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Assessing the role of learning systems in supporting local government climate change adaptation

by

Miriam Dudzai Murambadoro

(1323805)

Thesis

Submitted in fulfilment of the requirements for the degree

Doctor of Philosophy

in

Animal Plant and Environmental Science

in the Faculty of Science, University of the Witwatersrand, Johannesburg, South Africa

Supervisor: Prof Coleen Vogel

Co-supervisor: Dr Kaera Coetzer-Hanack

19 September 2021

Declaration

I declare that this thesis is my own, unaided work. It is being submitted for the Degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



Miriam Dudzai Murambadoro

19th day of September 2021 at Johannesburg

'Tell me and I forget, teach me and I may remember, involve me and I learn' [1]

[1] Benjamin Franklin

Dedication

This work is dedicated to my father, M.D.B Murambadoro, an ardent local government champion until his retirement and to my late mother, A.Z. Murambadoro, a dedicated mother, teacher, mentor until her very last breath.

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This thesis could not have been done and completed without the support that I received from many people and institutions - some not mentioned here.

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My thanks also go to the Council for Scientific and Industrial Research (CSIR), Witwatersrand University Global Change Institute and the South African Weather Service (SAWS). Their generous funding and support enabled me to pursue this degree. The institutions also provided funding for me to attend workshops and conferences where I had my work peer-reviewed locally and internationally whilst also opening opportunities for collaboration.

Lastly and most importantly, I thank God for being faithful because when I committed this work to Him my desires were established.

Preface

Some of the text included in this thesis or short versions of it have been published or presented at conferences as outlined below:

Parts of Chapter 3 on participatory action approaches and data collection instruments in engaging stakeholders such as local governments small extracts on the use of PAR to understand the value geospatial information have been published (lead author) in a book chapter. Murambadoro M. and Mambo, J., 2017. Qualitative and other social science-oriented methods to assess the importance of geospatial information. In: Kruse,J., Crompvoets., J and Pearlman, F. (Eds) *GEOValue: the socio-economic value of geospatial information*. CRC Press Taylor and Francis Group ISBN: 9781498774512 (see Appendix 1). My contributions were conceptualisation and initial drafting of the chapter, data collection, analysis, writing of the chapter and editorial.

Parts of Chapter 4 on policy and national initiatives supporting CCA learning were published as a book chapter as a co-author. The chapter illustrated socio-political factors contributing to municipal vulnerability to climate change in South Africa and a case study. Mambo, J. and Murambadoro, M., 2017. Municipal vulnerability to climate change. A book chapter in Mambo, J and Faccer, K. (Eds) *South African Risk and Vulnerability Atlas 2nd Edition: Understanding the social and environmental implications of Global Change*. Department of Science and Technology Pretoria South Africa. Africa Sun Media ISBN 978-0-992236-06-9 (see Appendix 2). My areas of contribution were the initial drafting of the paper, analysis and interpretation and led writing of the case study.

Parts of Chapter 3 and 6 were published in a publication were the candidate was a co-author. Virapongse, A., Pearlman, F., Pearlman, J., Murambadoro, M. D., Kuwayama, Y and Glasscoe, M.T., 2020. Ten rules to increase the societal value of Earth Observations. *Earth Science Informatics*. https://doi.org/10.1007/s12145-020-00453-w (see Appendix 3). My contributions were analysis and interpretation, data collection to illustrate case studies from South Africa that could be integrated into the paper, networking and writing of some sections of the paper.

Parts of Chapter 7 were presented by the candidate at the Fifth International Conference on Climate Services (ICCS5) 27 February - 3 March 2017 Cape Town South Africa. Murambadoro, M. and Mambo J., 2017. Lessons learnt regarding climate service needs for local government in South Africa. My contributions were data collection and analysis, drafting the presentation and presenting at the conference.

Parts of Chapter 7 on barriers to and challenges for effective flow and uptake of climate change at local government level were also presented at the Early Career Researchers event at the International Conference for Regional Climate, CORDEX, 14-18 October, Beijing, China were I was an Invited Speaker. The session focussed on challenges and opportunities in the application of climate science data and engagement with users. My contributions were data collection, networking and presenting at the conference.

Parts of Chapter 5 and 6 were presented by the candidate at the ICRC-CORDEX conference 14-18 October, Beijing China. Murambadoro M., 2019. Assessing the value of climate information for local government officials in South Africa. My contributions were data collection, networking and presenting the paper at the conference.

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Acronyms and abbreviations

AWARD	Association for Water and Rural Development
CCATP	Climate Change Adaptation Training Programme
CDM	Capricorn District Municipality
CCA	Climate Change Adaptation
CoP	Community of Practice
CoGSTHA	Cooperative Governance, Human Settlements and Traditional Affairs
CoGTA	(Department of) Cooperative Governance and Traditional Affairs
CoGSTHA	Cooperative Governance, Human Settlements and Traditional Affairs
CoGTA	(Department of) Cooperative Governance and Traditional Affairs
CSIR	Council for Scientific and Industrial Research
DALRRD	Department of Agriculture, Land Reform and Rural Development
DBSA	Development Bank of Southern Africa
DEA	Department of Environmental Affairs
DEFF	Department of Environment, Forestry and Fisheries
DPEMS	Department of Planning and Environmental Management Services
DRDP	District Rural Development Plan
DRDLR	Department of Rural Development and Land Reform
DSI	Department of Science and Innovation
DWS	Department of Water and Sanitation
EWS	Early Warning System
EPWP	Expanded Public Works Programme
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GCGC	Global Change Grand Challenge
ICRAF	International Council for Research in Agroforestry
ICT	Information and Communications Technology
IDP	Integrated Development Plan
IGCCC	Intergovernmental Climate Change Committee

IPCC	Intergovernmental Panel on Climate Change
LDARD	Limpopo Department of Agriculture and Rural Development
LEDET	Local Economic Development, Environment and Tourism
LED	Local Economic Development
LGCCSP	Local Government Climate Change Support Programme
MEC	Member of the Executive Council
MEL	Monitoring, Evaluation and Learning
NCCRP	National Climate Change Response Policy
NDC	Nationally Determined Contributions
NFCS	National Framework for Climate Services
NRF	National Research Foundation
NGO	Non-Governmental Organisation
PAR	Participatory Action Research
RVSC	Risk and Vulnerability Science Centre
SALGA	South African Local Government Association
SARVA	South African Risk and Vulnerability Atlas
SPLUMA	Spatial Planning and Land Use Management Act 16 of 2013
SAWS	South African Weather Service
SDG	Sustainable Development Goal
UNFCCC	United Nations Framework Convention on Climate Change
WESSA	Wildlife and Environmental Society of Southern Africa

1. Introduction

1.1. Climate change adaptation learning in complex governance systems

Climate change and associated impacts are some of the major wicked problems facing decision and policy-makers currently and in the future (Rittel and Weber, 1973; UNDP, 2018). It presents multi-scalar and multi-sectoral impacts that are not yet well understood, and there is incomplete information on how to respond. The process of climate change response, particularly climate change adaptation (CCA) is, therefore, a continuous learning process with trial and error that also does not have a specific stopping point. Globally there is growing interest to build the capacity of actors who can implement climate change responses at local government level (Kronlid, 2009; IPCC, 2014). Little, however, is known about how the actors are involved in CCA governance, how they learn, what they learn and from whom. The research presented here contributes to addressing this knowledge gap by drawing from CCA, governance and learning theories to understand the learning process of governance actors in Capricorn District Municipality (CDM), South Africa.

The evidence for climate change is growing, for example, projections indicate an increase in the frequency and magnitude of extreme weather events and other climate change impacts (AMCEN, 2011; IPCC, 2012; Allen *et al.,* 2018; Hoegh-Guldberg *et al.,* 2018). The impacts that may arise from climate change are, however, multifaceted and are worsened in countries such as South Africa among others, due to the prevalence of poverty, inequality, poor access to basic and social services, land-use change, and dependence on natural resources for livelihoods, especially in rural municipalities (Lethoko, 2016; Scheiter *et al.,* 2018; CDM, 2019a; AWARD, 2020a). In the absence of effective implementable measures to reduce vulnerability, the risk of disasters will also increase, and this has the potential to magnify the uneven distribution of risk between the poor and those with wealth (Hallegate and Rozenberg, 2017).

The United Nations Framework Convention on Climate Change (UNFCCC) continues to play a key role in steering the global climate change agenda with by investing in research. These global initiatives are then negotiated at a national level to inform national policy and programmes that have been developed in South Africa, which in turn are enacted at the local level. In 2017 and 2018 about R62.2 billion has been invested in climate change response for both mitigation and adaptation (Cassim *et al*., 2021). These funds have been disbursed through different channels including government departments, public agencies, donor agencies, commercial and financial institutions. National government departments such as the Department of Science and Innovation (DSI), Department of Environment, Forestry and Fisheries[2] (DEFF) and Department of Agriculture, Land Reform and Rural Development (DALRRD) have played a role in coordinating CCA related programmes, projects, scientific

[2] The Department of Environment, Forestry and Fisheries (DEFF) went through a name change and is now called the Department of Forestry Fisheries and the Environment (DFFE) from April 2021. Prior to this it was known as the Department of Environmental Affairs (DEA). For the purpose of this thesis I retain the name DEFF given that this is how the Department was represented when data collection was done.

and technical outputs to build the capacity of local government officials to respond to climate change. Evidence shows that even with all these investments, climate change efforts are still woefully insufficient to support comprehensive learning and implementation of CCA at local government level as officials still struggle to integrate this information into municipal operations (Murambadoro and Mambo, 2017a; AWARD, 2020a).

This thesis examines CCA capacity building in CDM, which is located in the Limpopo Province of South Africa. The CDM was selected for study because it is located in one of the Provinces most at risk to climate change due to projected droughts, increases in mean temperature and flooding due to extreme rainfall events(DEA, 2013; Lethoko, 2016; AWARD, 2018). Local government officials have a mandate described in the National Climate Change Response Policy and the Climate change Bill to ensure climate actions are taken at the municipal and at community levels (DEA, 2011; DEA, 2018a). In Limpopo Province, like many other parts of South Africa, officials do not only deal with climate change but must also deal with other pressing social-economic development challenges which create competing interests in terms of planning, budget allocation and implementation of CCA initiatives (Hungwe, 2017; Mambo and Murambadoro, 2017).

To put CCA science and policy into practice in such complex governance systems such as municipalities, one has to dig deeper to understand the context in which learning and decision-making take place and how to effectively support municipalities to integrate CCA into municipal operations. The governance of CCA at the sub-national level, therefore, is not only informed by the local actors, policies and legislation but it is also influenced by the interactions of multiple actors across a range of scales, and it has further entanglements with the social, economic political and environmental priorities to inform adaptive behaviour (Pelling *et al.,* 2008; Scott, 2017). The main research question that informed this study was: How do local actors learn to adapt to climate change and how can these learnings be scaled upwards and outwards if at all, to impact national learning systems that support local governments? The findings of this study provide insights into the different learning systems used by governance actors, the gaps and areas for strengthening uptake of CCA into municipal operations in CDM and any other similar contexts.

1.2. Framing of the research gap

CCA is a continuous process faced with many challenges and solutions which vary from one context to the other, making it difficult to predict a series of actions that would work best, especially at the local government. It is often suggested that there is a gap between science-policy and practice, but this is not entirely understood (Bultitude *et al.,* 2012; Swilling, 2014; Kirchhoff *et al.,* 2015; Choi, 2016). In my experiences as a researcher, there is a complex, messy, entangled and spiral relationship between science and policy which needs to be better understood to ensure that science is produced and communicated in a way that decision-makers will be able to use (i.e. practice) (Murambadoro and Mambo, 2017a) . Building effective climate change adaptive capacity in contexts such as CDM is neither an easy task nor is the decision-making a straightforward process that can easily be addressed by the provision of scientific data and information (Scott, 2017). In this thesis, an area of critical focus is on interrogating the learning systems and processes that users (actors) at the local government are using to learn about CCA.

Some of the barriers as well as opportunities to enhance these processes (flow of information, learning and uptake at local government level) are also examined.

Building on the work of Bennett and Howlett (1992), this study explores five key questions on the CCA learning process of governance actors. A participatory research approach was used to establish (i) who learns in the policy context, (ii) what is learnt and (iii) the effect of this learning and impacts on subsequent policies. Additional questions explored were (iv) who do governance actors learn from including how this learning takes place, as well as (v) what else can be done to enhance learning and policy implementation using the CDM as a case study. These five explorative questions are used in this thesis to improve understanding on the complex interactions of state and non-state actors in CCA learning including the intersectional learning of CCA and local development priorities (Mitchell, 1991 in Bennet and Howlett, 1992).

Before one can explore how learning on CCA occurs, there is a need to map out the actor landscape identifying who is who in the CCA local municipal space, what are the connections, loci of individuals and collective influence of actors as well as the power they may hold. The need for multiple actors with different types of knowledge is acknowledged to be central to climate change mitigation, but there is limited understanding of who the actors in CCA governance are, how such actors learn, what they learn and from whom (Fünfgeld, 2015; Wolfram *et al.,* 2019), especially in developing countries such as South Africa(Averchenkova *et al.,* 2019).

In the context of CCA in South Africa and other developing states, the dilemma for decision-makers often lies in finding a balance between socio-political obligations to their constituency and climate change commitments. An example is the need to provide basic services but also being cognisant of greenhouse gas mitigation commitments which all need to be addressed by government actors at the same time. The context in which CCA governance actors operate requires intricate processes of decision-making that are morally and ethically loaded, and they often become indecisive because of competing moral obligations that dictate the courses of action that should be prioritised. Bourdieu's (1990) notion of habitus is important in unpacking this complex environment that influences the action or inaction of CCA governance actors in local governments. Thus, the environment in which governance actors operate is influenced by the prevalence of interdependent interactions between the being (i.e. the individual decision-maker) and the sphere of existence (e.g. municipality), such that their decisions are shaped by and configure this sphere and processes of operation. Decision-making is therefore not an autonomous process in which officials can demonstrate self-governance as bearers of public office, instead they have varying levels of free will to make decisions because of social hierarchical structures and organisational norms and procedures that can constrain individual and/ or collective agency (Öberg and Wockelberg, 2021).

Local government officials, however, as individuals may have some level of autonomy but they are part of complex governance systems with a hierarchical organisational structure. In this structure, those at the highest levels of authority have the power to make decisions as well as enforce formal and informal rules which inform organisational norms and practices, i.e. governing variables (Bourdieu, 1990; Pesanayi, 2009; Sullivan, 2017). CCA requires behavioural and social change, hence the need to critique power relations embedded in organisations and norms

as they impact learning, decision-making and action (Bourdieu, 1990; Gaventa and Cornwall 2008; Davoudi *et al.,* 2012; Kaika, 2017; Boström *et al.,* 2018). As difficult and complex as it is, scientists need to understand the habitus in which decision-making occurs as well as the operational processes and appreciate the varying forms of knowledge within local government that enable or disable the flow and uptake of CCA information (Dilling and Lemos, 2011; Cvitanovic *et al.,* 2015; Vincent *et al.,* 2018; Kong *et al.,* 2020).

To address the question "who learns", the study draws from the governance lens to understand the governance actors making decisions and their links to other actors in the polycentric governance network (Ostrom, 2009; 2010). The adaptation action cycle is also used as a theoretical framework to understand what governance actors (e.g. officials) learn in relation to CCA, climate change and perceptions of risk. It is anticipated that, as governance actors complete each sequential step of the cycle, there is learning that takes place. For example, the initial step of detecting and defining the problem is based on, among other things, what governance actors have learnt, and it influences how they conceptualise climate change risk and policies to suit their context.

Following from this, there is also the need to improve the understanding on the different ways in which decision-makers learn and how they then try and institutionalise the learning from the scientific community and other external stakeholders on policy issues such as climate change and climate change response (Dunlop, 2009; Hopkins, 2013; Angeulovski *et al.,* 2014). Little is known about the different sources of information used by the policy and decision-making community to learn about climate change and CCA and the most effective learning systems to use (Dunlop, 2009; Hopkins, 2013). These challenges are linked to questions 3 and 4 (see page 6) on learning from whom and how the learning takes place, and to what effect? To respond to these questions, the study draws from various learning theories to illustrate how adult learners continuously learn through their lifetime (lifelong learning) through different types of learning, including collective learning as they interact with other social actors. The loop learning model (Argyris and Schön, 1974;1996 see Chapter 2) is thus also investigated to illustrate some of the derived effects of CCA learning on municipal operations.

Lastly, although recommendations from the research are that governance actors in CCA must socially learn based on some successes in the Global North (Pelling *et al.,* 2008; Pelling, 2015) as will be shown in this thesis (notably, Chapter 7), this is not so easy to achieve in the Global South and in contexts such as South Africa. Further to this, the role of human attributes in CCA is often overlooked (Grothman and Patt, 2005; Adger *et al.,* 2007; Thaker *et al.,* 2016). For this reason, the study will highlight the additional human and organisational or institutional efforts required to enhance the flow of information and uptake of CCA at local government, including the role of the social learning approach in supporting organisations to bridge the gap between what governance actors know and what they do. In so doing, I will be addressing key question 5 on what else can be done to enhance learning and uptake of information into planning and decision-making at the local government level. With this as background to the study, the attention now turns to examine the research aim and research objectives.

1.3. Research aim and objectives

The central research question of this study is:

How do local actors learn to adapt to climate change and how may these learnings be scaled up to impact national learning systems?

The overall aim of the study is to improve the flow and uptake of CCA amongst local government officials to enhance its integration into municipal operations. I disaggregate the central aim and question into the following specific research objectives linked to the specific questions as shown below.

Objective1: Establish the governance actors' current understanding of climate change, CCA, lived experiences as well as perceptions of risk.

Key question 1: Who are the governance actors making decisions, who should learn about CCA in CDM?

Key question 2: What do local government officials in CDM currently know about climate change and CCA and perceptions of climate change risk?

Key question 3: What is currently being done to respond to climate change in the CDM?

Objective 2: Identify the sources of CCA information, its flows and uptake at the local government level

Key question 1: What are the different sources of information and support (learning systems) currently used by officials in CDM to make decisions on CCA?

Key question 2: How does this information flow within the network and get to local government officials?

Key question 3: What is the role of information providers in supporting learning at the local government level?

Objective 3: To identify some of the challenges for effective flow and uptake of CCA knowledge in local contexts

Key question 1: What are the barriers to effective flow and uptake of CCA knowledge in local contexts?

