a recent study of the oil and gas sector (Sumbal, Tsui & See-to, 2017). This study found that decision-

making based on explicit facts and local knowledge, produce results which can be codified into explicit knowledge. This knowledge can then be used by academics who combine it with their own tacit knowledge to produce new explicit knowledge which can again guide decision-making (Sumbal, Tsui & See-to, 2017). This process is similar to the way tacit knowledge is transformed into explicit knowledge in the MBLM. The poor implementation of this process in the NMBMM is likely to be negatively affecting flood management, as the poor dispersal of explicit knowledge and underutilization of tacit knowledge will inhibit institutional learning in the municipality.

4.3.3 The Contribution of Formal and Informal Ties to Knowledge Sharing.

As demonstrated in the case of NMBMM, the possibility of diverse sources of knowledge does not guarantee the dispersal of knowledge within a network. The transfer of knowledge in social networks is largely controlled by the structures of social capital and the social ties of a network (Lawson et al., 2009; Fisher, 2013; Yu et al., 2013; Fischer et al., 2014). Knowledge sharing thus occurs through the formal and informal social ties of actors.

Formal or compulsory ties refer to interactions which occur between actors through formal channels such as organisational structures or compulsory reporting structures (Allen, James & Gamlen, 2007; Lawson et al., 2009). In the terms of local government, these ties would refer to governance structures and compulsory instances of collaboration. In the NMBMM there are very few of these formal ties, as defined responsibilities for sub-groups creates a separation between sub-directorates. Despite increasing emphasis on collaboration from legislation, structures of co-operative governance such as committees and forums are largely viewed as voluntary and are poorly attended. Similarly in the MBLM, co-operative governance forums and committees were in place to facilitate knowledge sharing between actors. However in the MBLM, collaboration was enforced by formal structures (such as management plans) which define the roles and responsibilities, as well as the standard procedure for actors in the MBLM network. Despite these formal structures having a large role in shaping social interactions, interactions between actors were often created and sustained naturally out of need.

Informal or voluntary ties describe these relationships which arise from organic social interactions occurring out of need (Allen, James & Gamlen, 2007). While formal ties are vital for the creation of compulsory collaboration, informal ties create social structures which facilitate knowledge sharing and support these formal structures (Lawson et al., 2009). The presence of informal ties were evident in the MBLM network, with most respondents (88%, n=8) from the municipality agreeing that formal structures were important in defining responsibilities, but pointing out that informal interactions were often needed to effectively manage complex systems. Respondents reflected on the formation of social structures in the following statements:

> *"*[Our relationship] *developed because we knew in 2003, with the flood… who's not around this table and who do we need. So because of major incidents we were forced to come together and work together, and then try and build a better programme. So no it's not because the* [Disaster Management] *Act says you supposed to do this, and this, and this. This came because things happened in the area and we had to figure it out."*(EDM, Respondent 1, Dept. A)

> *"*[the structure of interactions is] *a confusing mix between formal communications, communications through formal channels, and the informal stuff we need to do to make the formal stuff work."* (MBLM, respondent 3, Dept. C)

The first of these quotes illustrating how social interactions have developed naturally out of need, and the second elaborating on how these natural interactions often serve to reinforce formal structures.

As respondents from the NMBMM reported very few channels of formal interactions between actors (as covered above), all respondents stating interactions between departments only occurred when collaboration was needed. The institutional silos and weak bridging ties in the NMBMM network, leading to poor collaboration between actors, resulted in poor transfer of knowledge. Although attempts to create formal ties within the municipality have been made, actors from different sub-groups demonstrated very limited commitments. In many instances, voluntary ties for knowledge were only created when actors required information which could not be produced or sourced within their own sub-groups. An example of such an interaction exists in the case of the disaster management sub-directorate, which has created ties with the environmental

management sub-directorate in order to exchange climate change information as part of their disaster risk assessments.

While social capital has a considerable effect on knowledge sharing within a network , the lack of cohesion prevents the NMBMM network from benefiting from the weak bridging ties it has (Newell, Tansley & Huang, 2004; Fischer et al., 2014). As actors in the NMBMM network are divided into sub-groups, with weak social ties between sub-groups, the municipality lacked the strong bonding ties which make actors open to sharing information and experiences (Reagans & McEvily, 2003; Fisher, 2013). This lack of strong ties resulted in actors creating temporary informal ties to acquire explicit knowledge, however Reagans and McEvily (2003) emphasise the importance of strong sustained ties in developing trust and cooperation to enable knowledge sharing. As the actors in NMBMM lack these strong ties, it can be assumed that actors have little trusts between each other, resulting in a weak transfer of experience and tacit knowledge.

In the MBLM, instead, limited bridging social capital but strong bonding social capital meant actors were much likely to share knowledge through formal and informal structures. As actors within the MBLM were often forced to work in environments with limited resources (as stated by 66% respondents, n = 6), strong collaboration was often needed in order to manage and respond to flood-related risks in the municipality. Thus the strong ties in the MBLM network have allowed actors to share and rely heavily on the explicit and tacit knowledge from other actors within their network.

5 The Role of Social Networks in Building Resilient Flood Management for Local Governments.

Social networks have a large role in facilitating co-operative governance (Stein, Ernstson & Barron, 2011), making them a vital component for CCA at the local government level. As social networks facilitate knowledge sharing, resource sharing and collaboration, (Wolf et al., 2010; Ingold, Balsiger & Hirschi, 2010; Jordan, 2015), this research expected social networks to play an integral part in building the capacities of local governments to build resilience. Therefore the main characteristics of the NMBMM network (larger networks, defined sub-groups and weak bridging ties) and the MBLM (small bonded network, with few bridging ties) are expected to impact risk governance within the two municipalities. This chapter explores the role of social networks on building resilience by firstly examining the role of social networks on adaptive and inclusive governance, and secondly examining the implications of the findings from this research on the coping, adaptive and transformative capacities of local governments.

5.1 How Social Ties Impact Adaptive and Inclusive Risk Governance

As reviewed in section 2.3 effective governance of disaster risks under uncertain conditions requires local governments to practice adaptive and co-operative management. Therefore, in order for social networks to benefit the capacities of local governments to build resilience to climate risks, social ties should aid in the flexibility, innovation and inclusivity of actors.