Objective 4: To improve the effectiveness with which learning systems can be supported to enhance the integration of CCA into local government operations

Key question 1: How can the flow of knowledge, learning and effective uptake into municipal operations be improved (including actors, support structures or learning systems)?

The questions have all been linked to the study research objectives, as shown in Figure 1.1, followed by a brief description of how these are informed by various literature with a detailed discussion in Chapter 2.

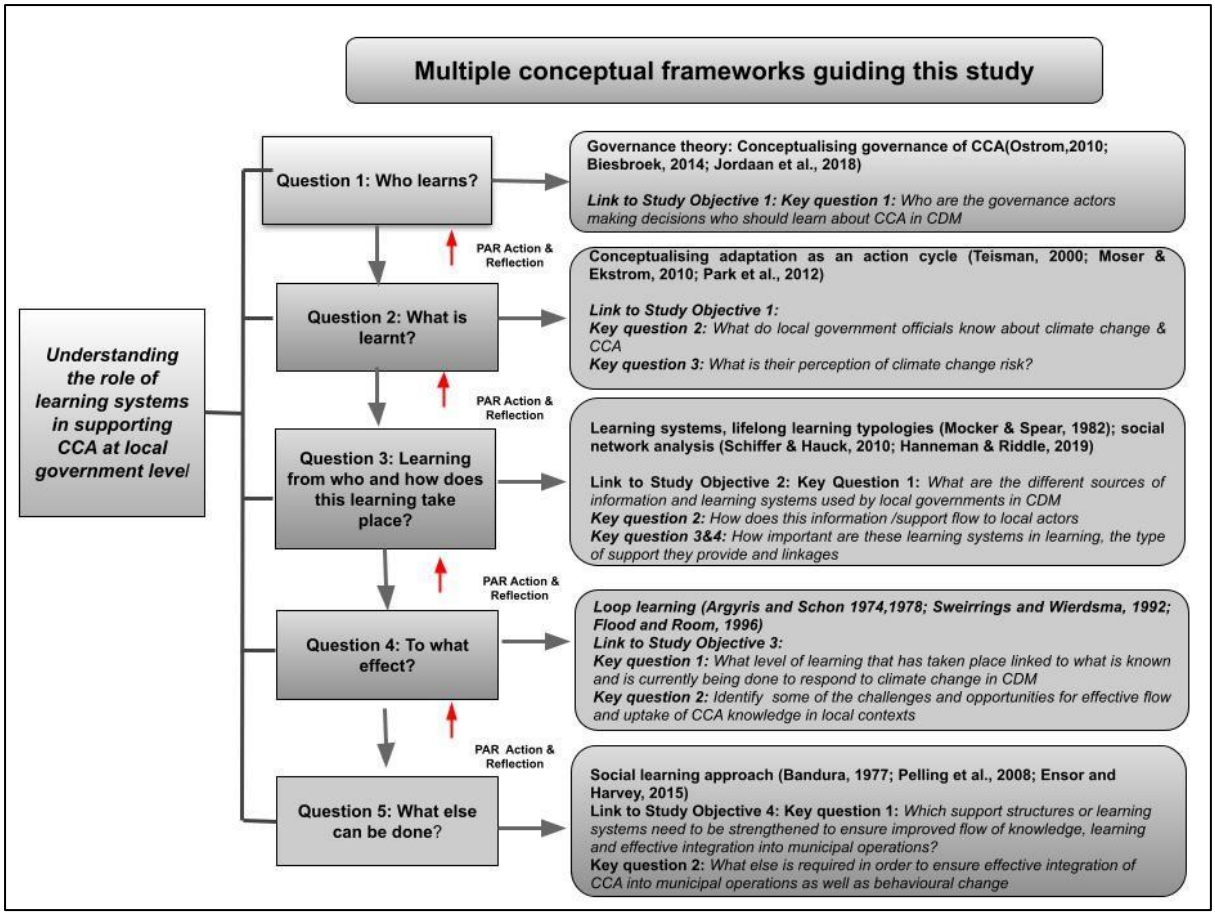


Figure1. 1: Multiple conceptual frameworks guiding this study building on Bennett and Howlett's (1992) explorative questions on policy learning

The red feedback arrows shown in Figure 1.1. illustrate the action and reflection process that I went through (Baum *et al.,* 2006) as I designed the data collection instruments and identified any gaps that needed further probing with the participants or secondary literature as part of the Participatory Action Research (PAR) approach adopted in this study (Chapter 3). The key terms used in this thesis are defined and described in the next section.

1.4. Definition of the central concepts

The key concepts used in the research that need to be defined are governance, CCA, learning, lifelong learning, learning systems and social learning. The following section provides an overview of these concepts and demonstrates how they have been applied in the research. The concepts have been further discussed and linked to literature in Chapter 2.

1.4.1. Governance

The concept of governance has been described as " …the process by which decisions, laws, and policies are made, with or without the input of formal institutions" (Hague *et al.,* 2019:4). In urban governance literature, governance has also been defined as "the multiple ways through which diverse actors intervene in controlling and

managing the city" (Broto *et al.,* 2015: 572). I use this concept in my study to broadly describe the collective means by which actors at local government level direct and manage parts of society in response to the emergence of societal problems such as climate change (Pierre and Peters, 2000; Torfing *et al.,* 2012 in Biesbroek, 2014). There are two main discourses on governance, the monocentric and polycentric forms that have been studied mostly in the public administration and the governance of natural resources (Carlisle and Gruby, 2017). Monocentric governance, on the one hand, is used to describe a system where there is one dominant actor (such as the government) that controls and manages society and sets up the societal development and policy agenda while also managing public goods and services through top-down policies (Aligica and Tarko, 2012 in Biesbroek, 2014). Polycentric governance, on the other hand, refers to a complex form of governance with different centres/loci of decision-making which may be independent of each other but are linked through mutual institutional settings (Ostrom, 2010; Biesbroek, 2014). In Chapter 5 and 6, I use the governance lens to understand the governance landscape in CDM and to identify the governance actors who make decisions in CDM, illustrating a polycentric governance system. Further to this, in Chapter 6 I also explore the social actors in the polycentric governance system that influence learning in CDM and use the social network analysis to illustrate the interactions between them using centrality measures of the degree of centrality, betweenness and nearest neighbour (Chapter 3).

Governance and climate change literature illustrate that, in addition to state actors such as local government other non-state actors including civil society, business, research and academic institutions and communities also contribute to shaping the governance CCA through complex social processes (Pelling and High, 2005; Ostrom, 2010; Leck and Roberts, 2015; Voß and Schroth, 2018; Jordan *et al.,* 2018). The critical question however, is, how are the governance relations articulated and what capabilities are required to enact any CCA policy?

1.4.2. Climate change adaptation

The term CCA refers to "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid hard or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects". (IPCC, 2014a:1758). While the focus of this study is on CCA, it is also important to acknowledge that climate change governance should also include mitigation, i.e. 'human intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC, 2014a:1769). Climate mitigation, just like adaptation, can also be implemented at local government level and links to municipal mandates, including monitoring and enforcement of air quality regulations, land use spatial planning and development of building codes. Efforts in climate change mitigation can also have co-benefits that contribute towards adaptation, for example, reducing air pollutants can contribute towards reducing the risk of respiratory diseases for communities. I use the adaptation action cycle as a theoretical lens to conceptualise the sequential process followed in adaptation and highlight the learning that occurs in each of these steps which starts by identifying and framing climate change risk and ends with an evaluation and adjustment of the interventions (Figure 1.2) (Park *et al.,* 2012). Chapter 5 (section 5.4) and Chapter 7 describe findings of this interrogation by highlighting some of the sequential steps of CCA that have been taken by the CDM, including conducting a risk and vulnerability

assessment that informed the development of the CDM CCA strategy and how this has influenced the framing and actions taken.

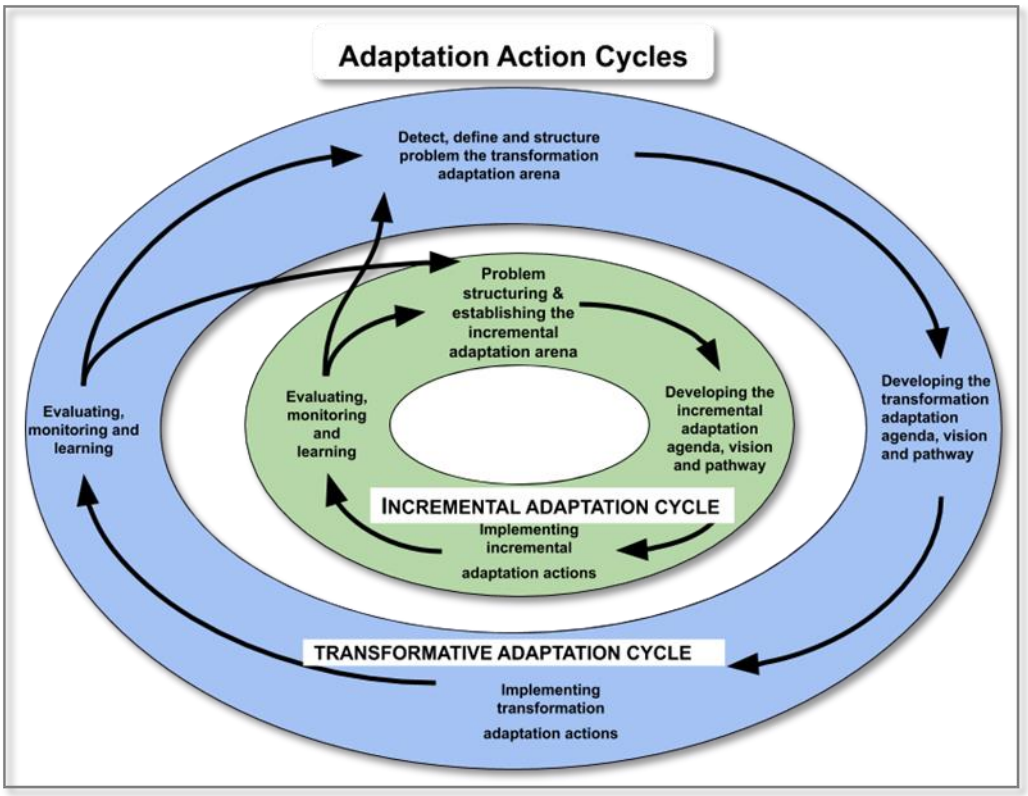


Figure1. 2: Illustration of the two concentric and linked adaptation action cycles of transformative and incremental adaptation actions adopted in this study as a conceptual framework to answer the key question learnt what (Source: Park et al., 2012:118)

Adaptation can be incremental, i.e. "...adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale" (IPCC, 2014:1758). It can also be transformational, i.e. "…changes the fundamental attributes of a system in response to climate and its effects" (Ibid). Adaptation can be implemented as a process through planned interventions, i.e. anticipatory or in response to emergencies, i.e. reactive (Smit and Wandel, 2006; Hopkins, 2013). Furthermore, it can be implemented in both human and ecological systems at various spatial and temporal scales, including individual efforts to mitigate impacts to climatic stress such as heatwave or floods (Smit and Wandel, 2006). CCA can also take different forms, including changes in cultural practices, organisational structures and processes. Learning to experiment with new information and technological innovations that support communities to cope and adapt with changes are also considered as adaptation (Tanner and Bahadur, 2012).

Studies show that not all efforts aimed at adaptation are positive as some result in maladaptation and increased vulnerability of systems to climate change (Grothmann and Patt, 2005; Hopkins, 2013; Magnan, 2014). Maladaptation can be a result of short-term interventions that increase the vulnerability of the most vulnerable parts of society or activities due to the resultant high social, economic and environmental costs which are difficult to sustain (Magnan, 2014).

Notwithstanding all the discourse on climate change and CCA, a central concept tracked in this work is that of adaptive capacity. Adaptive capacity is central in adaptation interventions and has been defined as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences" (IPCC, 2014:1758). The increased frequency and intensity of extreme weather related to climate change threaten the actor's governance capability to respond and achieve sustainability (Kronlid, 2009). A lack of adaptive capacity of a community or system is influenced by the available social, governance and economic resources available and the requirements will be different between risks and sectors (Climate-ADAPT, 2020). The adaptive capacity of actors such as local governments does not only entail being able to respond to disasters but also the capacity to seek out opportunities that enhance the sustainability of their communities (Davoudi *et al.,* 2012). Further to this, it requires dynamic policy-making processes that are flexible to unforeseen changes in the future and also consider the changing societal needs and values (Taebi *et al.,* 2020). Learning thus plays a key role in building the adaptive capacity of actors such as local government officials allowing an opportunity to expand their capabilities and knowledge on how best to respond (Kronlid, 2009). These concepts of CCA and adaptive capacity are explored in different parts of the thesis including Chapter 2, where I use adaptation action cycles to examine what local government officials learn as they go through incremental and transformative adaptation. Additionally, an assessment of the study site presented in Chapter 5 provides an overview of the CDM's exposure, sensitivity and ability to respond to climate and other stimuli.

1.4.3. Learning

The concept of learning is a complex process that has been theorised in various ways with a focus on the individual, social groups and organisations (Chapter 2). The concept of learning has been defined in different ways, including a short description by Argyris and Schön who define it as "the detection of error and correction of error (1978:2). Learning has also been defined as the way in which individuals or groups acquire, interpret, reorganize, change or assimilate a related cluster of information, skills, and feelings. It is also primary to the way in which people construct meaning in their personal and shared organizational lives" (London, 2012:3). In addition, Ison et al. (2000) have described learning as "the transformation in the potential for the behaviour of an actor in response to experience, as seen from the viewpoint of an observer" (in Pelling *et al.,* 2008:9). In this latter view of learning, it is anticipated that individuals, groups and non-human actors (e.g. technology and policy) are capable of change in response to certain stimuli for example, current and future climate change risks.

The various notions of learning used in the climate change social space pave the way for valuable intersubjective and, at times, opposing views of whether learning has taken place or not from the perspective of the learner and others (Pelling *et al.,*2008; Lotz-Sisitka and Kronlid, 2009). Learning is considered a dynamic and generative process where organisational attributes, as well as their adaptive capacity, is not seen as something static but rather a process that shifts in response to internal drivers and interactions with other actors in the system hierarchic scale (Pelling *et al.,* 2008; Pesanayi, 2009). Assessment of learning, therefore, should go beyond assessing what has been learnt and consider the institutional and actor attributes that enhance or constrain capacity and ability to learn (Checkland and Casar, 1986).

In this study, I use the concept of CCA learning to refer to changes in skills, knowledge and behaviour of governance actors which result from experience and the interactions with other social actors or the environment (Chapter 6 and 7). Changes observed in this study are broad and include conscious and unconscious actions that are not constrained by the behaviourist learning theory that only focuses on assessing conditioned human behaviour (Pelling *et al.,* 2008). Examples of changes and knowledge observed include how governance actors conceptualise key climate change concepts, adjustments in how governance actors plan and make decisions within municipal operations to integrate CCA (e.g. allocation of funding for CCA), participation in platforms of learning and development of policy to guide CCA implementation.

1.4.4. Learning systems

Having outlined what is meant by learning, attention now turns to expand on the sources of information that support learning, i.e. learning systems. Learning systems refer to a collection of products that are administered appropriately to incite various learning processes (IGI Global, 2017). The term learning system is used here to refer to "an interdependent combination of people, media and materials that work together to achieve a goal" (i.e. learning) (Clark, 2008:87). Learning systems appear in various forms which include published books, journals, newspapers, grey literature, the internet, forums, informal meetings/social interactions where traditional and indigenous knowledge is shared (see Chapter 6). People learn from these sources in different ways with each source having its strengths and weaknesses. Actors who are intermediaries, boundary organisations and civil society, for example, can also be considered to be part of a learning system as they are sources of information who can also use officials within the organisations as well as materials and media to support learning. As highlighted above, the governance of CCA usually occurs in a polycentric governance system due to the linkages of climate change to biophysical and socio-economic sectors that make overlaps and interaction with a wide range of actors inevitable (Van Asselt and Zelli, 2018).

The process of learning to develop self and group efficacy, through interactions in social contexts, can be linked to social cognitive learning theory which illustrates the reciprocal and causal relationship between humans and their learning environment as a key factor that influences their values, knowledge, ways of doing things and consequences for actions (Boudieu, 1990; Ziervogel, 2019). When tackling climate change using an adaptation framing, one usually requires the integrating of both explicit and tacit knowledge through transdisciplinary communities of practice where scientists and users of their products such as policy-makers and practitioners create hybrid knowledge through social learning (Audouin and de Wet, 2010; Vincent *et al.,* 2018). The term communities of practice refer to "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger, 2006:1). In Chapter 4, some of the global and national sources of information that are part of the CDM learning system are examined to illustrate the policy framework that shapes the climate change discourse. Furthermore, in Chapter 6 of this thesis, I present findings on the sources of information that form part the learning system used by CDM government actors for CCA learning.

Literature suggests that there is need for learning spaces where scientific and non-scientific actors meet to co-learn and these have been referred to as Agora or third spaces (Nowotny *et al.,* 2001; Roux *et al.,* 2017) or transformative spaces (Menelisi *et al.,* 2020; Pereira *et al.,* 2020). Actors in formal organisations such as local government can and do also interact with informal institutions that are part of their social network to influence their knowledge, interests and value systems. The term network refers to "relationships that cross boundaries of identity, providing an informal vehicle for the flow of information in an organisation" (Pelling *et al.,* 2008:7).The interactions between these formal organisation and the informal institutions can also influence learning, decision-making and implementation but can also constrain change and incite behaviour that is contrary to the formal organisational framework and institutional learning culture (Argyris and Schön, 1996; Pelling *et al.,* 2008; Leck and Roberts, 2015; Scott, 2017). The platforms in which these interactions occur provide governance actors with access to information from different sources of information. The spaces where such learning occurs has often been termed 'shadow spaces' which are defined as the spaces "which lie outside of formal platforms of engagement of actors… where knowledge is shared and new ideas are introduced and sustained" (Scott, 2017:9). These shadow spaces form part of the learning system whereby information and learning are facilitated through for informal interactions between social actors and used together with other information from formal meetings as well as scientific publications among others.

The role of shadow spaces in supporting decision-making around climate change has also been acknowledged in studies by Pelling et al. (2008); Pelling and Manuel-Navarrete (2011); Leck and Roberts (2015) and Scott (2017). In South Africa, the eThekwini Metropolitan Municipality's CCA efforts have been supported and sustained by the shadow system where information and knowledge are exchanged informally but supported by management (Leck and Roberts, 2015). The municipal officials were able to establish personal relations outside the formal Municipal Climate Protection Programme through which the informal interactions in shadow spaces enabled knowledge sharing, experimentation and learning, but they have also had challenges with getting political buy-in (Ibid). Nevertheless, although shadow networks play a key role in supporting adaptation, the impact of adaptation actions taken with or without the support of shadow networks may take years to emerge (Wutich *et al.,* 2020). Furthermore, these networks can also be destructive and negative to formal and transparently agreed objectives of organisations by working towards different and corrupt activities e.g. state capture. The role of shadow networks has not been fully explored in this study as this was beyond the scope of the study. Much more detailed interrogation of such actor spaces is required and should be undertaken.

1.4.5. Lifelong learning

In addition to understanding learning and learning systems above, there is a need to also provide an overview of how this process occurs from birth throughout adult-life by examining the concept of lifelong learning. Lifelong learning is a process through which individuals or groups acquire personal, social and professional development to improve the life of the individual and collectives (Dave, 1976). The European Commission (2001:9) defined lifelong learning as "all learning activity undertaken throughout life, with the aim of improving knowledge, skills and

competences within a personal, civic, social and/or employment-related perspective". The concept of lifelong learning or continuous learning is a dominant field of work in adult and continuation education that seeks to enhance a learner's prior knowledge and skills. The premise of the lifelong theory is that, although learners partake in educational activities in primary, high school and tertiary institutions to acquire formal qualifications, it is still not possible to equip learners with all the knowledge and skills required to sustain them throughout their lifetime (London, 2012). Therefore, learning has no specified start or end time, hence people learn throughout their lifetime (Downsborough, 2009).

Incorporating the lifelong learning approach is important, especially when dealing with complex, contested topics such as climate change that require learning processes that are more transformative (i.e. change cognition, values and experiences) and transgressive (i.e. challenge the status quo and cross borders and boundaries) (Lotz-Sisitka, 2016). As such, individuals in local government may consciously and unconsciously continuously update their skills and knowledge through different learning systems, mediated through salient features (e.g. managerial support) in organisations that can enable or disable continuous learning (Tannenbuam, 1998). Similarly, depending on motivation, skills and resources, the salient features that disable learning may be overcome for some (London, 2012).

Adult learners also have different preferences on how they want to learn as most prefer to use learning systems that enable them to capitalise on their strengths while also building on their weaknesses (London, 2012). To illustrate this, Mocker and Spear (1982) developed the lifelong learning typologies model that can be used to operationalise the learning that individuals and organisations use to prosper throughout their lifetimes (Chapter 2). The learning typologies identified by Mocker and Spear (1982) are self-directed, informal learning, non-formal and formal learning and have been integrated into this study to understand what local government officials in CDM perceive to be the most effective and preferred learning typologies and associated learning systems.

1.4.6. Social learning

In addition to defining learning, I also focus on social learning as it is espoused as a conceptual framework that can support collective learning for complex topics such as CCA learning. Social learning has been defined as "a process of collective and communicative learning, which may lead to a number of social outcomes, new skills and knowledge… a frequent entry point to learning in the context of environmental issues" (Pelling *et al.,* 2015:5). In recent years, there has been a growing literature in the field of social learning to understand and enhance the role of group and organisational learning in developing concerted efforts to respond to complex socio-ecological problems and disaster risk reduction (O'Donoghue *et al.,* 2007; Cundill *et al.,* 2014; Pelling *et al.,* 2015; Peters and Wals, 2016; Roux *et al.,* 2017). Forms of social learning address some of the shortfalls of the top-down and command and control approaches that have been used to design learning systems used by governance actors to learn about CCA (Pesanayi, 2009: Davoudi *et al.,* 2012; Peters and Wals, 2016; Kaika, 2017; Kong *et al.,* 2020). Given the complexity and uncertainty of climate change, actors in organisations such as local governments need to acquire different types of knowledge from their interactions with other actors who are part of their social networks

to build the resilience of their communities (Wenger, 2000; Pelling *et al.,* 2015). The learning also needs to go beyond just individuals in the local government to build the capacity of other actors in the social network including political leaders, traditional leaders, business, civil society and communities. Collective learning needs to incorporate the different concerns, interests and world views in a dialogic process to create a shared vision for CCA (Peters and Wals, 2016).

This study drew on experiences of CDM governance actors to examine the role of learning systems in building their adaptive capacity to respond to the current and future climate risks. Learning is central in this study because a number of national programmes on CCA are focusing on building the adaptive capacity of governance actors, but little is known about how much they know, how they know and what they do with the knowledge shared through capacity building initiatives.

1.5. Preamble on the research design

To understand the role of learning systems in supporting CCA learning within local government systems, I use the CDM as a case study which was selected because of my prior work experience in the province and the interest shown by the district to collaborate in climate change research. I use the PAR approach to engage with climate change governance actors in the case study site and those supporting CCA learning at local government level. The PAR was desirable in this study because it focuses on co-investigation with participants to understand how current learning initiatives influence what they know, the contextual CCA learning needs, factors that affect learning and implementation (Reason and Bradbury, 2008). The approach also empowers participants to take part in a collaborative inquiry into what can be done to improve the flow and uptake of CCA into municipal planning and decision-making by reflecting on what works and what else is required to meet their desired developmental and adaptation goals (Reason and Bradbury, 2008; Bradbury *et al.,* 2019).

Multiple qualitative data collection methods such as interviews, workshops, and systemic literature review were used to allow for a robust and diverse exploration of the key questions between 2016 and 2019 (Chapter 3). The rich narratives that were collected were analysed thematically to highlight actors' learning, what has been learnt and the effect of the learning (Chapter 7) and the social network analysis tool was used to demonstrate the flow of information and interactions between actors who support learning in CDM (Chapter 6). I then present this thesis in the manner described below.

1.6. Thesis outline

The thesis is traditionally structured with introduction and conceptual framework in Chapters 1 and 2, methods and context in Chapters 3-5, the results which illustrate the primary analytical contribution of the thesis in Chapters 6 and 7 and lastly the discussion and recommendations in Chapter 8. A summary on the contents of each chapter is provided below.

Chapter 2 presents the theoretical lens and literature used to frame the thesis. The study has been designed to answer the five explorative questions described above on who learns; what is learnt; learning from whom and how does this learning take place; to what effect; and what else can be done. The study drew from the polycentric governance theory (Ostrom, 2009) to illustrate the governance actors who make decisions and learn about CCA in the district. The CCA action cycle (Park *et al.,* 2012) is used as a conceptual framework to illustrate what governance actors learn about CCA. Learning theories such as lifelong learning, social learning and loop learning (Argyris and Schön 1974;1978) are used to illustrate how governance actors learn (or do not learn), from whom and from whom they learn as well as the gaps and opportunities to improve learning and integration of CCA into municipal operations CDM (Chapter 6 and 7). The chapter also includes a review of existing literature and knowledge gaps on organisational learning for CCA.

Chapter 3 provides an overview of the research approach, data collection and analysis methods used, justification of site and sampling methods used, ethical considerations, researcher positionality and limitations of the study. The social network analysis tool is also described here as a tool that will be used to illustrate the perceived influence and position of actors (major and minor actors) in CCA learning.

Chapter 4 provides the global and national scene for CCA by giving an overview of the global and national commitments, policies and programmes that support learning as well as the type of learning promoted. The chapter highlights global commitments such as the UNFCCC, the Paris Agreement, the Sendai Framework and Sustainable Development Goals (SDGs) that have informed national policies around climate change. Research at the global level by the Intergovernmental Panel on Climate Change (IPCC) has, for example, resulted in a series of scientific publications that influence the global and national climate change scene. Despite the delays due to COVID-19, experts in climate change impacts, adaptation and vulnerability continue to progress with their contributions to the Sixth Assessment Report of the IPCC (IPCC, 2020). Meanwhile, at national level, poor coordination and implementation of CCA has been attributed to a lack of a policy to guide adaptation among other factors, however, in August 2020 the government approved the National Climate Change Adaptation Strategy to guide CCA across all levels of government, sectors and stakeholders (DEFF, 2020).

Chapter 5 sets the local level scene by highlighting some of the social, economic, climatic, political factors that shape the social vulnerability context in which global commitments, scientific recommendations, national and sub-national policies for adaptation are implemented. The chapter also highlights the strategies that have been developed to support CCA at district and provincial level as well as the integration of climate change into key municipal planning instruments such as the Integrated Development Plan (IDP).

Chapter 6 contains the primary analytical contribution of this thesis. It provides findings on the three explorative questions of who learns, learning from whom and how does this learning take place. The chapter uses the polycentric governance lens (Ostrom, 2009) to illustrate the actors who are making decisions around CCA in CDM, the lifelong learning theory (Moser and Spear, 1982) to show the learning systems used to support learning and

the social network analysis to demonstrate the flow of information and support between actors who are part of the polycentric governance system.

Chapter 7 adds onto the primary analytical contribution of this study and provides findings on two explorative questions, i.e. what is learnt by using the adaptation action cycle (Park *et al.,* 2012) to illustrate what local government officials in CDM have learnt in terms of conceptualising and enacting CCA. Furthermore, the chapter uses the Argyris and Schön's (1974;1978) loop learning model to highlight how the learning that has occurred has influenced what they know and actions taken, the barriers and opportunities to support learning and uptake of CCA into municipal operations, including the role of social learning in transformative adaptation. Findings of this study highlight that, as local government officials gather different types of knowledge from learning systems to inform how they frame and enact CCA, they also face challenges that relate to how this knowledge has been produced and disseminated (Chapter 7).

The thesis is concluded in Chapter 8 with a synthesis of findings from the preceding chapters relating to the study objectives and outlines gaps for further research towards an improved understanding of the role of learning systems in supporting local government CCA.

2. Climate Change Adaptation, Governance and Learning: A Conceptual Framework

2.1. Introduction

Climate change is known among both the scientific and non-scientific community, although the levels of understanding about how it manifests vary and may be contradictory (Hopkins, 2013). Climate change is a global phenomenon, yet its impacts are felt at the local level - where solutions can be developed and implemented (i.e. solution space). Despite the conflicts that arise when integrating climate change response in municipal operations, the challenges and opportunities posed by climate change are becoming clear (Roberts, 2015; Boström *et al.,* 2018). Consequently, the need for adaptation and adaptive capacity at the local levels is also central to building sustainable communities (Jones and Boyd, 2011; Bourne *et al.,* 2017; AWARD, 2020a). As such, there is a need to understand local governance, the local context in which actors are engaged and enhance the adaptive capacity of actors (Lotz-Sisitka *et al*., 2016; André *et al*., 2020) such as local governments to develop appropriate plans, mainstream and implement adaptation action through effective learning systems. Further to responding to the impacts of climate change, actors in the solution space must also deal with multiple stressors emanating from the socio-economic, political, and environmental challenges that also include shocks to the system such as the recent COVID-19 pandemic. The theoretical lenses used to interrogate these questions are summarised below and have been introduced in Chapter 1:

1 *Firstly*, to understand who learns, a governance lens is used to explore who is involved in planning and making decisions around CCA in South Africa, particularly at the local government level.

2 *Secondly*, the adaptation action cycle is used as a conceptual framework to establish what is learnt during the adaptation process at the local level by looking at the officials' current understanding of some of the key concepts around climate change, e.g. climate change impacts, lived experiences, as well as perceptions of risk.

3 *Thirdly*, the study has drawn on Mocker and Spear's (1982) four lifelong learning typologies model to explore question 3, i.e. learning from whom and how this learning takes place by examining the learning typologies used by local government officials. Lifelong learning is a process by which individuals/actors acquire knowledge and skills throughout their lifetime. This includes knowledge acquired through 1) self-directed learning, 2) formal learning systems 3) informal and 4) non-formal processes including socialisation, networks and experience.

4 *Fourthly*, there are significant knowledge exchanges that occur between the local government officials and the knowledge producers (also referred to as the epistemic community; Haas, 1992), but the key question that remains is to what effect has learning taken place? To reflect on the effect of learning amongst local government officials and the challenges with flow and uptake of information, the study uses Argyris and Schön's (1974; 1978;1996) loop learning model.

5 *Lastly*, governance of climate change and adaptation learning at a municipal or organisational level usually takes place beyond the individual, hence collective learning approaches are perceived to be more effective learning systems (Pelling *et al.,* 2008; Harvey *et al.,* 2012; Cundill *et al.,* 2014; Oettle *et al.,* 2014; Bandura 1977 in Pelling *et al.,* 2015; Wolfram *et al.,* 2019). Similarly, the different components of the adaptation cycle (i.e. detailed in section 2.3, Figure 2.2 hereafter) are influenced by actors within and outside local government. Drawing on the work of Pelling *et al*. (2008; 2015) and Harvey *et al*. (2012), a social learning conceptual framework is adopted in this study to provide recommendations (study objective 4) to improve the effectiveness with which learning systems can be supported by internal and external actors (human, institutional and legislative) to enhance the integration of CCA into local government operations.

Individual and collective learning have been identified as some of the aspects required in the governance of climate change as they can influence how actors investigate, develop, adopt and review new forms of interaction decision-making processes and policy instruments to govern adaptation interventions (Kagawa and Selby, 2010; McFarlane, 2017; Wolfram *et al.,* 2019). In this thesis, I take an empirical observation view of how actors responsible for adaptation, who operate in complex governance systems, currently learn to direct and manage adaptation, using the case study of CDM. The following section provides an overview of the conceptual framework that guides this study to achieve the research objectives by interrogating the five explorative questions.

2.2. Conceptualising the governance of climate change adaptation

Governance of climate change at the national and sub-national level is work in progress and has been influenced by the 1992 UNFCCC (Jordan *et al.,* 2018). National governments' participation in the international climate change regime is mostly voluntary, and implementation must be done at national and sub-national levels, hence multi-levels of governance exist. Adaptation projects can also be initiated in a monocentric governance system, whereby the government works without external partners. Yet, owing to the complexity of climate change and its multiple impacts on society, various actors such as government officials cannot effectively respond to climate change without collaborating with other actors such as civil society, private sector, intermediaries and scientists. In this regard, polycentric governance can be used by "different actors to build explicit forms of support from other actors while also establishing authority beyond their own realm*"* (Castan Broto and Bulkeley, 2013:100). The concept of polycentric governance emerged from Ostrom's (2009; 2010) work to describe the new and dynamic forms of climate governance that were emerging from the bottom-up to feed into the UNFCCC which was more focused on the global scale (Jordan *et al.,* 2018). Polycentric governance has since been hailed in literature as one of the best forms of governance as it improves adaptive capacity, allows for context-specific natural resource management while also reducing the risks associated with redundant governance actors and institutions (Carlisle and Gruby, 2017; Jordan *et al.,* 2018).

Furthermore, climate change and systems research suggest that the impact of environmental phenomena such as climate change on complex social -ecological systems may introduce new complexities that are not confined by administrative boundaries at the sub-national or national level which may make CCA challenging (IPCC, 2014; Lioubimtseva, 2014). Consequently, there is a need for new governance arrangements that are flexible, accountable and go beyond administrative boundaries, altering the way actors across all levels engage in learning, policymaking and implementation (Ziervogel and Parnell, 2010; Wolfram, 2019; Celliers *et al.,* 2021). Studies show that the mismatch between the environmental phenomena and the scale of management used to support the human and natural systems can be addressed at multi-spatial scales and requires vertical and horizontal coordination (Cummings *et al.,* 2006; Giordano *et al.,* 2011; Cumming, 2018; Bordin *et al.,* 2019; Cumming and Epstein, 2020; Cumming *et al.,* 2020). Learning to shift the way things are done (policy development and implementation) and learning across boundaries are key attributes of transgressive learning (Lotz-Sisitka *et al.,* 2016).

Polycentric governance creates opportunities for actors and organisations to engage in participatory learning processes which are beyond the institutional control (i.e. monocentric governance) where actors are free to experiment, copy, communicate, learn from others and reflect on their actions as a social learning process. Castán Broto and Bulkeley (2013) echoed this in their study on 100 cities which found that the governance of climate change is becoming less distinct as interventions in the cities were largely driven by a partnership between local governments, private and civil society and this was also instrumental in collaborative problem solving and capacity building. Actors in the so-called adaptation action space therefore usually bring different capabilities which may complement each other. For example, international organisations can offer expertise and funding but need the buy-in of actors at national and subnational level to operationalise CCA in local contexts (Abbott *et al.,* 2015). In the South African context, local governments are often under-resourced and overstretched with service delivery issues; hence they struggle to integrate climate change into their planning, decision-making and implementation. Implementation of adaptation in such contexts requires coordinated efforts by multiple actors including national and local government, international funding institutions, private sector, non-governmental organisations (NGOs), local communities and individuals (DEA, 2011).

Satterthwaite, (2008 in Castán Broto and Bulkeley 2013) notes that collective responses have not always been able to address issues of climate justice as the distribution of responsibilities and vulnerabilities still reflect significant inequalities. This can result from instances where stakeholders fail to reach consensus on skewed trade-offs which favour a particular world view or social group without addressing some of the root causes of inequality (Berkes, 2010; Biggs *et al.,* 2015; Pelling *et al.,* 2015). Collaboration between the different actors to design and implement climate change interventions is a process of co-designing and co-sense making reality, with social actors learning under conditions that may have conflicting and asymmetric power relations (Voß *et al.,* 2009). In the Netherlands, for example, energy transition policy agendas and evaluation outcomes have been steered to meet the interests of a network of administration officials and big companies (Kern and Smith, 2008). Asymmetric power relations can impact on the selection of adaptation actions which can be influenced by dominant interests

and assertive actors who, when using social network analysis (Chapter 6), can include actors with high centrality, interconnections as well as those who can over-steer interactions for their gain.

Adaptation governance and learning at the municipal level as noted above is dependent upon actors, institutional and legislative structures and processes (Winsvold *et al.,* 2009; Jordan *et al.,* 2018). Human actors include intermediaries, knowledge brokers and funding institutions who can provide information, financial and technical support to facilitate learning. Policies and organisational structures, norms and processes that may enable or disable actors from learning and implementing CCA at the local level emanate from various levels including international conventions (e.g. Paris Agreement) and national policies (e.g. National Climate Change Response Policy). There have been some studies to understand the governance of climate change policy in South Africa (Petrie *et al*, 2018; Averchenkova *et al.,* 2019; Boulle *et al*, 2020) which highlight the well-established policies and horizontal and vertical mechanisms for climate change governance. The reports however indicate the need for improved vertical and horizontal coordination between actors, greater clarity on roles and responsibilities for sub-national governments and continuous learning to ensure effective implementation of CCA in South Africa.