5.1.1 Flexibility of local risk governance

One of the vital components of flexible management is the recognition and planning for change and uncertainty within a system (Bahadur, Ibrahim & Tanner, 2013). As climate risks are expected to increase due to climate change, the use of models and projections are vital for informing CCA paths for local governments (Wilby & Dessai, 2010). Despite

models and future projections being vital in guiding decision-making in uncertain conditions, respondents from both municipalities reported a poor awareness and use of models.

In both NMBMM and MBLM, respondents (NMBMM: 55%, n=5; MBLM: 33%, n=3)) reported using climate change risk projections which were produced by the SA Weather Service. However, respondents were not involved or fully cognisant of the modelling process behind the production of these projections. While there were some instances of respondents (NMBMM: 33%, n=3, MBLM: 22%, n=2) recognising that these projections accounted for uncertainty, the lack of insight into the modelling process meant all respondents had limited abilities to consider the uncertainty accounted for in these projections. Similarly with regards to the application and use of decision support tools (such as spatial development frameworks, flood line maps, vulnerability assessments, etc.), respondents were poorly informed about uncertainties, and held a limited ability to account for uncertainty or change.

Despite the limits to informed decision-making in uncertain conditions, the prevalence of social collaboration may facilitate knowledge-sharing from several of these decision support tools to make informed decisions. Most respondents (77%, n=7) from the MBLM reported using the same or similar decision-support tools as the NMBMM. However, where each sub-directorate in NMBMM utilized a single decision support tool, respondents from MBLM utilized various tools. The decision-support tools primarily used by respondents in MBLM included spatial development frameworks, flood line models, and disaster risk assessment models. The combined use of decision-support tools means decision-making in MBLM may be inherently accounting for various options, which is vital in uncertain conditions

As mentioned, in different sub-directorates of the NMBMM respondents generally made use of a different primary decision-support tool (for e.g., disaster management respondents used vulnerability assessments, roads and stormwater respondents used flood line maps, while environmental management respondents used climate risk assessments). This likely means that future projections between different subgroups in the network will not correlate; some projections carried little weight or were disregarded by other subgroups (mentioned by 22% of respondents). The disjuncture between the decision-support tools utilized by sub-groups in the network not only affects informed

decision-making but presumably limits the municipality's ability to be flexible to a range of outcomes.

According to Nichols et al. (2011) the range of solutions to reduce flood risks have a considerable effect on the flexibility of flood management. In this sense the presence or absence of collaboration within the municipal networks has considerable impacts on the flexibility of risk governance. For instance in MBLM, as actors share similar goals and actively collaborate to achieve those goals, the vast majority of respondents (88%, n=8) feel they are able to implement adaptive measures to mitigate flood risks. The strong social cohesion in MBLM results in respondents from MBLM having very similar views about the causes and solutions of flooding risks in informal settlements. Most respondents (88%, n=8) reported population growth and urbanisation resulting in a surge of residents in informal settlement as being a major contributing factor to flood vulnerability in the municipality. The poor locations and design of these settlements paired with hazardous climate risks was the main cause of flooding stated by all respondents. Similarly when asked about their personal views of the solution to flooding in these settlements, all respondents shared the same belief that these settlements should be relocated to better planned areas. The social cohesion between actors creates shared values, and appears to facilitate the contribution of multiple actors to solving the same problem.

In contrast, respondents from the NMBMM had varying personal views about the causes and solutions of flooding in informal settlements. Respondents stated issues such as the lack of infrastructure (44%, n=4), poor service delivery (44%, n=4), poor co-operative governance (33%, n=3), inappropriate locations (33%, n=3), overpopulation (33%, n=3) and natural occurrences (22%, n=2) as the causes of flooding. Solutions were similarly varied, with suggestions of better town planning and stormwater systems (66%, n=6), faster disaster response (55%. n=5), better infrastructure (44%, n=4), greater collaboration between directorates (33%, n=3), and relocation (22%, n=2). As actors within the municipality lacked strong inter-departmental social ties to create a shared goal, effective co-governance appears inhibited by the varying priorities and responsibilities of actors within the network.

Flexible flood management also entails adaptive governance to flood risks, and flexibility in the management resources available to actors (Nichols et al., 2011). One key aspect of

flexible resources is the flexibility of budget allocations for dealing with flood hazards. Weak ties and poor collaboration between different departments in the NMBMM likely negatively impacts the availability and flexibility of flood management budgets. Respondents in NMBMM often believed (66%, n=6) that the disaster management sub-directorate has primary responsibility for flooding risk management. While this sub-directorate is crucial, respondents from the sub-directorate mentioned only possessing the capacity to respond following an event and felt that plans to curb flooding and build resilience often needed to be done through other directorates (e.g. settlement planning around flood risks was seen to be the responsibility of the human settlements sub-directorate). One respondents reflects on obstacles of budget constraints for disaster risk reduction, in the following statement:

> *"I think* [there] *is a problem in specifying the plan to deal with a* [flood] *hazard. So that will be outstanding, because we still need to establish that. And budgeting obviously.* [disaster management] *has a budget for general relief, which is just assistance to communities that are destitute, and giving them something to start with. That's basically it. And other than that the budget will come from other departments."* (NMBMM, Respondent 2, Dept. A)

The quote demonstrates how the separate priorities and goals with the network is likely to negatively affect flood management, because it suggests that budget allocations are separated among departments, which will limit the ability of the disaster management sub-directorate to manage floods without collaboration.

In the MBLM, a third of respondents (33%, n=3) reported challenges in terms of the financial burden of CCA particular lacking emergency budgets and the bureaucracy of provincial and national funding. One respondent from human settlements reflected on the funding challenges in the following statement:

> "[there's] *a problem in a bureaucratic system to replace people's house. I can apply to provincial administration- there is a thick form that I have to fill in* […]*. And the thing is it takes years for that to be processed by government levels and to go through all the levels until they actually 'say okay we have funding you sign the agreement and you can get this million rand to help these people', but* [then] *it is too late."* (MBLM, respondent & department identifiers withheld for anonymity)

This quote demonstrates how despite linking capital being vital for financial aid, the processes to receive that aid often take too long. However respondents from MBLM appeared to be more equipped (as compared to the NMBMM) to effectively overcome the burden of high flood exposure through flexible management of resources. In terms of emergency budget, two respondents revealed how reshuffling may take place through the following responses.