The role of learning in sustaining climate change governance is that it allows governance actors to collectively experiment with adaptation actions, express their concerns, aspirations and create new forms of order (Voß and Schroth, 2018). Checkland and Casar (1986 in Pelling, 2008) add that the different viewpoints on the effects of learning can, therefore, direct the assessment of learning to move beyond what has been learnt and consider the institutional (governance system) and actor attributes that enhance or constrain capacity and ability to learn. These varied forms of governance, however, remain under-examined, particularly at the local government level in South Africa. As such, examining the governance actors who learn and make decisions in CDM will contribute to this body of knowledge (Wolfram *et al.,* 2019), including focusing on the need to improve understanding of the types of actors involved in adaptation governance, how they learn, what they learn and how this learning influences governance practices around adaptation. Understanding how local government actors learn is important as this highlights how the actors conceptualise and integrate CCA into municipal operations, any gaps in knowledge that may result in inaction and maladaptation as well as opportunities that external actors may tap into to strengthen their adaptive capacity.

2.3. Conceptualising adaptation as an action cycle

How decision-makers involved in adaptation governance perceive the problem of climate change can influence the actions that follow to address the problem either, through transformative or incremental adaptation (Park *et al.,* 2012). The IPCC (2014) notes that even though a significant amount of research has been done to understand the physical manifestation of climate change this has not always translated into effective adaptation action. The process of adaptation requires continuous engagement and inputs from a wide range of stakeholders such as the communities at risk, different levels of government, private sector and civil society to develop local solutions based on an understanding of the current and future risks and impacts, non-climatic factors that can increase/decrease vulnerability and adaptive capacity. Notwithstanding the acknowledgement that learning usually takes place in

complex, messy, interactive processes, and not in a direct, linear way, I use the adaptation action cycle as a conceptual framework to help me understand the generic process of adaptation. In this section of the chapter, I discuss the four activity clusters (Figure 2.1) that shape CCA policies and practices as a means of understanding the learning, decision-making processes and support needed to achieve their adaptation outcomes.

Adaptation is usually presented as a continuous cycle of incremental and transformative actions allowing for both short-term and long-term tactical and strategic actions to be implemented simultaneously. This conceptualisation is adapted from the work by Moser and Ekstrom (2010), UN-Habitat (2014), Teisman (2000), Park *et al*. (2012) and Taylor (2017). Incremental adaptation can be described as actions to address the proximate causes of vulnerability or developmental needs while also maintaining the essence and integrity of the system (Park *et al.,* 2012; IPCC; 2014). It is also described as the extension of current actions and behaviours to avoid or minimise the disruption of a system due to climate change (Kates *et al.,* 2012). However, some of the risks posed by climate change require substantial changes to occur in particular how adaptation is being framed. Transformative adaptation, in contrast to the incremental approach for example is an adaptation approach, that results in fundamental changes within and across systems and has a long-term plan that seeks to enhance the effectiveness of existing systems whilst also interrogating the issues around social injustice and power imbalances within the governance system (IPCC, 2014b; Barrot, 2015; Lonsdale *et al.,* 2015). There is a growing awareness and evidence that the current *status quo* of many local government systems will not adequately build the resilience of communities, hence there is need for a more transformative adaptation, and indeed a transgressive approach (Park *et al*., 2012; Lonsdale *et al*., 2015; Lotz-Sisitka *et al*., 2016). Arising from these approaches is the 'learning' that should enable action. Transgressive learning, for example, creates opportunities for learners, such as local government officials, to go beyond boundaries and co-experiment with others to improve understanding of the CCA actions that can build the resilience of their communities (Lotz-Sisitika, 2016).

There is often resistance to fundamental changes in a system's values and function that are a key component in the transformative adaptation as these threaten the stability that people are accustomed to. This resistance also restricts higher levels of learning, such as triple-loop learning (learning that goes beyond provision of new information or skills but also facilitates transformation of values, attitudes and habitus (The Living Core, 2019). Comparative studies have highlighted that in cases where transformative adaptation is required, it does not always happen, and when it does happen, its pace is very slow (Olsson *et al.,* 2006). An illustration of the adaptation action cycle is shown in Figure 2.1. and builds upon Figure 1.2 (Chapter 1) to include some of the possible learning that would occur in the different phases as part of lifelong learning (Mocker and Spear, 1982; London, 2012).

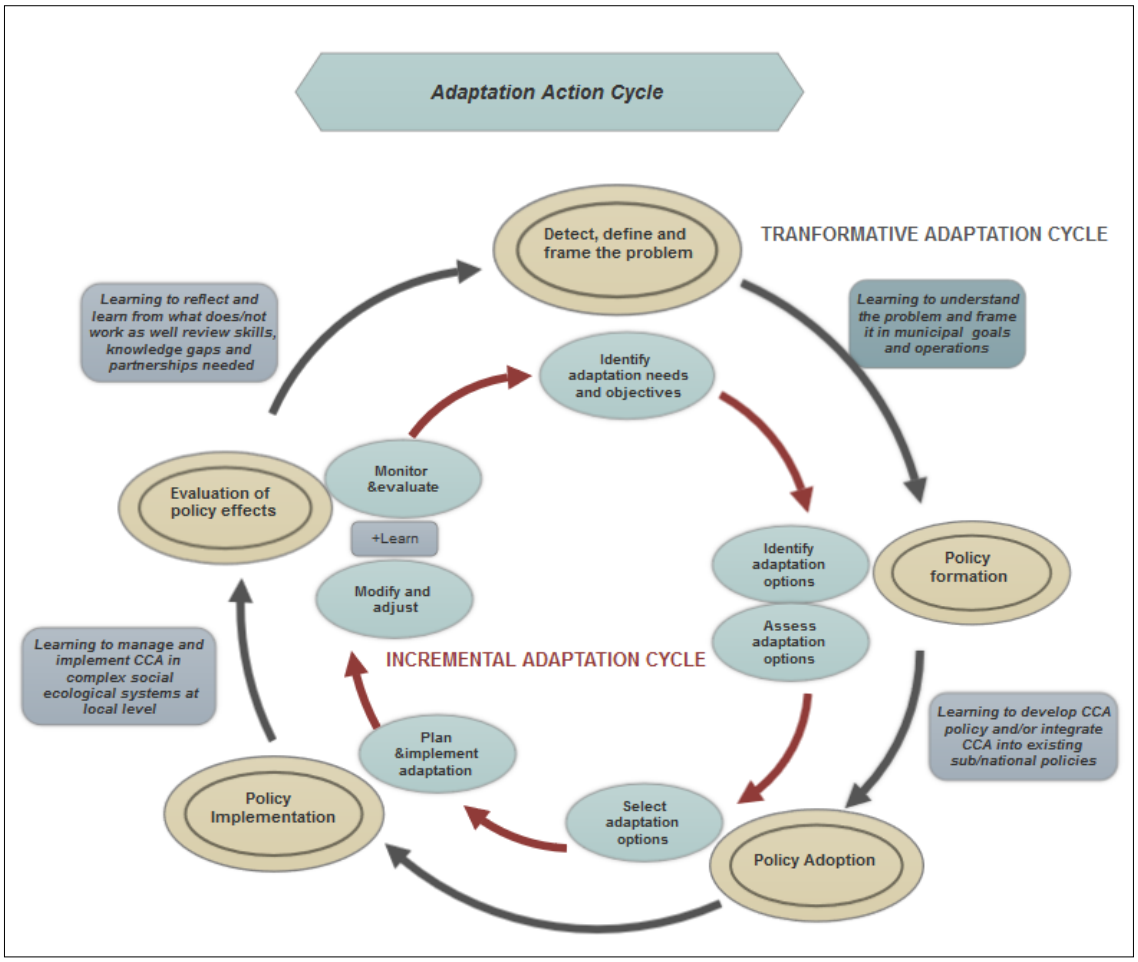


Figure 2. 1: Illustration of learning throughout the adaptation action cycle (adapted from Taylor, 2017).

Questions have been raised on the scale of change that needs to occur and the duration of an intervention that would be classified as transformational adaptation (Dinshaw, 2014). More work is also needed to illustrate examples of successful transformative adaptation interventions as the resources required to achieve this are not necessarily available at the level at which transformation should occur (Park *et al.,* 2012). There is currently a dominance of and preference for win-win adaptation options that maintain the essence and integrity of a system at a given scale, and thus a predominance of incremental adaptation. Herein, the focus is on taking advantage of the low-hanging fruits without questioning the fundamental systemic changes that need to occur to deal with a changing climate in a rapidly changing world (Lonsdale *et al.,* 2015; Bendell, 2018). Thus, the management of incremental adaptation intervention, on the one hand, is often reactive management that focusses on fixing or getting past an emergency (e.g. ongoing drought) and often results in lower levels of learning (Aygris and Schön; 1974), i.e. single-loop learning, that does not address the key factors leading to vulnerability to climate change. Transformative adaptation, on the other hand, involves greater uncertainty on the outcomes which makes it difficult to implement as there is currently an incomplete supply of information to support the complex and risky decision-making outcomes associated with transformative adaptation actions (Verweij and Thompson, 2006; Park *et al.,* 2012). Nevertheless, transformative adaptation is required to effectively address the causes of vulnerability and sustain system-wide changes in the long term (Pelling, 2011; Lonsdale *et al.,* 2015).

Notwithstanding these concerns, recursive transitioning between incremental to transformative CCA has been shown as possible. A study in the grape and wine industry in Australia highlighted that actors such as small-scale wine enterprises could transition between transformative and incremental adaptation because of the support received from actors from multiple scales (Park *et al.,* 2012). In the Australian case study, key actors provided farmers with climate change information and included the Australian Wine Research Institute, CSIRO and national departments of agriculture. The small-scale farmer enterprises implemented transformative adaptation by changing the location of their vineyards to cooler areas such as Tasmania and incorporated incremental adaptation actions using climate-sensitive practices and technologies to manage farming activities in the new farming sites (Park *et al.,* 2012). Therefore, adaptation can be a continuous process where both incremental and transformative adaptation processes are implemented in a complementary way to build climate change resilience at the local level (Lonsdale *et al.,* 2015). The following section presents a brief discussion of the components of how this notion of an adaptation action cycle can be used and the different sections of this study they are linked to.

2.3.1 Detect, define and frame the problem

Fatti and Vogel (2011: 57) note that "…enhanced understanding of both current and past climate phenomena ... can be invaluable in enhancing the dialogues needed to improve adaptation to future climate change". Accordingly, the initial step in the adaptation process, be it in transformative or incremental adaptation, is acquiring an understanding of the actors and their contexts that informs decision-makers' understanding of climate as risks. To achieve this, the study here firstly identifies the governance actors who make decisions on the implementation of CCA initiatives at the local government level using the case study of CDM (Chapter 6). Secondly, the study interrogates their current understanding of climate-related concepts such as climate change, CCA, perceptions of risk as well as their lived experiences of climate change (Chapter 7).

Climate change, including key concepts such as risk, hazard, vulnerability and adaptive capacity, all require some form of local contextual understanding to be useful (O'Brien at al., 2007; Fünfgeld and McEvoy, 2011). This understanding of the problem and its solutions is not always present amongst the actors who must engage in planning and decision-making for adaptation, particularly at a municipal level, especially in a country constrained with developmental backlogs, lack of service delivery and various capacity issues. Hence, as will be shown here, the actors engage in a learning process whereby they are thrown in the deep end, bringing into the learning process different learning systems and tools such as books, internet and interactions with peers, both in and outside their CoP to learn about the problem, enhancing their understanding of the key concepts associated with climate change and how to address it. In some instances, actors may know about climate change and its causes, but this knowledge is usually not consistent (Hopkins, 2013).

The scientific community, for example, usually relies on geospatial, physical and biophysical data to help us understand the climate change phenomenon. Actors in the non-scientific community, on the other hand, draw mostly on personal experiences of weather to interpret other sources of information (e.g. scientific), as well as confirm or reject any new information on the manifestations of climate change (Hulme, 2012; Hopkins, 2013). This

has resulted in different understandings of the same phenomenon, including an understanding of the spatial and temporal scale and connectivity of the climate system and impacts, as well as the urgency of the response needed that is influenced by the different learning systems through which individuals are socialised through. These differences, in turn, shape the people's values and perceptions of the risks associated with climate change and how they respond to them and will be shown to be critical to understanding in this thesis.

South Africa is a country rich in cultural diversity, but terms such as weather, climate and climate change are presented and need to be understood in all the eleven official languages. The understanding of climate change is given value and meaning through different social, political and cultural interpretations. Jasanoff (2004) notes that politics, power and culture cannot, however, be separated from the scientific and technological innovations as engagements between these systems define and refine epistemic and normative understandings of the world. This value-based knowledge comes from different learning systems that provide scientific, indigenous and experiential knowledge through formal, informal non-formal and self-directed learning exchanges. While it is acknowledged that there are different ways of knowing about climate change, research gaps still exist. Dunlop (2009), for example, illustrates that little is known about the variety of ways in which decision-makers learn from the scientific community. This has also been reiterated by Hopkins (2013) who shows that there is a need for more research to examine the different sources of information used by the non-scientific community to learn about and respond to climate change, especially in developing countries such as South Africa. This component of the adaptation learning cycle links to study objective 1 that seeks to establish the current understanding of climate change, CCA, lived experiences as well as perceptions of risk of decision-makers.

Park *et al*. (2012) show that having this ready access to appropriate information on its own does not necessarily, however, lead to action due to the distinction between information and knowledge. On the one hand, information is simply refined or organised forms of data on a topic/issue (e.g. climate projections), and it lacks the translation of factors that allows users to evaluate it to be fit for purpose in a particular context. On the other hand, knowledge is derived from understanding and interpreting information to influence individual or group capacity to act (know-how), cognition (know- what) and understand patterns and rules (know why) (Liew, 2007). Learning occurs during the process of evaluating how information fits each context, whereby learners may or may not have prior knowledge about the topic but may be constrained by policy timelines and limited human capacity to implement policy actions. Thus, while it is hoped that "increasing levels of information about an environmental problem would make people more active in protecting the environment, they may be overwhelmed and paralysed by not knowing where to start and doubting whether or not they can address the problem at all" (Prager, 2012:12). Municipalities in South Africa have received support from national and international actors to conduct risk and vulnerability assessments and develop adaptation plans. However, the evidence shows low levels of implementation, monitoring, evaluation and learning thus data and information is available but it's not being internalised as knowledge (Ziervogel and Parnell 2010; McNamara, 2013). The current interventions are often for short periods due to, among other factors, limited donor funding and limited human capacity, resulting in their failure to translate CCA into long-term outcomes. This

suggests that, while the necessary support may enable appropriate information gathering, the contextual factors of appropriate knowledge to inform action (i.e. the contextual translation of fit for purpose) remains lacking.

Given these oversights and challenges, a social learning conceptual framework is adopted in this study to assess how local government officials collectively gather CCA knowledge from different learning systems, what forms of learning then occur, the challenges encountered, and opportunities provided to inform the subsequent adaptation action cycle components and how this can support the integration of climate change into local government operations (study objective 4).

2.3.2 Policy formation, adoption and implementation

Public policy formation to guide CCA implementation is informed by, among other things, what is known about the climate risks, their potential impacts on sectors and population groups as well as how these matters are understood and implemented at the local level. The exposure, sensitivity, as well as the adaptive capacity of sectors and population groups to projected changes in climate determine their level of vulnerability. These factors also provide a starting point for devising appropriate response plans and adaptation strategies. From as early as 1997, South Africa ratified the UNFCCC as well as volunteered to be part of the voluntary emissions reduction pledge under the Copenhagen Accord in 2010. Several policies and initiatives have been implemented at the national level and for various sectors etc (e.g. Figure 2.2). However, implementation has been constrained by political events such as cabinet reshuffles and frequent changes to senior management within departments. For example, between 2008 and 2015, there were eight cabinet reshuffles with *wide-spread corruption and state capture* (Averchenkova *et al.,* 2019:8). The charges levelled against public officials have contributed to increased concerns on the stability of the economy and continuity of government activities and this has been highlighted in the 2019 World Economic Forum report as the second most cited risk for doing business in South Africa (WEF, 2019).

As the challenges posed by climate change are becoming clear, the opportunities that actors in the public and private sector can take advantage of need to be clearly articulated and refined. The development and implementation of a municipal CCA strategy, for example, is also influenced by, among other things, availability of knowledge from actors such as the epistemic community who have different levels of power that they exert to try to influence the adaptation policy and actions as part of the governance arrangements (Scott, 2017). To explore these complex power relations, I use social network analysis tools, i.e. Net-Map Tool and Visualizer (Schiffer, 2007; Medical Decision Logic Inc; 2014; Hanneman and Riddle, 2019) to illustrate these interactions and the levels of influence of each actor to distinguish between the major and minor actors in the climate change municipal adaptation space (Chapter 3 and 6).

In South Africa, the tensions between the government and private sector have been identified as one of the governance challenges emanating from the country's political history as well as misalignment of policies (i.e. climate change goals and those guiding the country's development trajectory) that have delayed implementation of CCA policy at the sub-national level (Averchenkova *et al.,* 2019).