> *"… if it is a capital problem* [i.e. requiring new developments] *then you have to wait for the next year. And if it's an emergency then you have to re-prioritize your budget. We don't get more money. You'll say 'stop one project and then continue with recovery' because of some emergency."* (MBLM, respondent 8, Dept. F)

> *"We have also got a deviation process so if it's some emergency then we just go in and address it and then our town treasury will sort out the finances and get the necessary council votes."* (MBLM, Respondent 7, Dept. F).

These quotes illustrate how actors in the MBLM are flexible in light of financial constraints, being willing to either reprioritise projects (respondent 8) or reshuffle budgets (respondent 7).

Adaptive risk governance, also requires adaptive learning and flexible management resources which allow actors to respond to a changing climate (Armitage et al., 2009). Adaptive learning is crucial for ensuring municipal actors improve their responses to flood events in order to benefit from flood events (Armitage et al., 2009). Respondents from NMBMM had different opinions regarding how they perceived their experiences of flooding events to affect their capacity, On one hand, some respondents (33%, n=3) believed that experiencing flooding events improved municipal capacities. These respondents believed that flooding events provided lessons on how to improve systems to ensure weaknesses can be addressed in the future, by exposing flaws in flooding management systems. On the other hand, other respondents (55%, n=5) believed flooding events often had little positive impact on the capacities of the municipality. These respondents reported minor adjustment on an operational level but very little improvements in preparedness, policy and management tools. Therefore it is possible that the lack of strong social ties to facilitate collective response and shared problem-solving, produces limited adaptive learning resulting in minor system improvements,

rather than the development of flexible management. On the contrary the strong bonded network of MBLM enables actors to develop collective and flexible responses, as will be demonstrated below.

Through shared experiences, the MBLM utilizes adaptive management in order to reassess and fine-tune risk management. The frequency of flood events has allowed all respondents in MBLM to gain experience in dealing with flooding, but in particular it is their ability to learn from events, that facilitates the development of flexible policy and plans within the municipality. Respondents from the MBLM (44%, n=4) reported having emergency plans in place in case of disaster, however stated that experience has demonstrated the shortfalls of rigid policy and plans. These emergency plans rather act as guidelines, to designate mandates and facilitate coordination so as to ensure that all actors are aware of the correct procedure and responsibilities during an emergency. The move away from rigid plans was evident in both flood constituency plans (emergency response plans described as "living documents" which are constantly changing), and estuary management plans. These plans ensure the municipality benefits from flood experience by enabling adaptive learning in the management of flood risks in the municipality.

As experience has a limited impact on the capacity of NMBMM, actors fail to develop flexible flood risk management to overcome resource constraints in future flooding events. In terms of the management resource NMBMM respondents (66%, n=6) acknowledged the municipality's JOC which is active in times of disasters to bring all stakeholders together. This JOC is vital in bringing together different directorates to addressing crises, however is highly dependent on inter-departmental participation. Along with the JOC, respondents (33%, n=3) cited emergency services (rescue, communications, etc.), and relief budgets as key resources which enable the municipality to respond to these crises. While the JOC, emergency services and relief budget ensure the municipality bounces back from a disaster, the interactions of the JOC are limited to times of disaster. Therefore actors are able to collaborate to respond to a disaster but have limited co-operation to prevent the disaster from occurring again. As previously illustrated by the quote from respondent 2, financial resources are limited to disaster relief, with no other respondents acknowledging any finances dedicated to flood risk reduction. Thus even though the municipality's disaster report ranks flooding as the

highest risk hazard (van der Linde et al., 2010), the lack of commitments from different directorates suggests that the absence of co-operation inhibits the ability of actors to collectively build resilience. Therefore the weak ties in the NMBMM network appear to limit the ability of actors to effective utilise available resources, while the strong ties in the MBLM allow actors in the network to overcome resource constraints for more effective flood management.

5.1.2 Social Cohesion and Innovation

One key aspect of adaptive risk governance in a changing climate is the predisposition to seek and implement innovative means to risk reduction (Anguelovski & Carmin, 2011). In terms of innovation in the NMBMM network, respondents reported varying instances of innovation in flood management. Respondents within the engineering and infrastructure directorate reported an ethic of constantly learning and trying to implement new approaches and innovative designs. One of these respondent provides an example of one such instance of innovation in the Walmer township where drainage ponds have been developed with a dual functionality (water drainage during rainfall and public spaces during dry periods) to reduce flood risks and provide social benefits to the community. The responds explain:

> *"I think the Walmer project is one of our close-to-heart projects. We have created* [drainage] *ponds,* […] *now you have this beautiful space* […] *inside these ponds,* [so] *we are going to have a soccer field so when its dry* [residents] *could use it for soccer and we are going to have an* [outdoor] *gym. So there is innovation for any project. Its changes every time. Each time you think of something else."* (NMBMM, respondent & department identifiers withheld for anonymity)

However, respondents from other sub-directorates, such as environmental management for example, believed that while their sub-directorate regularly tried to be innovative, their attempts were often ineffective because of the perceived lack of innovation within other sub-directorates. One respondent from this sub-directorate states:

> *"From our side we are very unique and there is always a lot of resistance. And I don't think people are always ready for what we are trying to implement."* (NMBMM, respondent & department identifiers withheld for anonymity)

The two quotes taken together suggest that innovation in the network is often restricted to sub-groups, and not recognized by other subgroups, and the second quote suggests further that innovations may often be limited by the lack of social cohesion. Poor innovation is reflected by respondents from disaster management suggesting their sub-directorate does not implement any new or innovative approaches. These respondents believed it was not their responsibility to be innovative, and were primarily concerned with ensuring they are doing what they are expected to do in terms of legislation. The weak bridging ties and poor collaboration with the NMBMM network thus appear to inhibit a combined effort to find new approaches to reduce flood-related risks. Similar findings from the wider literature suggest that ideal network conditions for innovation require strong bridging ties and strong social cohesion to facilitate knowledge-sharing (Sosa, 2011; Rost, 2011). Therefore innovation in the NMBMM is likely to be negatively affected by poor social cohesion and weak bridging ties in the network.

While the lack of social collaboration in the NMBMM inhibits innovation in the network, the MBLM is far more adept at implementing innovative means to address flood-related risks. The strong bonding social ties have enabled the municipality to practice innovation in terms of engineering, design and technology. Engineers, in particular, reported constantly looking for new approaches and new technology for flood risk reduction. One of the most common instances of innovation cited by the respondents (88%, n=8) was the practice of breaching estuaries (i.e. draining of estuaries) before large rainfall events to reduce the risk of flooding. According to findings from Sosa (2011) social cohesion facilitates knowledge-sharing and social collaboration, which cultivate innovation and promote the effectiveness of innovation. Thus while innovation was largely restricted to new developments in engineering, strong ties ensured knowledge sharing and cooperation between actors to promote innovation in flood management in the municipality.

Despite the fact that social cohesion between respondents creates a suitable environment for innovation, the lack of strong bridging ties may be inhibiting some innovation. Bridging ties are vital in providing new information and new views which can challenge

the perceptions of actors, and therefore the lack thereof may be limiting the ability of the municipality to receive new knowledge which could allow them to improve strategies (Hansen, Podolny & Pfeffer, 2001; Rost, 2011; Sosa, 2011). This sentiment is reflected by respondents who were more service-oriented (e.g. emergency services) than their engineering counterparts. These respondents (33%, n=3) reported constraints to innovation such as limited skills transfer, and lack of access to research and information. In this case innovation was described as being good on paper, but not always the most effective means to deliver services, because weak bridging ties did not facilitate enough skills transfers to enable actors to manage innovative systems without the assistance of actors outside the network. With regards to innovation one respondent provided the following explanation:

> *"I think we look for ways to make our existing interventions work better, it's very difficult to start thinking about new innovative* [approaches], *so the innovation occurs with how we can deliver the same services with less resources."* (MBLM, Respondent 3, Dept. C)

This quote suggest that actors within the network may not be thinking of fundamentally new approaches to flood management, however this respondent then goes on to detail how social collaboration ensures a combined effort to achieve municipal goals under resource constraints. Lutte et al. (2012) state that while social cohesion may encourage collaboration, it may limit innovation within networks if structures are biased towards specific forms of knowledge within the network. Thus while the NMBMM network lacks the social collaboration needed to implement new approaches to risk governance across the municipality, the MBLM network features the required high collaboration to effectively utilize innovation. However, its strong bonding capital may risk enforcing existing norms and thus prevent the creation of fundamentally new approaches.

5.1.3 Inclusive Risk Governance

The inclusion of multiple stakeholders, as well as residents of informal settlements, is a vital component of resilience (Bahadur, Ibrahim & Tanner, 2013). The inclusion of these actors not only ensures a diversity of knowledge but ensure government priorities are aligned with those of local residents (Bahadur, Ibrahim & Tanner, 2013).

In the NMBMM, there are various opportunities for local stakeholder inclusion in the planning and management of flooding risks. Respondents from the disaster management sub-directorate reported having community disaster management committees to facilitate local cooperation and the co-creation of knowledge. Similarly these respondents reported ward councillors as being useful sources of local knowledge. While these key links to local residents are beneficial in addressing local vulnerabilities, respondents believed opportunities for inclusion are challenged by issues of poor public commitment, as will be elaborated below.

Respondents from the disaster management sub-directorate reported that local partnerships were essential for cooperation, but that communities often seemed to lack commitment and did not share responsibilities with local officials. The effectiveness of public participation was questioned by various respondents (66%, n=6), who reported having no guidelines as to what constitutes adequate public participation. A ward councillor reflecting on poor participation made the following statement:

> *"You do have town hall meetings. Where you send a SMS to all your voters,* [and] *regardless of how many people attend, you've had the meeting and you've advertised it. The people didn't want to come and put their input well that's it."* (NMBMM, Respondent 9, councillor)

This view demonstrates how town hall meetings are held in order to facilitate the input and engagement of local communities. However the respondent implies there is an issues as to these meetings ineffectively facilitates community engagement, and that legislation only provides guidelines stipulating that meetings must be held and advertised. Furthermore another respondent implied poor public administration and failed political promises to be the reason for the lack of public interest in these meetings. This respondent alluded to past poor attendance being attributed to lack of public trust in the municipality, going further to state that since recent shifts in political leadership attendance has increased due to the public's belief that the new political administration will serve the municipality better than the previous administration.

While the inclusion of local residents is essential in addressing local vulnerabilities, government partnerships with local experts, NGOs and private businesses can also be vital sources of aid (Field et al., 2014). When asked about the inclusion of different experts

in planning, respondents in the NMBMM rarely reported a wide range of experts being consulted. The most common experts involved were engineers and environmental consultants (reported by 55% of respondents, n = 5). Often in these cases (mentioned by 33% of respondents), it was assumed that environmental consultants would consult in turn with a range of other experts. Additionally respondents (33%, n=3) reported having very weak ties with private corporations (such as insurance companies like Santam) in terms of disaster management. Respondents (33%, n=3) reported having open discussions with these sorts of entities, but stated that specific agreements have yet to come to light. This lack of collaboration with a diversity of experts, NGOS and private sector entities thus implies a poor inclusion of different types of stakeholders to aid and assist in flood risk reduction in the municipality.

In contrast to the NMBMM, the smaller size of MBLM had distinct advantages on its inclusivity for risk governance. As a local municipality, MBLM presumably has a considerably smaller range and amount of stakeholders in the management of flood-related risks than the NMBMM. Despite the various social and political factors which may affect inclusion of actors, it has been argued that there are limits to the size of an effective network (Hansen, Podolny & Pfeffer, 2001; Roberts et al., 2009). In this case while the lack of stakeholders could be an obstacle to the representation of a wide range of stakeholders, it also offers an opportunity for the fewer stakeholders to effectively work together. While respondents from the NMBMM reported poor attendance at forum meetings, respondents (88%, n=8) from MBLM expressed stronger commitments to these kinds of forum meetings. In addition to forum meetings, post-flood debriefing meetings and service meetings were reported (77%, n=7) to be attended by multiple stakeholders. This is evident in the following response:

> *"After every big incident we have a debriefing session. We invite all the role players that were involved with the flood - we do it with floods, accidents. Where we have a debriefing we discuss all the positives, where did we go right and where did we go wrong, and how can we improve. And the information from the debriefing gets used and we look and see how we can improve the contingency plans"* (MBLM, Respondent 2, Dept. B)

This responses indicates social cohesion facilitating a diversity of stakeholders (from within and beyond the municipal network) being included in discussions regarding the

lessons, both positive and negative, that can be learnt from each major flooding incident in the municipality. The process of collective sharing of experiences is vital in facilitating social learning within the municipality, which is an essential component of adaptive flood management (Leys & Vanclay, 2011). Thus, it is expected that social cohesion facilitates the development of adaptive risk governance within the MBLM municipality.