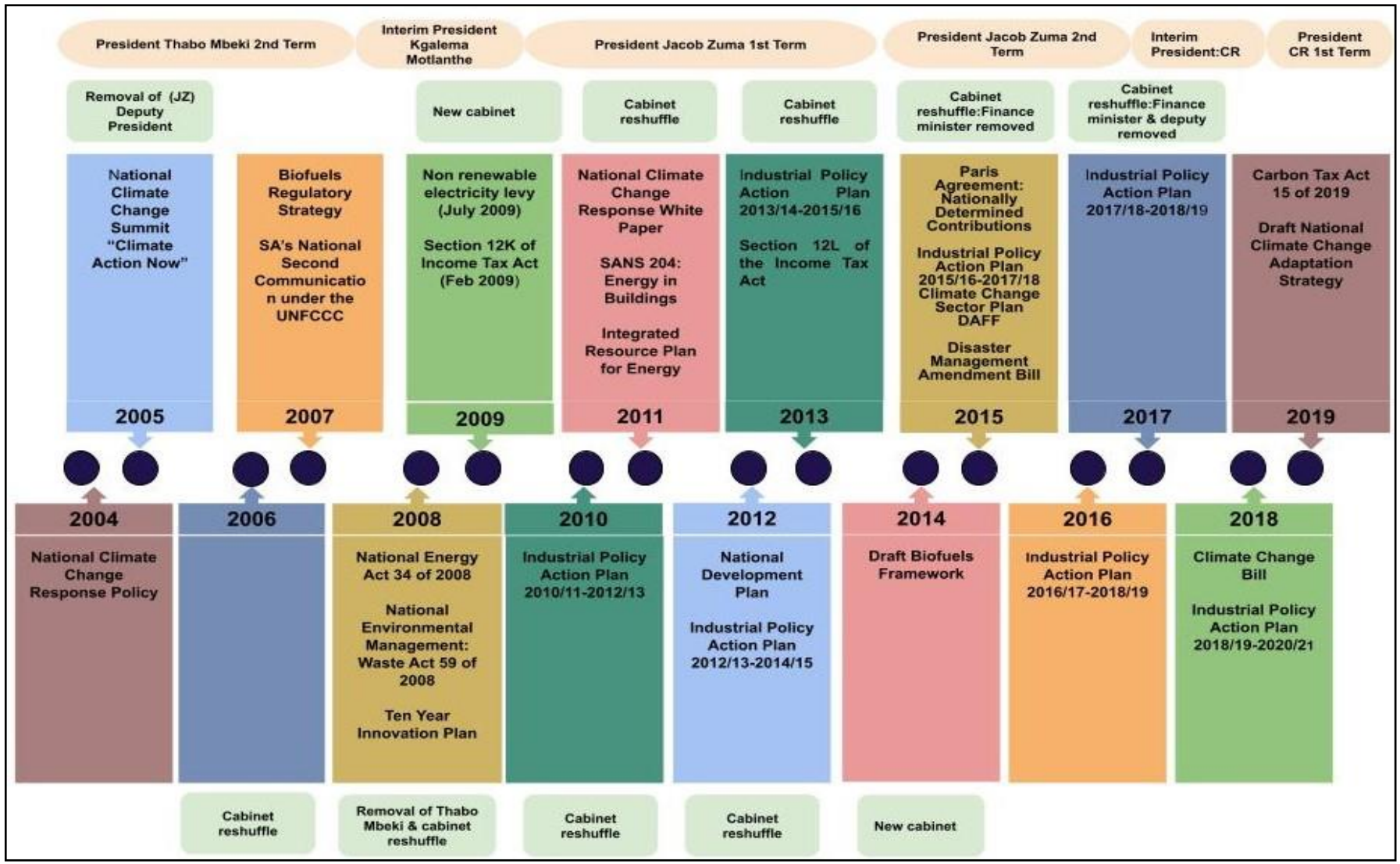


Figure 2. 2: Development of climate change-related policy in South Africa at the backdrop of key political events between 2004-19 (adapted from Averchenkova et al., 2019)

The gap between the planning and implementation timelines requires policy-makers to start examining the solution space by enhancing the adaptive capacity of actors such as local government officials to develop appropriate plans, mainstream and implement adaptation action through effective learning systems. The research-policy-practice relationship is necessary, but it is a messy landscape that is difficult to navigate and, at times, is very dysfunctional (Sutherland *et al.,* 2012). South Africa, for example, has been through a turbulent political and economic period between 2009 to 2020. In this period, the post-apartheid economy tripled in size, and there was increased investment in the provision of basic and social services. From 2013, however, the country has been faced with a period of stagnant economic growth and an increase in poverty, inequality, unemployment coupled with political turmoil evidenced by an increase in corruption, restructuring of the cabinet stagnating implementing of climate change policies and commitments as now there is the COVID-19 pandemic (Public Prosecutor, 2016; Averchenkova *et al.,* 2019).

CCA at the South African national level, and with variable adoption at the sub-national level, is guided by the Climate Change Response Policy (DEA, 2011), sector-specific Long-Term Adaptation Scenarios technical reports (e.g. see DEA 2013a, b and c) and the recent National Climate Change Adaptation Strategy (2019). At the sub-national level, all provinces in South Africa have developed climate change and adaptation plans to guide adaptation actions in each respective province (DEA, 2019a). At the lower levels of government, a significant number of district and local municipalities have developed adaptation strategies with support from national departments such as the DEA and South African Local Government Association (SALGA) in partnership with international organisations such as the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH as part of the Climate Change Local Government Support Programme(DEA *et al.,* 2020).

Chapter 5 sets the local scene in detail including the policies that inform adaptation and how these are conceptualised at the local level and will address a gap identified by Anguelovski *et al.* (2014) on how adaptation programmes supported by external actors are institutionalised at local government level. Hopkins (2013) also adds that there is the need for more research to examine how the different learning systems used by decision-makers interact and what the non-scientific public perceives to be the most effective learning system (e.g. policies, strategies and toolkits). This will contribute to the second and third objectives of the study and the results are presented in Chapter 6 and 7.

2.3.3 Monitoring, evaluation and learning

The third component of the adaptation cycle focuses on monitoring, evaluation and learning (MEL) of adaptation actions throughout the cycle to improve development outcomes, whilst also enhancing accountability for resources used (USAID, 2019). The MEL component of the cycle is used to provide organisations with feedback on current incremental or transformative adaptation actions while also enabling decision-makers to make better-informed decisions on future actions (Pringle, 2011; Scott, 2018; UFCCC, 2019). Evaluation of organisational performance (e.g. municipal budget

spending) and the implementation of adaptation measures can for example, be done by CCA actors in local government as well as those from civil society and communities. The process allows local governments to critically reflect and draw lessons from what has worked, for whom and to what effect, what failed, why (i.e. question organisational values, policies, etc.) and what could be done differently. The process of evaluation is a key component in double-loop learning (Argyris and Schön, 1974; 1978; see also section 2.5) as it enables both the learner and facilitator to reflect on whether the anticipated learning has occurred. There should be learning for actors that is based on evaluation of the policy cycle outcomes which should highlight what worked and where there are gaps as well as opportunities that can be explored within the cycle. Within teaching and learning philosophy, evaluation is a component of assessment because it is done together with the learner to gather evidence to make sense of the information obtained from various sources and apply it to enhance their learning process (i.e. feedback and feed-forward) (Harvey, 2002;Council for Higher Education, 2016).

Given the complexity and the projected long-term impacts of climate change, MEL is a critical and flexible process. However, it is a complex task as organisations such as municipalities are still trying to understand what constitutes a significant change in terms of reduced vulnerability to future climate impacts and how best to adapt (Anderson, 2011; Scott, 2018). Further to this, determining successful adaptation interventions is challenging (Adger *et al*., 2005; Dilling *et al.,* 2019; Morecroft *et al.,* 2019). Reports indicate that although at national level most countries have developed adaptation strategies this does not necessarily result in implementation and achievement of targets set (UNEP, 2021) across levels and scales (Adger *et al*., 2005). Furthermore, the financing of adaptation at subnational level is still lagging behind the set targets and there is also need to create an enabling environment to that facilitates the private sector and civil society to scale up initiatives to subnational and national level (UNEP, 2021; Winkler *et al.,* 2021). Despite the challenges and knowledge gaps, the MEL process provides an opportunity for actors to document evidence to assist in identifying the changes / significant change in the system, that can thereafter be used in the social learning process to understand how best to adapt. It is also seen as a process where learning takes place.

Biggs (2001) point out that assessment helps to identify what the learner regards as important about the subject, how they relate to the content as students (i.e. lifelong learner) and practitioners in the subject area. Boud and Soler (2016) add that knowledge generation and competencies are cultivated in learners when they partake in assessments that forge their ongoing knowledge acquisition process. Assessment enables governance actors to adapt and apply their developing intellectual acumen and research capacities on CCA within a situated CoP that allows for both self-driven and life-long learning. Thus, MEL is a key phase of the adaption cycle because it helps to facilitate the shift between incremental and transformation adaption, by stimulating learning and providing evidence on the gaps and strengths within the learning process.

Due to uncertainty surrounding climate change and adaptation, understanding of the phenomenon and how to respond will need to be iteratively reframed based on practice and feedback on lessons learnt, hence it is a continuous learning

process. In this process, actors draw from different types of knowledge and learn in different ways, however, less is known about how governance actors learn about CCA and from who (Dunlop, 2009: Hopkins, 2013; Fünfgeld, 2015; Wolfram *et al.,* 2019). To respond to these knowledge gaps, I draw from Mocker and Spears' (1982) lifelong learning model discussed in the following section to illustrate the different types of learning that officials in local governments potentially use to learn about adaptation influencing their actions (or non-action).

2.4. Learning systems and learning types in climate change adaptation

Climate change information is found in a variety of sources that can be used for information for example, academic journals, policy documents, magazines, newspapers, social media, as well as beliefs, perceptions and cultures, including that of experiential and indigenous knowledge and that can ultimately contribute to a learning system (Clark, 2008). In furthering understanding on how learning takes place, I use Mocker and Spear's (1982) four possible learning types which are self-directed, informal, non-formal and formal learning that is continuously used by individuals and groups in their lifetime, also referred to as lifelong learning. The four learning types are presented in a two by two matrix (Figure 2.3) to illustrate the different ways in which decision- and policy-makers can acquire knowledge from the epistemic community, i.e. "a network of experts with a particular knowledge of a policy domain and an authoritative claim to that knowledge within that domain or issue-area*"* (Haas, 1992:3).

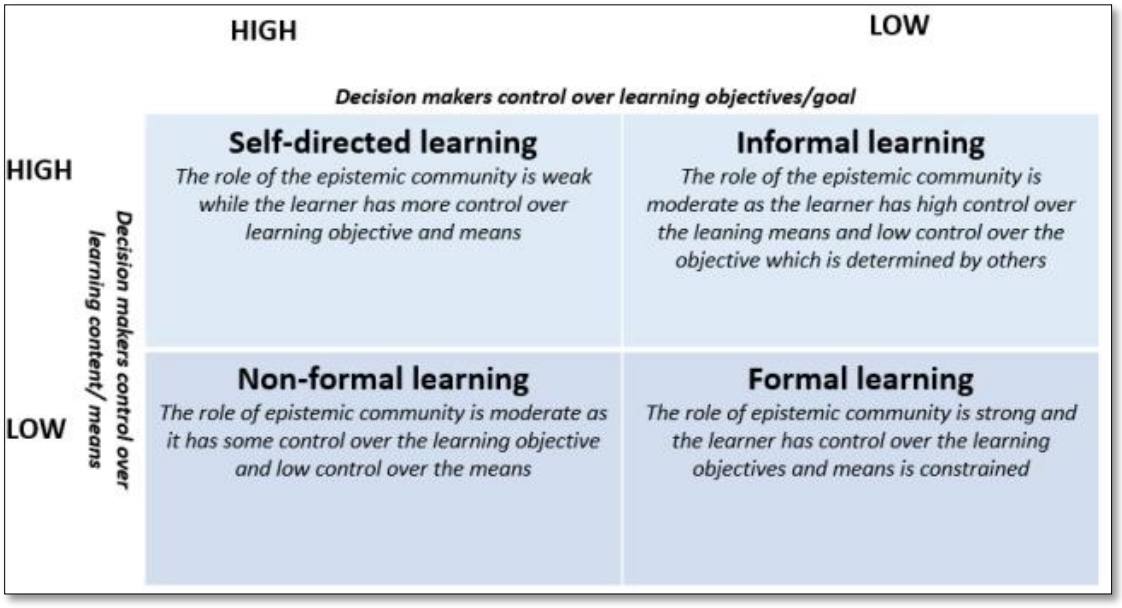


Figure 2. 3: Lifelong learning types adapted from Mocker and Spear (1982) and Dunlop (2009)

The concept of epistemic community comes from the international relations discipline, but it is used here to include a wide range of actors in the climate change polycentric governance system who are experts (e.g. knowledge producers such as climate scientists) and those who have an authoritative claim to the knowledge or policies that influence CCA governance at a sub-national level, e.g. national departments. Chapter 6 (section 6.4.2) highlights some of the epistemic communities who support climate change learning in CDM. In each of the learning types, the decision-makers and knowledge producers enjoy different levels of control which may influence the effect of that learning type in terms of its uptake to inform decisions and behavioural change (Moser and Spear, 1982; Dunlop, 2009).

1. **Self-directed learning** is driven by the learner who has high control over the learning objective (Mocker and Spear, 1982; Dunlop, 2009). It is unstructured, the epistemic community role is weaker and allows the learner to critically reflect on experience or learning by doing. The learner can consult a variety of sources at their pace with no time limitations to identify or understand a problem as well as its solutions. As such, the learner learns from multiple epistemic communities, and their learning may reflect one or multiple information sources depending on learner preferences. Rogers (2002), however, notes that in its extreme forms, self-directed learning can result in learners who would not accept any expertise to be superior to their own. Examples of self-directed learning include searching for information on the internet (websites, journals, newspapers) and reading hard copy books.
2. **Informal learning** is learning that results from unintended activities that are outside the formalised learning settings such as family, work community and day-to-day activities (UNESCO, 2011; Boeren, 2016). It is centred on assembling the means to dispatch a specific task that has been effectively set for learners who have low- to-medium control over the learning objective (Mocker and Spear, 1982; Dunlop, 2009). The role of the epistemic community in this type of learning is moderate, but they can also coerce learners into a certain direction to meet specific objectives (Dolowitc and Marsh, 1996 in Dunlop, 2009). An example of informal learning can include a public participation workshop to identify issues that a municipality should integrate into their IDP or Environmental Management Framework.
3. **Formal learning** refers to externally enforced learning where the learner has limited control over content taught, how it is administered, the pace and duration (Mocker and Spear, 1982; Dunlop, 2009). The epistemic community's role in learning objectives and structure is high. In formal learning, the epistemic community is cushioned from political interference where policy-makers would have more control. Formal learning can take the form of teacher-learner guided learning exchanges which are often found for example in university, high school or college and upon completion, a certificate or diploma, for a course or degree is obtained (Dunlop, 2009; Boeren, 2016).
4. **Non-formal learning** refers to learning that is customised to meet the learner's needs/circumstances and the epistemic community plays a facilitation role or is the provider of information (Mocker and Spear, 1982; Dunlop, 2009): "The learner awareness of what they want to do with what they learn ensures that their engagement with codified knowledge is mediated by pre-existing expectations for determining the use or success of that knowledge"

(Dunlop 2009:298). Decision-makers engage the epistemic community to provide information that would help them manage identified complex topics and also help deliver, legitimise and justify policy preferences that have been "formed independently of their relationship with these experts" (Dunlop, 2009:16). The epistemic community has some level of control on the resources that guides what is learnt but do not have an influence on the ends to which the resources are directed (i.e. learning objectives). The epistemic community, however, does not always provide learners with all the information and may not relax the hierarchy of knowledge to give meaning to information while also ensuring that it is context-specific and can be used to inform decisions (Dunlop, 2009).

Mockers and Spear's (1982) lifelong learning model has been adopted in studies including Dunlop's (2009) work cited above to understand the different ways in which decision-makers learn from the epistemic community and the control they each have on informing policy and policy objectives. Haas's (1992) work shows that policy-makers and decision-makers learn and make decisions based on among other things the interaction and information derived from the epistemic community. Dunlop (2009) notes that there is still limited knowledge on the variety of ways in which knowledge is exchanged between the epistemic community and users at local government and policy level, hence there is a need for further research to identify a range of learning types for different policy aspects such as climate change. One way of understanding interactions between local government decision-makers/actors and knowledge producers is to recognise decision-makers as intentional actors who choose to learn and are responsible for the decisions regarding goals and means of their learning. Similarly, as individuals learn and plan for CCA, their decisions or actions do not always follow what they have learned or planned because of the gap that exists between what consciously and unconsciously drives decision-making (Argyris, 1991).

Rogers (2014) also uses the lifelong learning model to illustrate the breadth of informal learning, expanding upon the original work of Mocker and Spear (1982). The study identifies other subcategories of the informal learning typology that include conscious learning, unintentional learning, incidental learning and accidental learning. Rogers (2014) concludes that, although learners engage in formal learning, they also have pre-existing knowledge and skills that evolve throughout their lifetime. Further to this, formal learning even though it is described as being objective, consists of worldviews/ value systems of the particular epistemic community that control the learning objective and means of learning, for example, a course prescribed textbook. Thus, issues of power in knowledge production impact on learning as the knowledge producer/epistemic community dictates the type and amount of knowledge shared. These have been documented in several studies including the work by Oettle *et al*. (2014) who illustrated that scientific knowledge is often given more credence while indigenous and experiential knowledge, often shared through informal and non-formal learning, are seen as inferior. This can result in a dependence on external information which is not always available or easily accessible and undermines the agency of local actors to address their problems.

In the adaptation action cycle, adaptation is an iterative learning process that is often clouded by uncertainty and social disagreement resulting from a lack of information and conflicting information used to pursue certain agendas

(FitzGibbon and Mensah, 2012). Further to this, although there is the certainty that the climate is changing, there is still uncertainty on climate responses to greenhouse gas emissions and its impacts on socio-ecological systems (Kunreuther *et al.,* 2014). The uncertainty is due to model limitations, the complex climate and socio-economic feedback loops, limited knowledge on future economic development and emissions trajectories, tipping points as well as trajectories (Tye and Altamirano, 2017). It is also often assumed in rational decision-making that decision-makers always have access to complete information and can make the best decisions by assessing all the possible alternatives (Moser and Ekstrom, 2010). However, decisions around climate change response is not an easy task as it requires, among other things, technical knowledge on appropriate interventions, sizeable funding, political will and coordination between different actors (Hallegatte and Dumas, 2008). The lifelong learning lens posits learning as a continuous process within various settings, as such decision-makers will continuously learn more about CCA and acquire the necessary skills to implement as new knowledge on some of the current uncertainties becomes available. There are also recent calls for systemic transformation as part of the Fourth Industrial Revolution (4IR) for decision-makers and implementers at local government among other stakeholders to adopt a lifelong learning approach for them to seamlessly upgrade their knowledge and skills to stay at par with the technological innovations that affect municipal operations (Gladstone, 2018; Roberts, 2018; Verwey, 2019).

In the South African context, however, adaptation efforts have also been driven by international actors in the scientific community who have promoted adaptation as a key response effort that should complement mitigation efforts (Ziervogel and Parnell, 2010). Hence the learning that occurs is largely not self-directed as local government officials have little control over the goals of the learning event and how it is implemented. The officials receive invitations to participate in learning or knowledge sharing events, whereby the learning objectives are set by the organisers of the event who would have the objectives they want to achieve from the workshop or project. Organisers are usually at higher levels of the organisation, e.g. provincial or national government departments, who usually use workshops or forums to facilitate non-formal learning. The challenge with this learning process is that there is often a limited understanding of what the learners have understood and whether this has been the appropriate learning experience for the learners; the focus is on information transmission rather than advancing skills and knowledge as well as incite behavioural change (Ison *et al.,* 2000; Pelling *et al.,* 2008). Added to this, cognitive constructivism theory (Piaget, 1972) suggests that local government officials' pre-existing knowledge before the learning exercise such as a climate change workshop, values as well as the socio-political factors may also conflict with the new knowledge presented, resulting in cognitive dissonance (Lave and Wenger, 1991; Dunlop, 2009). Divergent knowledge and value systems can create tension that makes it difficult for an individual to engage in certain behaviour that is in contrast with their beliefs and the context of CCA, environmental attitudes and beliefs need to be organised to produce cognitive consistency to enhance the implementation of CCA (Heberlein and Black, 1981; Funke *et al.,* 2017). Dunlop and Radaelli (2018) suggest that such theory-driven learning processes that seek to translate theory directly to practice should not just provide policy recommendations but rather firstly understand and articulate whom the learning is for and for what

purpose. Further to this, external actors supporting learning at a local level should ensure that the climate change policy and theory are relevant in the context of its application and by also taking note of the realities which may constrain implementation (Dunlop and Radaelli, 2018). These factors have been described by Argyris (1977) as the governing variables, i.e. the values that actors or institutions such as local governments try to satisfy or maintain. This process is similar to what occurs in incremental adaptation where learning and actions operate within the status quo with little or no change to the way of thinking or actions (Lonsdale *et al.,* 2015).

Governing variables provide insights into the situations in which learning takes place at the local government level. Colley *et al*. (2003:39 in Boeren, 2016:11) conclude that "in all or nearly all situations where learning takes place, elements of both formal and informal learning are present. But the most significant issue is not the boundaries between these types of learning, but the inter-relationships between dimensions of formal/informality, in particular, situations*"*. The lifelong learning typologies are supported by different actors in the social network and it allows the researcher to draw patterns of epistemic community influences in learning within the case study area and this can also be applied between cases. Lifelong learning typologies can be used to make systematic comparisons of cases and learning exchanges for the different governance actors. The interactions between the social actors are described in Chapter 6 to illustrate the connections and positions of the actors supporting learning in CDM using centrality measures which illustrate the position and influence of actors in the CCA governance network. Lastly, the use of PAR allows the researcher to identify the learning types that are perceived by local governments to be the most effective and make recommendations to the epistemic community based on evidence. In the next section, the study draws on specialised literature on loop learning (e.g. Argyris and Schön, 1974;1978; Sweirings and Wierdsma, 1992; Flood and Romm, 1996; Wadell, 2011) as a conceptual framework to assess the level of learning that has occurred and the role of governing variables in supporting or constraining learning.

2.5. Different levels of organisational learning

Implementing climate change at the local level involves several social actors (e.g. councilor's, traditional leaders and municipal officials) who assume different roles and adopt practices, processes and knowledge to plan and make decisions around CCA. These actors, however, are not a homogenous group as they have different skills, interests, aspirations and knowledge which need to be coordinated through collective learning processes to create and implement a shared adaptation pathway, a learning process that can be linked to social constructivism (Tschakert *et al.,* 2016). The field of organisational learning draws from behavioural studies of organisations where the conventional interest is in understanding why and how organisations change their behaviour. Wenger's (2000) work on communities of practice and social learning shows that humans have a history of being part of a community where there are opportunities for collective learning, i.e. communities of practice. Collective learning is, however, not the total of

individual learning but is rather "collective action and reflection that occurs among different individuals and groups" (Keen *et al.,* 2005 in Pelling *et al.,* 2008:13).

As individuals learn, they also contribute to organisational routines and values. Organisational learning and change are influenced by individuals who make up that organisation, its structures, values and processes as well as the external actors they interact with. The concept of organisational learning is, at times, linked to social learning as individuals learn through the social process of interaction and interdependence with a social world (Antonacopoulou and Chiva, 2007). The possibility, however, of collective learning may conceal individual learning by members of an organisation (Argyris and Schön, 1996 in Pelling *et al.,* 2008). This has been illustrated by Janis' (1989 in Pelling *et al.,* 2008) "groupthink" theory, who showed that the organisational structure and functioning can suppress the knowledge of certain individuals, resulting in deficient collective learning when compared to individual learning. Groupthink occurs as individuals conform to group values and norms in their pursuit of maintaining harmony and loyalty to a group which can inevitably also result in highly defective decisions and outcomes (Cherry, 2020; Psychology Research and Reference, 2020). In organisations such as local governments, groupthink can be enhanced by factors such as the need to maintain cohesion, expected compliance to directives from leadership (at district, provincial and national level), low self-esteem and limited capacity to address a complex problem such as climate change (Janis, 1989; Packer, 2009; Psychology Research and Reference, 2020).

The work on loop learning by Argyris and Schön (1974; 1996) is arguably the most influential research on organisational learning that helps reflect on changes in understanding and behaviour resulting from learning. The scholars have developed a complex set of theories to explain intrapersonal, interpersonal and systemic causes and reinforcements of these inconsistencies in behaviour at the organisational and individual level. Argyris and Schön (1974) argue that individual and organisational behaviour is guided by theories of action, i.e. espoused theories and theories in use. The espoused theory refers to the worldviews and values people believe their behaviour is based upon. This includes the words that local government officials use to describe what they know (e.g. how they detect, define and structure a problem such as flooding in the municipality), what they say they do around CCA (e.g. climate change policy and other guidelines) and what they want others to think they do (e.g. sharing of adaptation interventions). This is driven by the social norms that inform acceptable actions and behaviour in a particular context.

Espoused theories of action explain what consciously drives local government officials' adaptation efforts while theories in use explain the unconscious individual motivations of adaptive behaviour that may, at times, overshadow acceptable organisational norms (Argyris and Schön, 1978). Smith (2013) posits that, even though we need congruence between the theory in action and the espoused theory, the gap between the two is not a bad thing, and only becomes a problem when it gets too wide. The gap allows one to confront ones behaviour and the governing variables, leading to more self-analysis and reflection, for example, questioning if there is need to change the current adaptation actions based

on new information presented in a workshop. When the gap is too wide, defensive routines are used by individuals as well as organisations to keep the governing variables in an acceptable range, and there is little room for dialogue and reflection (Argyris, 1986; Smith, 2013). An example of defensive routines includes shifting blame to other actors for challenges faced by an organisation and failing to acknowledge the organisation's complicit participation in creating these challenges.

Argyris and Schön's (1978; 1996) work describes the relationships, between individuals and organisations in organisational learning that include:

- The inclination to adapt to change as new information becomes available;
- Emphasis on group learning rather than individual learning;
- Creating an enabling environment (including structures and strategies) that facilitates learning and change.

The process of learning can occur on three levels, i.e. single-loop, double-loop and triple-loop learning which are described in Table 2.1 and illustrated in Figure 2.4 where an example of managing floods is used to illustrate the three levels. The different levels of learning are, at times, met with distrust, lack of cooperation and resistance. It is, however, beyond the scope of this study to evaluate which of the different levels of loop learning have been achieved within CDM as this would require a different in-depth learning investigation and much longer timeframes to study this comprehensively.

In single-loop learning, the process is more reactive than anticipatory, enabling the organisation to carry on with its current policies or realise its objectives. Single loop learning, as described in Table 2.1, has traits of incremental adaptation as its actions are done in response to a problem. This can be illustrated by a situation where, after a flooding event, an informal settlement community loses its homes and the responsible government department provides the affected communities with temporary shelter and assists them with rebuilding these informal structures. If the responsible local government department takes actions to improve their skills and knowledge on flooding risks, develops strategies including vulnerability maps to anticipate future flooding events and plans for coordinated efforts with other departments such as stormwater management, then there is an additional layer of inquiry and learning that occurs, referred to as double-loop learning (Table 2.1). The work by scholars such as Swierings and Wierdsma (1992) and Flood and Romm (1996) has given rise to a third level of learning, i.e. triple-loop learning which emphasises fundamental changes in the way adaptation is done and includes changes in learning, mental models and examines the role of power. Triple loop learning also includes unlearning practices and behaviour that often maintain the acceptable norms in an organisation and could be classified as transformative adaptation. In the flooding example, triple-loop learning would include the relocation of communities from high-risk areas to low-risk areas. Triple-loop learning is not easy given the uncertainty around climate change and political resistance to organisational transformative change, hence it may not necessarily have the anticipated outcomes (Tosey *et al.,* 2012; Leck and Roberts, 2015).

Table 2. 1: The characteristics of single, double and triple-loop learning (Source: Argyris and Schön, 1974; Smith, 2013; Muller, 2016)

Single-loop learning	Double-loop learning	Triple-loop learning
• The lowest level of learning • Detects and corrects the error • No changes are made to the policies and goals • Focus on doing things right • No changes in the fundamental structure and values of the organisation and its functions	• Changes the existing procedures • Changes the organisations' knowledge base and competencies • Also referred to as higher-level learning • Allows learners to think outside the box • Change what is often taken for granted • Questions the governing variables • Attempts to make changes that are more holistic and wide-ranging rather than solving the problem itself	• Adds dimension to double-loop learning and questions how learning has taken place and why • Includes reflection to determine if fundamental shifts in behaviour are required • Understand why previous actions led to current problems (situatedness) • Creates a new reality as there is a paradigmatic shift attitude, assumptions, rationale and context • Also referred to as deutero learning

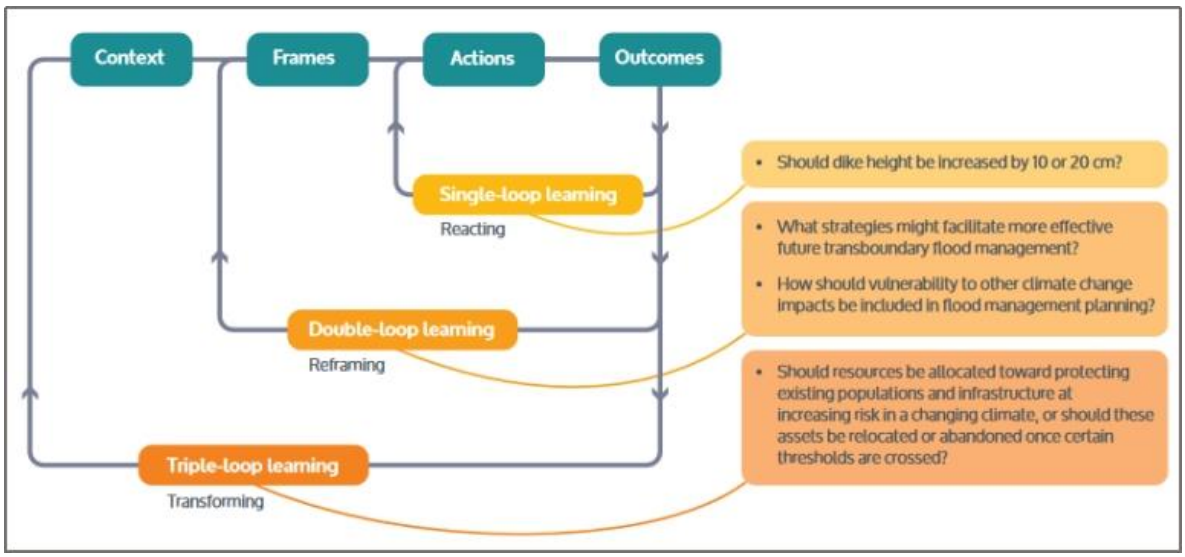


Figure 2. 4: Single, double and triple-loop learning to manage flooding as part of climate change adaptation (Source: Lonsdale et al., 2015).

To explain organisational learning, Argyris and Schön's work distinguishes between theory in use and espoused theory to illustrate how personal motivations drive actions or lack of action within organisations. Thoughts and actions according to Argyris and Schon (1974) are informed by governing variables, action strategies and consequences:

- **Governing variables:** those dimensions that people try to keep within acceptable limits. Internal or external actions can impact on and compromise these governing variables.
- **Action strategies:** actions that are used by people to keep their governing values within a tolerable or accepted range.

- **Consequences:** is what happens as a result of an action. These can be both intended – those the actors anticipate will occur – and unintended. The consequences can be for the self, and/or for others (Anderson, 1997).

Action strategies have intended and unintended consequences for an individual and others. When actions match consequences (i.e. intended consequences), then the theory in use is confirmed. For example, local government officials can be expected to have a certain number of awareness-raising campaigns on climate change that are articulated in the municipal IDP against which their performance is assessed (governing variable). The local government officials can then take actions such as agreeing to collaborate in externally driven campaigns by stakeholders such as civil society organisations to meet the target in the IDP (intended consequence). Argyris (1991) suggests that change within organisations is, at times, constrained when a person is trying to keep some governing variables within some acceptable range and when there is a mismatch between action strategy and consequence. When there is a gap between espoused theory and theory in use, decision-makers design action strategies to keep both these governing variables within acceptable limits (Anderson, 1992).

The concept of loop learning was used by Huntjens *et al*. (2008) in a study to assess the role of adaptive and integrated water management in developing CCA strategies and applied it in eight case studies in Europe, Asia and Africa. The study found that learning in water management systems in the Alentejo Region, the Amu Darya and Kagera Basin were characterised by a high level of top-down governance and were dominated by lower levels of learning (single-loop learning / *ad-hoc* problem solving). This was because the focus was on parts of a problem in isolation, yet the problems in water management systems were complex and required a systems approach. The low levels of learning were also evidenced by fewer innovative adaptation strategies that failed to include the people on the ground in creating and implementing the solutions. Huntjens *et al.'s* (2008) study also shows that in some of the case studies higher levels of learning were demonstrated by advanced or more transformative strategies that were developed in water management systems with the support of shadow networks as shown in the case of Tisza in Hungary. A shadow network by its nature, as outlined earlier, creates opportunities for informal stakeholder engagements to coordinate transitions towards sustainable management of socioecological challenges such as climate change (Olsson *et al.,* 2006; Pelling *et al.,* 2008; Wutich *et al.,* 2020).

The loop learning model can be used to understand how theories of action are illustrated as local government officials go through the adaptation action cycle impacting on how they plan, implement and review CCA actions. Learning needs to be converted into action as a result of the change in understanding but Arygris' (1991) research shows, however, that change in organisations is often constrained by the gap between what consciously and unconsciously drives decision-makers actions. Most people are not aware that their consciously espoused reasons for their behaviour may be different from the unconscious factors that drive their behaviour even though others may see it. Anderson (1992) shows that when individuals within organisations are provided with a safe, structured environment to give honest

feedback on each other's behaviour, they can identify the incongruities in behaviour. This is key to raising awareness of this gap and its reduction thereof. The study also recommends that organisations should provide a safe environment for individuals to take risks and try out new behaviour (Anderson, 1992) that would promote higher levels of learning that could drive transformative adaptation.

Argyris and Schon's work on loop learning has been criticised as it assumes that individuals within organisations can design actions; a process that can be daunting and exhausting (Richardson, 2014). In any given day, several to dozens of errors can be identified that could be changed to create a more productive and humane workplace. However, Richardson (2014:5) argues that "the human mind can only tackle and create so many changes at a time—usually only two or three". The mental and emotional process of identifying the gap, reflecting on the fault within and addressing it requires considerable courage and energy, particularly when resulting behavioural changes may conflict/are incongruent with embedded practice. This is particularly even more difficult for CCA because there is so much uncertainty, necessitating a learn by doing response in the absence of complete information (Rijke *et al.,* 2012; Wolfram *et al.,* 2019). A review of literature on climate change learning in South Africa highlights fragmented offerings on how the different learning typologies are used to support climate change learning. Anyanwu *et al*., (2015) work for example illustrated the role of formal learning in building the capacity of geography teachers to teach climate science. Meanwhile, Vogel and Schwaibold (2015) research focused on improving teaching and curriculum design for high schools and tertiary institutions (formal learning). There has also been some work by civil society actors (e.g. AWARD) who have focused on using workshops that are designed to support climate change learning for various stakeholders including local government level (non-formal learning) (AWARD, 2020). CCA requires actors such as local government officials to continuously learn as new information becomes available hence this process requires multiple platforms for learning especially in poor rural municipalities such as CDM. The review of South African literature highlights that there is still very limited understanding of how the different learning typologies could be used in a complementary way build the adaptive capacity of government actors at municipal level who play a key role in implementing CCA at the local level. Therefore, this study contributes to addressing this gap by using a case study of CDM to highlight the different learning typologies, the opportunities and gaps within them to impact on national learning systems that support local government.

2.6. Social learning as a lens for climate change adaptation

The literature on CCA shows that adaptation requires not just the social and physical constructs of adaptation to reconcile but also the mobilisation of coordinated actions to respond (Park *et al.,* 2012). As highlighted earlier, adaptation can be a source of dispute for political actors operating across different scales of interest who, at times, have dissimilar interests and ideas of how to implement adaptation, coupled by the exertion of top-down command and control risk management (Tompkins, 2005; Pelling *et al.,* 2008). Dialogue, as suggested by Freire (1972), plays a key

role in enhancing collective action as it allows social actors to confer and co-create a shared vision for a climate-resilient society. Social learning, introduced in Chapter 1, is an approach recommended to enhance CCA as it can address some of these tensions through long-term dialogue, collective action and reflection amongst both individuals and groups as they work to improve the management of the interrelationships between social and ecological systems (Harvey *et al.,* 2012; Cundill *et al.,* 2014; Boström *et al.,* 2018). The concept draws from fields such as management science, systems theory, institutional economics and social capital theory. Social learning like other participatory approaches needs to be continuous, hence it requires a coordinator and/or champion to ensure constant communication regarding activities and new information that is shared from person to person (Pelling *et al.,* 2015; Kong *et al.,* 2020). Communities of practice have been linked to social learning as these informal structures can create opportunities for members to collectively learn from each other and in turn inform practice through transdisciplinary projects (Wenger, 2006; Vincent *et al.,* 2018; Kong *et al.,* 2020).