Besides the inclusion of multiple stakeholders in adaptive governance, MBLM respondents (55%, n=5) reported a strong sense of community inclusion. Whereas the NMBMM featured community engagement through public participation meetings, MBLM was more reliant on community engagement throughout the risk management cycle. Respondents (77%, n=7) reported community meetings being held for various reasons in order to consult local communities. On respondent in particular stated community engagement in the MBLM as being a process of consultation and negotiation as opposed to the public participation meetings of NMBMM where public could only provide input or raise issues. For instance the local ward-based community risk assessments developed for the municipality provided local residents with the opportunity to discuss their experiences and observation of risks within their wards. These risk assessments facilitate a bottom-up approach to knowledge development by transforming the local tacit knowledge of municipal residents into the explicit knowledge of the municipality. In comparison the local disaster management committees of the NMBMM were stated as being a means through which the municipality can coordinate community involvement in flood management.

In addition to these risk assessment meetings, communities (particularly residents of informal settlements) in MBLM are involved through various other committees. Respondents (44%, n=4) revealed the crucial role ward councillors play in creating a bridge between residents and government. Thus the municipality often relies on liaison groups (local residents used by officials to disseminate information), ward committees (local residents who represent the interests of specific wards) and beneficiary committees (local residents who consult with the municipality regarding the roll-out of housing and other services) to represents the interests of settlements. One respondent stated that these groups are vital in securing 'social contracts' whereby the residents of informal settlements and the municipality come to an agreement regarding a particular settlement. Residents of informal settlements were also involved in the dissemination of

information through education campaigns and workshops from the social services directorate.

In terms of inclusion of local experts, business and NGOS, while it might be expected that a metropolitan municipality would have a greater inclusion of these entities, the inclusion of these actors appeared greater in the MBLM. While the most dominant experts who were consulted by the municipality were private engineers and town planners (mentioned by 77% of respondents, n=7), some respondents (22%, n=2) also reported inclusion of stakeholders from the agricultural, transport and educational sectors. Two respondents also reported the inclusion of social facilitators, to assist with the social dynamics of informal settlements. In terms of businesses, large corporations were cited (44% of respondents, n=4) as either providing relief in times of disaster or as supplying early warning systems and communication infrastructure to the municipality. Similarly, various NGOs were cited (by 33% of respondents, n=3) as being involved at various stages of disaster management, predominantly offering relief and volunteers during disasters. Thus the strain on resources in the local municipality appears to foster the formation of weak bridging ties which enable actors to utilise outside assistance from private and non-governmental entities to improve risk governance in the municipality. However it should be noted that there may be various factors (such as financial constraints, political environment, actor stability, etc.) which can affect the inclusion of non-governmental actors in municipal networks, which could be further examined in future research.

5.2 A Social Networks Approach to Local Capacities to Build Flood Resilience in Informal Settlements

As demonstrated above, social interactions have a considerable effect on adaptive and inclusive risk governance at the local level (Luthe, Wyss & Schuckert, 2012). Thus social networks influence the system components which enable the capacity of local governments to build resilience.

With the risk of flooding-related disasters expected to increase under climate change, the capacities of local governments to build resilience is vital in addressing vulnerabilities in the most vulnerable communities. Informal settlements in the NMBMM and MBLM are

highly exposed to flooding risks and have very high sensitivities to these risks (van der Linde et al., 2010; Faling, Tempelhoff & Van Niekerk, 2012). As informal settlements are extremely vulnerable to flooding, building resilience in these settlements is crucial for reducing the harm of flooding risks on these communities (Kotzee & Reyers, 2016). The three mains forms of capacity which are essential in building resilience are: coping capacity, adaptive capacity and transformative capacity (Walker et al., 2004; Miller et al., 2010). Figure 6 provides a summary of main findings from each parameter of data collection in the previous sections of this research. These figures illustrate how each parameter may influence the differences in the capacities of the two municipalities to build resilience, as will be discussed further in the next section.

5.2.1 Social Capital for Coping Capacities

Coping capacity, in terms of risk governance, refers to the ability of systems to persevere despite the presence of a hazard (Gaillard, 2010). Coping capacities are here assumed to be vital for local governments, because they allow actors to utilize resources to resist and recover from harm caused by flood events (Gaillard, 2010). Social capital, and particular bonding social capital, is vital for coping capacities because it aids in the sharing of resources and knowledge to collectively respond to risks (Wolf et al., 2010). Strong social ties and bonded networks in MBLM thus strengthen the municipality's coping capacity to flood risks, with actors collaborating to collectively respond to flooding risks and flood events. Additionally the role that the EDM plays in creating linking ties for the municipality ensures the actors have access to external aid and assistance during flood events. The social ties of MBLM thus support coping capacities within the municipality.

In comparison, the weak bridging ties and institutional silos within the NMBMM result in poor collaboration in responding to flood risks. While the NMBMM network features a JOC for period of disasters, the separate priorities and goals and poor collaboration of actors in the network results in little co-operative responses to flood management. Respondents from NMBMM reported flood risks to be the priority of the disaster management sub-directorate, while this directorate reported only having the capacity to provide relief and starter kits to informal settlements. This response has little effect on the resilience of these settlements, and likely results in a poor coping capacity for the municipality. Disaster relief in the municipality is carried out by a single sub-directorate

and does not involve the cooperative interdisciplinary and multi-stakeholder responses required for effective risk reduction according to Miller and Douglas (2016).

Figure 6- Summary of findings for each parameter for the Social Networks Framework for (a)Nelson Mandela Bay Metropolitan Municipality (top), and (b) Mossel Bay Local Municipality (bottom). Each parameter was assessed using qualitative assessment and was assigned either a high, medium, or low value. The images show how Mossel Bay Local Municipality is much more likely to possess the capacity to build resilience than Nelson Mandela Metropolitan Municipality.