Pelling *et al*. (2008) suggest that individuals can benefit from social learning if their employers provide them with opportunities to develop personal as well as officially recognised social relations. If such opportunities are not present, participation in informal networks can be difficult as one would need to take leave from work to participate in these events. This is illustrated in the case of the Western Cape, where the Bergrivier Climate Knowledge Network was developed as a collaborative effort between CCA specialists, the Western Cape provincial government, local decision-makers, residents and other stakeholders in Bergrivier. All participants had full-time jobs that would make it difficult to allocate time to participate meaningfully within the network, but some participants' line managers supported their involvement in the network by giving them time off to build those networking interactions outside the formal working space (Oettle *et al.,* 2014). By adopting the PAR process, the network was able to improve the frequency of communication between scientists and decision-makers in Bergrivier as actors shared their knowledge, expertise and experiences on climate change and identify adaptation actions that could be adopted. Additionally, the success of this network was facilitated by the availability of funding from the African Climate Change Initiative that supported the networks' different activities that would otherwise be impossible for the first 18 months. Importantly, a key lesson from the Bergrivier Climate Change Knowledge Network study is that securing funding to sustain a network is not easy as evidenced by difficulties in securing funding beyond the 18-month period. Hence as much as social learning through networks can provide positive results, it is not an easy process (Ibid).

Despite this, approaches such as social learning challenge current norms, practices and values through group deliberation and reflection as new ways of knowing about adaptation emerge that lead to changes in practices, policy and institutions. Participants in the Bergrivier Climate Knowledge Network, for example, indicated that informal learning enabled stakeholders to build trust and cohesiveness that helped the group to navigate through the tensions whilst also allowing the participants "to walk in each other's shoes" (Oettle, *et al.,* 2014: 85). The network in Bergrivier is an example of a transformative space (Menelisi *et al.,* 2020) or third space (Roux *et al.,* 2017) where scientists and non-

scientists make sense of climate change and co-produce knowledge to support climate change responses through CCA. Undoubtedly, networks play a role in increasing the uptake of scientific information as users of information are involved and bring with them their tacit knowledge in the knowledge production process (Cook *et al.,* 2013). This is also supported in a study by Angeulovski *et al*. (2014) on CCA in the Global South which concludes that when adaptation is formulated as a learning process that is supported by the political leadership and involves a wide range of stakeholders, it will result in sustained, legitimate and comprehensive plans and policies. Currently, there is, however, no formula that exactly prescribes what has to be done to make cities work better in their goals for CCA, but mere provision and even overloading officials with information is increasingly being reflected as inadequate to address the problems that cities and towns are faced with, e.g. flooding of settlements (Patel *et al.,* 2015). Other factors such as creating an enabling environment for political and administrative champions, that allow for collective learning to ensure conflicts do not deter implementation of CCA at the local level (Pasquini and Shearing, 2014). Moreover, self-directed and informal learning through networks and forums can be used to promote co-learning and co-production of knowledge which enhances CCA implementation (Ziervogel *et al.,* 2014).

Building the resilience of communities to deal with current and new unknown hazards as well as multiple hazards, therefore, requires different capacities and resources. The resilience of communities is strengthened by the broadened flow of knowledge from different levels and between different social actors through social learning (Pelling *et al.,* 2015). This has been illustrated in the City of Quito in Ecuador where social learning, on the one hand, has been supporting climate change actions at various scales through, for example, the former mayor of Quito who joined international networks such as ICLEI - Local Governments for Sustainability and United Cities and Local Governments. Participants in this network shared climate change experiences and solutions that were used to initiate local activities in their respective cities. The youth in Quito, on the other hand, adopted the social learning approach to develop a youth program that enabled learning and climate change awareness-raising in the city, allowing citizens to make recommendations to decision-makers on what should be included in the city's climate response plan (Anguelovski *et al.,* 2014). Further to this, the city of Quito has been able to engage and share knowledge with eighty other local authorities in Ecuador and signed the Quito Climate Pact in 2011 to motivate other municipalities to learn from their experience and build partnerships (Ibid). In New Zealand, Hill *et al*. (2007) adopted the co-design laboratory as a collective learning process to address regulatory and compliance tensions between government agencies and stakeholders in the apple industry. The approach was used by participants to identify the connections between their work, highlight the cultural, historical and systemic factors that prevented actors from complying with regulatory systems and lastly co-design and test ways of transforming the entire system so that it works for everyone (Ibid).

The success of organisations and institutions (e.g. local government) therefore depends on whether the communities can organise themselves as learning systems that are linked to other systems (polycentric governance) and processes of knowledge production, its flow and impact, i.e. transformation (Wenger, 2010). In such instances, governance

processes that consider the role of different types of knowledge, learning and consensus-building are called for to aid strategic conversations across decision-makers in cities. Scholars and practitioners in support of social learning argue that using this approach creates an opportunity for learning to go beyond knowledge transfer from scientists to users as it allows for collaborative learning and problem solving (Roux *et al.,* 2006) and also builds the adaptive capacity of organisations to respond (Pelling *et al.,* 2008; Kronlid, 2009; Tanner and Bahadur, 2012). In addition, social learning influences transformative change in behaviour through, for example, taking proactive actions to mitigate the impacts of projected changes in climate (Ison *et al.,* 2000), referred by Lotz-Sisitka (2016) as change-oriented leaning. Equally important, social learning can be used to facilitate changes in actors' value systems so that they can do things differently, i.e. transformative and transgressive learning so as to sustain the systemic changes required in the long term (Tanner and Bahadur, 2012; Davoudi *et al.,* 2012; Kates *et al.,* 2012; Cundill *et al.,* 2014; Pelling *et al.,* 2015; Lotz-Sisitka, 2016; Bendell, 2018; Boström *et al.,* 2018; Kong *et al.,* 2020).

Leck and Roberts (2015) note that adaptation efforts by local governments can benefit from the relationships and links within and between formal and informal institutions where different types of learning can occur. Formal institutions that support adaptation include boundary organisations that use different strategies to facilitate learning through evidence-based and socially beneficial policies and programmes (Drimie and Quinlan, 2011). Informal structures include networks that include personal relations that actors in adaptation governance develop with other state or non-state actors that cross boundaries of identity and provide an informal vehicle for the flow of information and learning (Pelling *et al.,* 2008). This can include relationships established through interactions as a conference or forum pursued on an ongoing basis. These social systems can help in understanding the instances where scientific information is available to inform potential climate change responses, but the decision-makers have a different understanding of the problem and how to address it which does not always match the recommendations provided from science (Adger *et al.,* 2007). While such informal institutions such as networks have been noted by Fünfgeld (2015) to play a key role in advancing knowledge in climate change mitigation in developed countries as part of the social learning process, less is known about their catalytic potential for adaptation and its implementation, especially in developing countries.

2.7. Conclusion

In this chapter, I drew on a wider range of theories in governance, adaptation and learning to understand how CCA learning is potentially taking place amongst local government officials in CDM. The literature on governance and organisational learning highlights the complexity of learning and enacting change within organisations (Anderson, 1992) and individuals (Argyris, and Schön, 1978; Argyris 1986; Janis, 1989; Smith, 2013; Tosey *et al.,* 2012; Leck and Roberts, 2015). I posit that, when the foundational phase of meaningful participation of actors at local government in learning types that allow for co-production of knowledge and co-implementation of climate change projects is not present, officials often fail to develop the agency required for them to function as genuine partners in CCA. Such cases result in lower levels of learning (single-loop learning), and actors opt to preserve the existing rules, norms, power

structures and relationships between members of the governance system. There is a need to understand how best to support local governments and enhance their adaptive capacity so that they do not just adjust decisions in response to an identified fault or inappropriate response (single-loop learning) and promote the reframing of problems and challenges of underlying assumptions (multi-loop learning) (Turner *et al.,* 2016).

Research work on lifelong learning typologies and social learning shed light on the types of learning that can support CCA and transformational adaptation, but there is need to look at how governance actors make sense of and enact the learning that occurs through these different types of learning. Lifelong learning also helps identify the current learning types reverted to or reinforced at the local government level. The adaptation cycle illustrates that responding to climate change requires both incremental and transformational adaptation and the former, at times, shifts to transformative adaptation to allow for new ways of doing things (Lonsdale *et al.,* 2015). Decision-making can be transformative but cannot stay in that mode for a long period as that would be disruptive to an organisation, hence it has to revert to an incremental cycle for stability (Lonsdale *et al.,* 2015). Social learning is one of the approaches that can be used to help both individuals and organisations to improve their self-efficacy as they learn to live with uncertainty and risk (Pelling *et al.,* 2015). Yet, social learning is not a perfect process but includes inevitable errors which can cause governance actors to be anxious and careful in how they approach change, often opting potentially for short term and safer choices (Cundill *et al.,* 2014; Bostrom *et al.,* 2018). In summary, from the extensive literature presented in this chapter, the thesis draws from the following literature to address the research questions:

- The governance theory was used to respond to the key question who learns by identifying actors who make CCA decisions and should learn about CCA in CDM (Chapter 5 and Chapter 6). The polycentric governance theory (Ostrom, 2009; 2010) was used in the study to improve understanding on the multiple actors at multi-scalar level who are interconnected and interlinked in the governance of climate change, who influence what is known and done to respond to climate change through CCA responding to key questions *learn from who* (Chapter 4 and Chapter 6). Social network analysis centrality measures were used to illustrate the position and influence of the actors who support learning in CDM (Chapter 6).
- The adaptation action cycle (Park *et al.,* 2012) provided a conceptual framework for understanding adaptation and addresses the study's key question on what is learnt (Chapter 7).
- In addition to this, the learning theories were used to address the question how this learning takes place (Chapter 6) by examining how adult learners continuously acquire, process and retain knowledge (Mocker and Spear, 1982- lifelong learning). Along with this, Argyris and Schön's (1974;1996) loop learning model is used to illustrate how the governing variables, action strategies and consequences influence how governance actors make sense of and enact CCA in the different phases of the adaptation action cycle. This included identifying the barriers and opportunities to enhance learning at the local government level (Chapter 7) and in so doing address the question on the effect of learning.

- Lastly, the study draws from social learning literature (Bandura, 1977; Pelling *et al.,* 2008; Ensor and Harvey, 2015) to respond to the key question what else can be done and make recommendations on how to overcome the barriers that local governments face as well as highlight the opportunities that are available to enhance adaptation at local government level (Chapter 7).

The next chapter provides the research approach and methodology that was adopted for this study to achieve the research objectives. It also includes some of the ethical considerations, a reflection of my positionality in the study as well as limitations of the study.

3. Engaging Different Knowledge Types: Methodology and Methods

3.1. Introduction

In this chapter, I reflect on my encounters as both a learner and a researcher to improve the broader question posed in this thesis: understanding learning within the local government context. The study was conducted in CDM, making use of the qualitative research methodology to understand what local government officials know and understand about CCA, how they have acquired this knowledge, what they do with this knowledge and who they work with as part of the governance network. I adopted the PAR approach to understand how actors in governance settings learn both in their places of work and with one another as they take actions conceptualised in the adaptation action cycle to enhance the resilience of their communities (Reason and Bradbury, 2001; Brydon-Miller *et al.,* 2003). In this case, I used multiple data collection settings and methods (workshops, semi structured interviews, focus group discussions, participant observation and secondary data) to explore and obtain rich data on multiple meanings or experiences that reflect a dynamic reality as to address the five explorative questions on *who learns; what is learnt; learn from whom and how this learning takes place; the effect of learning; and what else can be done to enhance learning and policy implementation*.

By using the PAR approach, I was able to actively engage and involve the local government officials to share personal narratives on their experiences of what and how they learn, the effect of the learning and recommend learnings systems or changes that are acceptable to them. Actors who support adaptation in CDM were also engaged to get insights on how learning takes place in terms of the flow of CCA information, barriers and opportunities for effective flow and the uptake of information for action. Fieldwork research for this study was conducted between January 2016 and August 2019.

The primary data collected was in the form of rich narratives that provided trends in thoughts or experiences that were thematically analysed. Additionally, I used the integrative literature review to analyse explicit knowledge that has been produced that relates to my study to provide relevance and coherence to the existing literature (for example LEDET, 2016; CDM, 2019 a, b; AWARD, 2020, a, b). Literature that was reviewed include books, journals, reports, online resources and grey literature on governance systems, learning typologies, international agreements and research as well as national policies that inform adaptation. A literature review also provided insights into the intricate processes that are part of the local government system, which may enable or disable adaptation and complemented the primary data collected in interviews and workshops. Triangulation in the form of combining data sets obtained from primary and secondary sources and then trying to trace interactions using software was used to provide rigor to the study. In this way, the multiple data collection methods, i.e. interviews, focus groups, workshops and an integrative literature review were used to increase the validity and credibility of the research findings as well as overcome the biases that arise from using one method (Cresswell, 1994; Noble and Heale, 2019).

In this chapter I will describe in more detail the research approach and methods used to achieve the research objectives, a description of the data analysis approach used, ethical considerations, positionality and limitations of the study.

3.2. Research Approach

Climate action requires transformations that firstly allows actors to experiment, learn and engage in processes that they have never done before (Bradbury *et al.,* 2019). Secondly, the challenges posed by climate change cannot be solved by simply providing scientific evidence. To actively deal with climate change will require personal engagement and self-awareness so that individuals and organisations can change both their internal and external relations as well as their governing variables (e.g. organisational norms, policies and structures) (Batras *et al.,* 2014; Bradbury *et al.,* 2019). The PAR is adopted in this study to allow for conversations with governance actors in CDM and external actors who support CCA (e.g. DEFF officials and NGO's working in CDM) to determine the role of learnings systems in supporting adaptation at local government level (Oettle *et al.,* 2014). This includes examining their learnings and exploring the role of learning systems in informing how local government officials make sense of climate change and CCA actions in the adaptation action cycle. My study also seeks to establish factors that enhance or constrain the effective flow of knowledge on CCA to create more avenues of local change in the municipality.

PAR has been defined as "the systemic collection and analysis of data for the purpose of taking action and making change by generating practical knowledge" *(*Mc Donald, 2012:35). Akofi and Parker (2015) add that PAR is a methodology of research that is based on intensive and strategic engagement with members of a community to define and address a shared set of challenges-drawing from the resources, values, strengths and innovations of the community to work towards a common set of goals.

In this study, PAR involved among other things bringing together local government officials in CDM in a number of facilitated engagements to share and reflect on climate change experiences and on learning systems that frame their knowledge and responses to CCA. Furthermore, these engagements offered officials a platform to deliberate and assess how political, social, economic and structural contexts in their organisation impact on their work-life, including planning and decision-making (McIntyre, 2002). Initiatives to support CCA at local government level, including knowledge production, have often failed to pay attention to how social and emotional contexts influence how local municipality actors interpret knowledge and then try and make decisions (Bradbury *et al.,* 2019). PAR offers effective ways of developing solutions to various issues in society because people can partake in a reflexive process that allows them to revisit their history, culture and local context, including social relations and how they influence the current state and the desired outcomes of a climate-resilient society (Reason and Bradbury, 2008; Bradbury *et al.,* 2019).

PAR differs from traditional social or scientific research in that it integrates a participatory framework, usually at the very onset of engagement, that examines the context and multiple temporalities in which the participants

operate in and recognises that knowledge is socially constructed resulting in multiple interpretations or meanings of reality (Brydon-Miller *et al.,* 2003; Reason and Bradbury, 2008; Mac Donald, 2012). This approach was selected because of its potential to create a learning platform that allows participants and the researcher to share and reflect on personal, interpersonal and impersonal knowledge about climate change and CCA (Bradbury *et al.,* 2019). The use of PAR required my position as a learner to share a space with participants to understand their experiences and knowledge of climate change while also carefully ensuring the potential influence of my position and identity in the study context. Secondly, it also provided an opportunity for external actors who support learning to share their experiences of how they support local governments such as CDM, barriers they have encountered that affect the flow and uptake of adaptation information as well as recommendations on how best to support local governments. Overall, utilisation of qualitative methods in PAR has the potential to create greater awareness amongst the local government officials and actors who support learning and how learning takes place.

The PAR approach also, however, has some challenges or limitations that may constrain its application in certain contexts. Mackenzie *et al*. (2012), for example, used the PAR approach to identify planning tools that could be used to improve statutory water planning in Australia. They note that PAR is a valuable approach that supports social learning and adaptive management; however, its success depends on the ability to spend time building relationship and trust with the participants and their willingness to participate. Participants must be allowed to influence the work; however, those who do not wish to participate should not be forced. MacDonald (2012) also acknowledges that PAR is time-consuming. Further to this, PAR can be difficult to implement in areas where the researcher is not familiar with and may struggle to get permission to undertake the study as required by research ethics (Winter, 1987; McDonald, 2012). I was able to navigate through some of these challenges, although delays could not be avoided, and this is discussed in detail in the section on my positionality below.

The following section presents the justification of the case study site used and the sampling approaches used, followed by the specific research methods that were used for data collection and analysis.

3.3. Case study location

The CDM is one of the five districts in the Limpopo Province, South Africa. It is a category C municipality, meaning that it has municipal oversight of certain category B municipalities, i.e. local municipalities that it shares jurisdiction with (SALGA, 2017). The district is strategically positioned to the north of Gauteng and includes the provincial capital Polokwane. Major roads linking South Africa to Botswana, Mozambique and Zimbabwe pass through the district, providing a gateway for regional development (Figure 3.1).