While the persistence of systems under pressure from flooding risks is vital for resilience, systems which rely on persistence only may often lose resilience over time (Miller et al., 2010). While strong bonding social capital is vital for enabling coping capacities, bonding ties enforce norms and may serve to maintain that status quo of a system (Dowd et al., 2014). This is evident in the MBLM, where high network homophily results in innovation in flood risk reduction often being limited to structural interventions such as breaching estuaries, with limited emphasis on addressing conditions of socio-economic vulnerability. According to Miller et al. (2010) vulnerability is shaped by the processes of historical, political and economic inequality. Thus coping strategies which enforce status quo can lead to the loss of resilience over time, because these approaches preserve the conditions which produce vulnerabilities in the informal settlements of the municipality.

5.2.2 Fostering Adaptive Capacities through Strong Bridging Ties

Adaptive capacities (as outlined in section 3.2.4) are vital in overcoming the shortcoming of coping capacities in maintaining the status quo, by moving informal settlements away from a condition of vulnerability (Smit & Wandel, 2006). Adaptation to flooding risks is important because it refers to the ability of municipalities to respond to increasing flooding risks and effectively manage resilience (Walker et al., 2006). Social ties play a vital role in resilience-building because adapting to a changing climate requires interdisciplinary collaboration from a diversity of actors (Luthe, Wyss & Schuckert, 2012). Thus the institutional silos and poor collaboration in the NMBMM will result in municipal actors lacking the necessary social capital to address vulnerabilities in informal settlement, because silos and poor collaboration inhibit the municipal actors' development of adaptive capacity. Strongly bonded sub-groups with weak bridging ties can result in conflict within a network (Wolf et al., 2010), and findings from the NMBMM reflect this trend, with actors in the NMBMM network often face conflicting values and priorities. Thus the network lacks the collaboration between a diversity of actors in flood management that Lutte et al. (2012) argue as being crucial for adaptive capacity.

In the MBLM, by contrast, strong ties between municipal actors appear to facilitate adaptive management and collective goal-setting, to ensure that multiple parties collaborate on informal settlement flooding issues. While strong bonding capital may

inhibit innovation, strong ties and the strong exchange of knowledge (both explicit and tacit) among multiple actors allows resource and knowledge-sharing to enable locally-relevant CCA measures. While the MBLM network lacks strong bridging ties outside of the municipal network, and therefore faces limits on the amount of new information entering the network, the diffusion of knowledge within the network ensures that when new information does enter the network, it is shared between all the actors in the network. Additionally the inclusion of local residents into knowledge production and decision-making ensures locally-relevant risk-reduction strategies to reduce vulnerabilities. According to Pelling and High (2005), strong and multifaceted ties are essential in developing adaptive capacities of actors in a network. Thus the strong ties between actors in the MBLM network facilitate the collaboration and knowledge-sharing necessary to improve the adaptive capacities of its actors.

However, due to financial constraints, CCA measures at the local government level often represent incremental CCA to prevent damage (Dowd et al., 2014). According to Tyler and Moench (2012), incremental resilience-building (or building resilience against a specific hazard) often does not account for uncertainty and risks maladaptation. Due to the financial burdens of CCA on local governments in South Africa (Tempelhoff et al., 2009; Pasquini et al., 2015), CCA at the local level often occurs on a needs-based basis. This approach to flood resilience, where local governments are inclined to adapt to current impact of hazards, may have limited impacts on building long-term resilience due to the emphasis on structural flood interventions. The bias toward these approaches is evident in both municipalities' use of engineering and structural interventions to prevent flood risks, but fails to address conditions of vulnerability in informal settlements. While financial constraints play an important role in the bias towards incremental CCA, there are various other constraints to CCA at the local government level (e.g. cognitive barriers). This means social capital could be increasing important for overcoming challenges to local CCA, especially in the developing world. It can thus be argued that social networks are vital in facilitating cooperative learning to overcome resource constraints for CCA could be vital in creating a mix of structural and non-structural CCA strategies for local governments.

5.2.3 Convening in Social Networks to Enable Transformative Capacities

Transformative capacity refers to the ability to shift a system to a new state in order to remove conditions of socio-economic marginalisation which produce vulnerabilities (Walker et al., 2006; Ziervogel, Cowen & Ziniades, 2016). As transformative interventions move a system away from rigid interventions which prevent harm, transformative CCA builds inclusivity, innovation and flexible systems (Ziervogel, Cowen & Ziniades, 2016). While strong bonding ties facilitate social cohesion, which is essential in the formation of trust and co-operation for adaptive risk governance, bonding ties may also work to maintain social norms within a network (Barrington et al., 2009; Dowd et al., 2014). This conformity may inhibit transformative capacity by preventing interventions which inherently seek to change the system. However, social networks are also vital in the emergence and spread of new norms (Paluck, Shepherd & Aronow, 2016), which means it is vital for local governments to create a diversity of strong bridging ties which could challenge status quo norms and introduce new norms.

The obstacle of bonding social capital to building transformative capacities is evident in MBLM, with strong bonding social ties maintaining homophily in the values, attitudes and goals of respondents. In this context, respondents share similar views regarding how to address flood vulnerabilities in informal settlements (i.e. using relocation as a solution). However relocation has been criticised as disrupting community social structures and removing residents' sense of place (Boon, 2014). Relocation has also been argued to be less inclusive of residents of these settlements and ineffective in addressing socio-economic vulnerabilities (Huchzermeyer, 2006). Thus while the network implements adaptive risk governance, features local inclusion and is open to innovation, the social forces produced through social networks appear to be preventing a fundamental reorganisation to build resilience in informal settlements. This is evident in respondents' views on innovation, where actors are open to implementing innovation however social structures result in the focus of innovation being on structural interventions. According to Few (2003) however, non-structural interventions often cost less and enable local communities to respond and adjust to flood risks. The focus on structural interventions in the MBLM could be a product of social norms in the network which inhibit transformative capacities of the municipality.

On the other hand, the NMBMM is not subject to the same level of network homophily, but instead deals with institutional silos and network conflict. While the NMBMM does not appear to have to deal with the problem of strong ties enforcing and maintaining norms in the network, respondents in the municipality report being inhibited by (a) the lack of collaboration (which limits the ability of single sub-directorates to enact interventions), and (b) tension arising from conflicting values, attitudes and goals. This poor collaboration likely negatively affects the ability of the municipality to implement adaptive risk governance (Ashley et al., 2012). In addition to poor collaboration and adaptive governance constraints, transformative capacities are inhibited by the low inclusion of vulnerable communities, which is core to transformative CCA. Therefore both the MBLM and the NMBMM appear to lack the necessary transformative capacities to build long-term resilience in informal settlements.

Thus, building flood resilience in vulnerable informal settlements require local governments to develop their capacities to cope, adapt and transform to increasing flood related risks. These capacities are largely supported by municipal networks which facilitate knowledge transfers and improve adaptive and inclusive risk governance within local governments.

6 Conclusion

The aim of this research was to examine the role of social networks in transferring flood-related knowledge within local governments to improve the capacities of local governments to build flood resilience in the most vulnerable communities. Through the application of a social network framework to flood resilience, this thesis examined the interactions between tie strength and types of social capital, and the influence and transfer of knowledge within a municipal network. This research then examined how these factors enabled or inhibited adaptive and inclusive governance, and the subsequent implications for municipal capacities to build resilience. Drawing a comparison between metropolitan and local municipalities further served to highlight the impact of different governance structures on the components of the framework for this study.

Social networks with a strong bonding social capital, and a diversity of strong bridging and linking ties, are a vital aspect of informed decision-making for resilience building (Dowd et al., 2014). In examining the strength and function of ties in municipal networks, the size and structure of local governments had a considerable effect on ties between municipal actors. In the NMBMM network, actors were bonded in small sub-groups with weak bridging ties between different sub-groups and with actors outside of the network. This network structure depicts the institutional silos typically expected from metropolitan municipalities (Pasquini et al., 2015). The result of these institutional silos, with regards to flood risk management, were poor collaboration and instances of conflict in the network. In the case of the MBLM network, the entire municipality formed a strongly bonded network with few bridging ties outside of the network. This bonded network facilitated collaborative flood management within the municipality.

The structures of interactions between the actors in the municipal network have a considerable effect on the use and transfer of knowledge within the social network (Fischer et al., 2014). In examining the types and influence of knowledge within the municipal networks, it was found that despite having a presumable greater source of explicit knowledge in the municipality, the NMBMM did not feature a greater utilization of explicit knowledge than the MBLM. The NMBMM also relied less on tacit knowledge, with a poorer incorporation of local knowledge and shared experience into decision-making. On the other hand, actors in the MBLM indicated a strong reliance on, and high

use of, tacit knowledge gained from local knowledge and shared experience. Thus knowledge dispersal and use seemed to be a product of social structures: NMBMM lacked the bridging ties with actors outside the network needed to bring new information into the network, and the bridging ties within the network to effective transfer knowledge among actors. While MBLM similarly lacked bridging ties with actors outside the network, the strong bonding social capital allowed actors to develop strong relationships which facilitated the sharing of knowledge. The stability of actors and community involvement in flood management additionally facilitated the strong development of a tacit knowledge base which could then be transformed into explicit knowledge.

Once patterns of social interactions and knowledge sharing were examined, their effect on adaptive and inclusive flood management was examined. Aspects of social collaboration and shared goals are vital components of effective flood management and resilience-building in local governments (Miller & Douglass, 2016). In the NMBMM, poor bridging ties inhibit collaboration, which negatively affects the flexibility of flood management. Additionally the poor collaboration and conflict between actors presents an obstacle to innovation in flood management in NMBMM. The limited bridging ties and poor dispersal of knowledge in the NMBMM network further limits the inclusion of various expert and local actors in flood management. However, in the MBLM strong ties facilitated knowledge sharing and adaptive learning which enabled flexible flood management. Innovation was supported by strong collaboration but was inhibited by the lack of strong bridging ties. Furthermore the municipality featured the strong inclusion of various actors in flood management in the municipality.

These results are likely to play a large role in the capacity of local governments to build resilience in informal settlements. The weak social ties in the NMBMM inhibit social collaboration, knowledge sharing and dispersal, thereby negatively affecting adaptive and inclusive flood risk management. This results in the municipality having poor coping capacities and lacking the cooperation needed to enable adaptive capacities (Ingold, Balsiger & Hirschi, 2010). Furthermore the conflict which arises between different sub-groups in the network is likely to inhibit the development of transformative capacity for the municipality. In the MBLM, while the strong bonding capital likely works to maintain coping capacities, it also facilitates the collaboration and knowledge sharing needed to develop adaptive capacities (Wolf et al., 2010). However as strong bonding capital

enforces norms in the network (Dowd et al., 2014), the municipality's transformative capacity may be negatively impacted.

The social networks framework for municipal analysis thus integrates the key components of social networks, knowledge and adaptive and inclusive governance to inform the possible implications of these components on the capacities of local governments to build resilience. This framework offers key insight into understanding the obstacles to mainstreaming CCA at the local government level. In particular findings from this research improve the understanding of the social structures which produce or inhibit collaborative governance of climate-related risks.

As urban growth is likely to drastically increase the percentage of marginalised groups living in highly unsuitable areas (Revi et al., 2014), adaptive and inclusive urban risk governance will be essential in reducing the vulnerabilities within informal settlements. This research sheds light on the effect of poor social cohesion and knowledge dispersal on adaptive governance. While various authors have emphasised the value of weak bridging ties in bringing new knowledge into networks (Brass & Krackhardt, 2012; Dowd et al., 2014; Wang, 2016), results from NMBMM suggest the institutional silos which arise in larger metropolitan municipalities may negate the effects of weak bridging ties in local governments.

In contrast results from MBLM suggest that strong social ties could ensure local governments are able to overcome the challenges to local CCA. As bonding ties connect individuals with strong ties, these ties are usually the first point of contact and deliberation for actors in a social network (Hampton, 2011). Results from MBLM demonstrate how strong bonding social capital between all directorates in local government can facilitate knowledge sharing and co-operation in order to create shared goals in risk reduction and collaborative means to achieve these goals.

While the social networks approach sheds light on some of the possible challenges and opportunities to building resilience at the local government level, it should be noted that governance of climate risks is riddled with complexities and uncertainties. While social network structures may work to enable CCA at the local government level, social capital can present actors with positive and negative impacts (Woolcock & Narayan, 2000). Therefore studies of social network structures and influences should always be cognisant

of the contexts the networks operate within. Additionally it should be acknowledged that while studies which examine institutional-level resilience for the basis for building local resilience, it is also necessary to bridge the knowing-doing gap. As resilience of a system is not solely based on the governance of the system, the capacities of communities are vital for resilience. In this sense, resilient governance may not always directly transferring to effective capacity building at the community level.

This research is also limited due to the absence of ties between academics and scientists and government official within the two municipalities. Further research is needed to examine the opportunities and challenges to creating sustained ties between scientists and local government officials. As knowledge exchange is a complex process, internet sources may also play a vital role in knowledge formation processes and more research could be carried out to examine the impact of internet sources on knowledge formation in social networks. Furthermore more research is needed regarding the factors which enable social collaboration and prevent the formation of institutional silos in metropolitan municipalities. Additionally further work is needed to examine the link between social network structure and transformative capacities. As transformative capacities are vital in address vulnerabilities in informal settlements (Ziervogel, Cowen & Ziniades, 2016), understanding how to improve these capacities is vital in ensuring local governments will be able to address the informality and uncertainties which surface in rapidly expanding cities in changing climates.

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Appendices

Appendix 1 – Interview guide for social network ties

Interview guide for first section of framework (social network ties). 'Component' Column indicating the component of the social network framework. 'Parameter' Column indicating the parameter being used to assess social network ties. 'Questions' Column listing the questions used to collect data for each parameter. 'Outcome' Column providing an indication of the desired result to be produced by each question.

Component	Parameter	Questions	Outcome
Social Network Ties	Social Ties	Who are five main people (individuals/departments/institutions) who you consult for flood risk related information?	Identification of actors in the social networks of respondent.
	Dependency	How dependent are you on each of these persons for flood risk-related information? I.e. could you access the same information if this person was no longer in your social network? Why would you say you are/ are not dependent on this person?	Identification of essential ties for providing information to respondent.
	Intensity	How frequently do you interact with these people? Every day, at least once a week, at least once a month, two or three times a year, or once a year	Identification of actors that share frequent interactions with respondent.
		Of the five people you interact with the most, what would you consider to be the nature of the relationship between yourself and the individuals? I.e. is the relationship purely professional, or would you say you are acquaintances, friends, close friends or family?	Identification of emotional closeness of actors with respondent.
	Affect	Do you feel like each of the five people you interact with share the same values and goals as yourself? Why do you feel you may be similar or different to this individual and how does this affect relationship between you and this individual?	Identification of the homophily between actors and respondent.
	Bonding/Bridging/ linking ties	For each of the five individuals you interact with are these individuals in the same municipality as yourself? Are they in the same department? Are they from a different level of government? Or are they from a different organisation, (and if so, at what level)?	Identification of the types of ties held by respondents

Appendix 2 – Interview Guide for Knowledge

Interview guide for second section of framework (knowledge). 'Component' Column indicating the component of the social network framework. 'Parameter' Column indicating the parameter being used to assess knowledge. 'Questions' Column listing the questions used to collect data for each parameter. 'Outcomes' Column providing an indication of the desired result to be produced by each question.

Component	Parameter	Questions	Outcome
Knowledge	Explicit Knowledge	With which of the 5 individuals that you interact with would you consider the tie to be a compulsory or formal tie that has been created by the organisation structure of your department/municipality?	Identification of formal ties.
		What kinds of knowledge do these ties share with you?	Identification of knowledge which is explicit
		Is what you have learned from experience different from the formal knowledge you gain from your ties?	Identification of locally relevant forms of knowledge
	Tacit Knowledge	What experience do you have in dealing with floods? What did you gain from this experience in terms of increased capacity to manage floods?	Identification of the tacit knowledge of respondents
		Which of the 5 individuals you interact with are ties that you have created naturally outside of the organisation structure? How does the information shared to you from these ties differ from your formal ties?	Identification of informal ties and types of information shared by these ties.
		Do you feel that the knowledge you receive from social networks, or the knowledge from your own experience have a greater influence of your decision-making and planning?	Identification of the influences explicit and tacit knowledge have on decision making.

Appendix 3 – Interview guide for Adaptive and Inclusive Governance

Interview guide for third section of framework (adaptive and inclusive governance). 'Component' Column indicating the component of the social network framework. 'Parameter' Column indicating the parameters being used to assess adaptive and inclusive governance. 'Questions' Column listing the questions used to collect data for each parameter. 'Outcome' Column providing an indication of the desired result to be produced by each question.

Component	Parameter	Questions	Outcome
Adaptive and Inclusive Governance	Flexibility	What do you believe to be the main cause(s) and solution(s) of township flooding in your municipality?	Identification of objectives
		What kind of management resources do you possess to respond to urgent or unexpected crisis? How flexible would you consider these resources to be?	Identification of current management resources
		What kinds of future projections or scenarios do you consider when making decisions to prevent flooding risks in townships? Do you feel your budget and plans allow you to respond to a variety of outcomes?	Identification of the models used in respondents decision making
		Bearing in mind this question might not be relevant in your departments' case … How often does your department come together and reflect on what went well and did not, during past flood management, in order to reflect and improve future planning?	Identification of the monitoring of management practices
	Innovation	Would you say your department regularly considers trying new approaches and/or implements innovative interventions(e.g. pilot projects)	Identification of solutions
	Inclusivity	What kinds of individuals (what occupations) are involved in your decision making process regarding township flooding? These could be from any sector or organization, from civil society, the community, etc.	Identification of the diversity of approaches considered by respondent
		How are the residents of informal settlements that are directly affected by the floods involved in planning/ decision-making process?	Identification of locally produced tacit knowledge being incorporated into flood risk management

Appendix 4 – Ethical Clearance Obtained from the Faculty of Science (University of Cape Town)

UNIVERSITY OF CAPE TOWN
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25 October 2016

Mr Roy Bouwer
Department of Environmental and Geographical Sciences

The role of social networks in facilitating the transfer of flood risk related knowledge within local governments to build resilience in informal settlements.

Mr Roy Bouwer

I am pleased to inform you that the Faculty of Science Research Ethics Committee has approved the above-named application for research ethics clearance, subject to the conditions listed below. You are required to:

- Implement the measures described in your application to ensure that the process of your research is ethically sound; and
- Uphold ethical principles throughout all stages of the research, responding appropriately to unanticipated issues: please contact me if you need advice on ethical issues that arise.

Your approval code is: **FSREC 062** – 2016

I wish you success in your research.

Yours sincerely

Prof Timm Hoffman
Chair: Faculty of Science Research Ethics Committee

Cc Supervisor: Dr. Lorena Pasquini