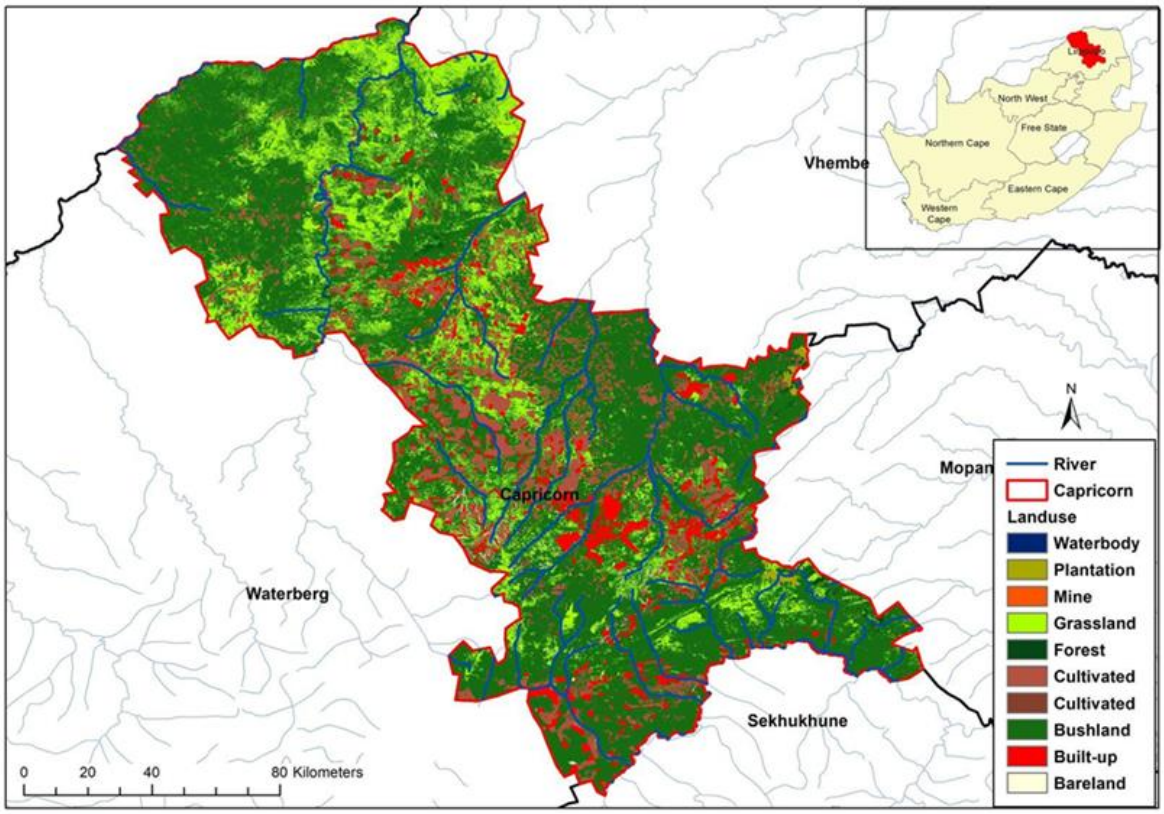


Figure 3. 1: Map and location of Capricorn District Municipality, Limpopo Province South Africa (Source: Own map based on DEA, 2018 land use data).

The district is made up of four local municipalities, i.e. Lepelle-Nkumpi, Blouberg, Molemole and Polokwane. CDM is located in one of the most climate-sensitive locations in South Africa, and developmentally, it faces the triple challenge of poverty, inequality and unemployment (as will be shown below in Chapter 5).

3.3.1 Justification of Study Site and Sampling Approaches

The CDM in Limpopo Province was purposively selected as the site for the case study for several reasons. Firstly, research points out that Limpopo province is one of the provinces most at risk to climate change due to projected drying and increases in temperature (DEA, 2013; Davis *et al.,* 2017; Archer *et al.,* 2018; Mbokodo *et al.,* 2020; also see chapter 5). Therefore, there is a continued need for research to strengthen adaptive capacity and to influence the CCA pathways adopted in the province. Secondly, I had previous experience of working in the province through the work I conducted under the South African Risk and Vulnerability (SARVA) project, and this made me familiar to both the research context and government actors I needed to engage for my study which curtailed some of the challenges of PAR.

In my previous work, at the CSIR I had engaged extensively with administrative officials from CDM through the SARVA project stakeholder capacity building workshops, and they had shared their interest to engage further in research collaborations. I responded to their offer by inviting them to take part in my study because such networks are crucial when conducting research using the PAR approach adopted in this study. Furthermore, in qualitative

research, gaining the trust of the research participants is vital when working with governance actors in the public sector such as government employees because it allows one to engage with the respondents with ease. Therefore, in using purposive sampling to select my research site I was able to engage with key actors within the CDM taking advantage of the pre-existing networks and need for my study in this area. I was able to obtain rich narratives relating to CCA from my key participants as well as from other actors where referrals played a key role in securing interviews. A disadvantage of this sampling technique, however, is that its findings are not representative of the larger population of municipalities nor local government officials in South Africa. Nonetheless, as a non-probabilistic research study, this sampling technique was best suited because it compliments PAR whereby the findings are not meant to be used for generalisation but contributes towards understanding how learning takes places and the current state of adaptation implementation.

Participants for the workshops were selected using stratified purposive sampling, whereby the respondents were intentionally selected using a stratum. The research used the following categories of strata to select workshop participants who were invited, namely local government official, environmental official, air quality official and climate change or disaster management official. Officials working in other climate sensitive sectors such as agriculture and health were also interviewed and invited for the workshops. For the first workshop, I communicated with the provincial department of Local Economic Development, Environment and Tourism (LEDET) person responsible for coordinating climate change who also provided a permission letter for me to undertake the study in CDM. The department sent the invitations to the officials from the province who met the above criteria. It was also important to use the provincial and district municipality to send the invitations to legitimise the research and also increase the response rate however, participants indicated that coordination between sector departments at provincial level is still a challenge hence some external invitations to workshops are not always prioritised. For the second meeting, the focus was on CDM; therefore, participants were invited through the CDM's Department of Planning and Environmental Management Services (DPEMS) because the department is more informed of the actors who operate at the district level and would help invite participants who meet the stratum described above.

A combination of stratified purposive sampling and snowball sampling (selecting through referrals) methods were used to identify interviewees from CDM and those supporting learning in the municipality. The participants were firstly purposively categorised based on the stratum to which they belonged and the role they play within the district or in CCA learning, e.g. funder, knowledge producer or provide technical support. Examples of participants identified here include key actors in academic and scientific institutions that provide provincial and district level climate information such as South African National Biodiversity Institute (SANBI), CSIR and University of Limpopo. Secondly, the respondents were also selected using referrals starting with key governance actors, civil society and academics within the municipality who identified other stakeholders with a similar portfolio or fitting the categories above. Consequently, through a combination of purposive sampling and the snowball sampling techniques I was able to recruit people who meet criteria above to participate in this research study and this consequently allowed me to collect rich data (see Venette, 2013; Silverman, 2016). Equally important, the detailed ethics processes

pursued at both the university and the municipality to shape the stakeholder engagement and data collection processes are discussed later in section 3.

3.4. Fieldwork experience

Specific qualitative data collection methods used to achieve the research objectives began with the workshops described briefly above and, in more detail, below were then followed by focus groups, semi-structured in-depth interviews and an integrative review of secondary literature. The study used qualitative methods, including interactive, one-on-one dialogues, and participatory group discussions to collect primary data as they were best suited to capture the multiple experiences or perceptions of climate change as well as learning systems used by local government officials shared through the research process. Engaging and listening as participants shared and compared their different experiences and worldviews was a learning process for me (as a learner) as I gathered a wealth of knowledge that was shared through this dialogic process "whereby the research game was joined by more and more players - not simply a wider and more eclectic range of producers but also orchestrators, brokers, disseminators, and users" (Nowotny *et al.,* 2003:5). The PAR approach adopted also facilitated dialogue with a wide range of participants from CDM, civil society, national departments, research and academia who helped me answer the study research questions. Details of the specific methods used during fieldwork are described below.

3.4.1. Workshops and Focus Groups

Two workshops were held with local government officials in the study area in January 2016 and October 2017. The term workshop has been defined by the Cambridge Dictionary (2020) and is used here to refer to "a meeting of people to discuss and/or perform practical work in a subject or activity". Workshops gained popularity in the 1960s and are linked to work by social constructivists to describe the participation of stakeholders which can take different forms (Ørngreen and Levinsen, 2017). Workshops allow for facilitated participation of participants who have something in common (e.g. local government officials, CCA knowledge producers) to learn, acquire new knowledge and contribute to the problem-solving for a set period (Chambers, 1983; Putnam and Borko, 2000 in Ørngreen and Levinsen, 2017). Workshops were selected as a data collection method because they permitted participants to learn through dialogue and reflection on their knowledge and experiences of climate change and CCA. This is process is a key component of PAR that provided an opportunity to meet the study objectives. The technique of probing was used to elicit expanded discussions whenever there was a need.

These workshops and discussions provided tacit knowledge that was shared through narratives that are extremely valuable as they include vivid and rich descriptions from participants that would not have been possible through other data collection methods such as a questionnaire. I facilitated both workshops and had a research assistant who assisted with capturing the discussions whilst I also made notes of the observational data afterwards during the debriefing sessions. Details of the two workshops are described in detail below.

a) **Workshop 1**

The first workshop was held over two days in January 2016 with thirty-five participants from the local, district and provincial departments, research and academia working in Limpopo Province on climate change and CCA. Invitations were also sent to other stakeholders such as business and civil society, but they did not attend. The workshop was part of the piloting process for the study but also provided an opportunity to understand the breadth of climate change in the province. The workshop was conducted with support from LEDET and the University of Limpopo Risk and Vulnerability Science Centre, who hosted the workshop. The objectives of the workshop were to:

- Allow officials to share knowledge and experiences on climate change and highlight climate change response initiatives in the five districts of Limpopo.
- Present the latest climate change science and projections for Limpopo collated through the SARVA.
- Improve understanding of local government adaptive capacity (strengths and weaknesses), information needs, and other development challenges faced by the districts.
- Engage with officials from the province to garner support for further engagement in one district municipality that would serve as a case study for further inquiry as part of my study.

The workshop created an opportunity for me to understand the learning that participants have acquired from different actors and platforms provided to them as part of initiatives such as the Local Government Climate Change Support Programme by DEFF and SARVA by DSI. The officials shared their knowledge and experiences of climate change and how they respond to such initiatives thereby providing important baseline information for this research. Given that the group of participants was large, officials were convened into five breakaway groups with about 5-7 members to discuss district level specific information based on the representation of officials who work in the respective districts of Limpopo. Although the groups did not have an equal number of participants, all the participants who took part had met the strata above. The professional roles of participants were shared during the workshop introduction session, but most participants did not capture these roles on the attendance register. Hence, they have not been included in this section. The breakaway groups could, however, be referred to as focus groups a term used here to refer to, "a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research" (Powell *et al.,* 1996: 499). A focus group size varies and is conducted with about 6-15 people (Gibbs, 1997). Breaking the participants into smaller groups was necessary to permit all participants a chance to participate and share their knowledge (acquired as part of their work or research) and lived experiences from the five districts. The focus groups also facilitated intensive discussions as everyone participated and could not avoid tasks like they might in a larger group. The general profile of participants is shown the Figure 3.2.

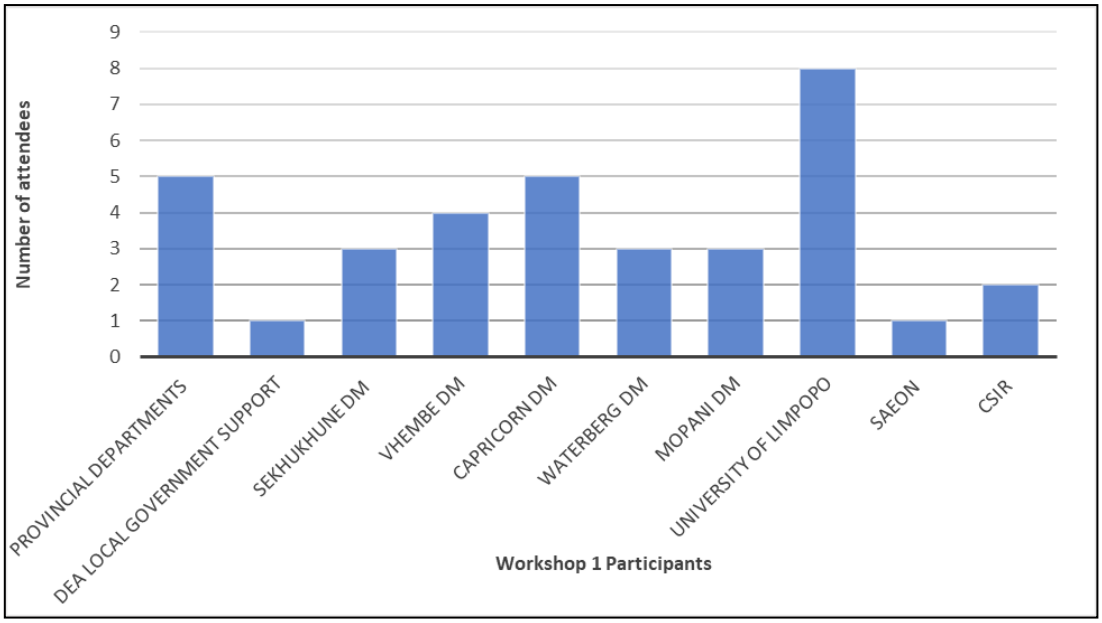


Figure 3. 2: Profile of workshop 1 participants. (DM=District Municipality; DEA= Department of Environmental Affairs now Department of Environmental Affairs Forestry and Fisheries; SAEON= South African Earth Observation Network)

To promote collective learning, each group had a map stuck on the wall for everyone to see their district and its location in the province. Participants were provided sticky notes to capture their current knowledge and experiences of climate change in their district/local municipality which contributed to Objective 1 of the study. More so, they were requested to highlight their matters of concern, that is, key vulnerable sectors in their district, key development challenges faced by their municipality and adaptive capacity issues that affect uptake of CCA which contributed to Objective 3 of the study. During this exercise, participants shared information on some of the extreme weather events that they had experienced, including the then, ongoing drought. Their written experiences were placed on a large sheet of paper on the wall for everyone to see and learn. These inputs were noted as the collective experiences for each group that emerged from a participatory social learning process.

b) Workshop 2

The second workshop was held in October 2017 at the CDM offices. The time lag between the workshops was due to changes in management at LEDET hence I had to build relations with the new management so that they could facilitate the administrative process required to engage district officials in research studies of this nature. This included engaging the management in CDM whose permission I also needed so that their administrative officials could take part in the study without which it would not be possible for the CDM DPEMS to send out the invitations. Further to this, as a full-time employee, I also had other work commitments. However, this time allowed me to reflect on the research process, a critical element of a PAR approach (Reason and Bradbury, 2001). This time was also used to review the CDM IDP and other municipal reports to see if climate change was being integrated into these municipal documents following on the information officials had received from sources such

as the SARVA workshops where participants had been trained on how to navigate on the spatial portal (informal learning) and received a hard copy of the SARVA to support self-directed learning.

The workshop was attended by twelve participants working in the CDM as well as provincial and national department officials assigned to work directly within CDM under the environmental portfolio, which includes CCA. All twelve officials had participated in several capacity-building workshops between 2014-2018 at district and provincial level facilitated by different actors including the CSIR/SAEON through the SARVA, DEA's (now DEFF) Local Government Support Programme. Efforts were made to gather some details on the highest level of education, years of experience and position in CDM and the profile of the participants. This information was collected as part of an icebreaker exercise where participants shared information in a way that would not compromise participants confidentiality and was manageable because the group was smaller than in the first workshop. This was done to better understand the backgrounds and interests of the participants present, which includes their years of experience, the highest level of education and professional level at which they worked. The information is integrated into the analysis of their general understanding of climate change, CCA and current initiatives, learning systems used as well as perceptions on the most effective sources of information. As a participant-observer, this feedback was captured as part of the workshop and is summarised in Table 3.1.

Table 3. 1: Profile of workshop 2 participants who work in climate change related projects within the CDM

Highest level of education	**Postgraduate:** n=2
	Degree: n=6
	Diploma: n=4
Post of level	**Senior management:** n=2
	Middle management: n=4
	Lower management: n=4
	Other: n=2
Years of experience	**0-5 years:** n=2
	5-10 years: n=6
	10 years +: n=2
Gender	**Male:** n=5
	Female: n=7

The specific objectives of the second workshop were to:

- Identify the governance actors who make decisions on CCA in CDM
- Identify the learning systems that provide climate change information, its flow, barriers and opportunities

- Identify actors that support CCA including major and minor actors the linkages between them
- Identify actors with whom local government officials share the same goals with who are currently not supporting their municipality and minor actors who share the same goals whose role should be strengthened
- Identify support structures needed to ensure effective CCA decision-making and implementation at the local government level

To achieve the objectives of this workshop, I used the Net-Map tool developed by Schiffer and Hauck (2010) to complement the PAR approach. The Net-Map tool was adopted to establish the flow of CCA information and interactions between the different actors. Questions were posed to understand,

- The actors who support climate change, their role and how they interact (who works with who and who disturbs who)
- The level of influence (major versus minor actors)
- The perceived goals of each actor and;

a. Identify other actors whose role should be strengthened to support

The Net-Map tool is one of the approaches that can be used to understand governance in terms of institutional structures and actor constellations. Some of the key questions it poses are, for example, who influenced or can influence learning, where (e.g. in local governments) and how (different learning systems that can be used) (Schrötter *et al.,* 2018). Understanding the level of influence of the actors and how they interact helps improve understanding of the barriers to the flow of information including actors who presume they support adaptation yet are perceived to be causing conflict or disturbing the local government actors in pursuing their goals (Schiffer and Hauck, 2010). The tool has been used as it helps in analysing and improves understanding of the complex governance systems in which planning and decision-making on complex issues such as climate change is done. Net-Map also allows users to identify possible avenues that can be used to address these barriers as participants also identify what else could be done to enhance effective flow.

Officials identified the actors who support learning in CDM, and these were written and posted on a large sheet of paper on the wall for the group to discuss. The large sheet of paper helped participants to discuss and visualise the interactions while also highlighting the direction of influence (positive or negative). A red colour pen was used to represent negative influence, i.e. actors who support but also disturb while a blue colour represented a positive influence. The study made use of an influence tower exercise to illustrates the perceived power and influence of actor in the knowledge enterprise by asking officials to identify the major actors and minor actors using a “three-dimensional sketch to structure a qualitative discussion of the governance situation” (Schiffer and Waale, 2008:8). Participants were allocated plastic gaming discs (Figure 3.3) to illustrate the level of influence for each actor in learning, whereby the higher the tower for that actor, the higher their influence (Figure 3.4). A discussion to confirm the visual display ensued to validate the information captured. Further validation of how social actors in this network

interact and their level of influence was done through twenty-nine interviews that included actors who were not present in the workshop. The interviews provided more detailed insights on the type of support provided and materials and media used to support the flow of information as well as constraints to the effective flow of information. Analysis of this data was done using VisuaLyzer software described in section 3.5 of this thesis.



Figure 3. 3: The red and blue markers used to illustrate the linkages between the actors. Blue linkages were used to show actors with positive influence while red colour indicated actors who support but were perceived to also disturb. The plastic gaming discs were used in the hierarchy tower exercise to illustrate the level of influence in learning major actors versus minor actors. The colours of the gaming disks played no role in the influence towers, rather only the height of the tower was considered.

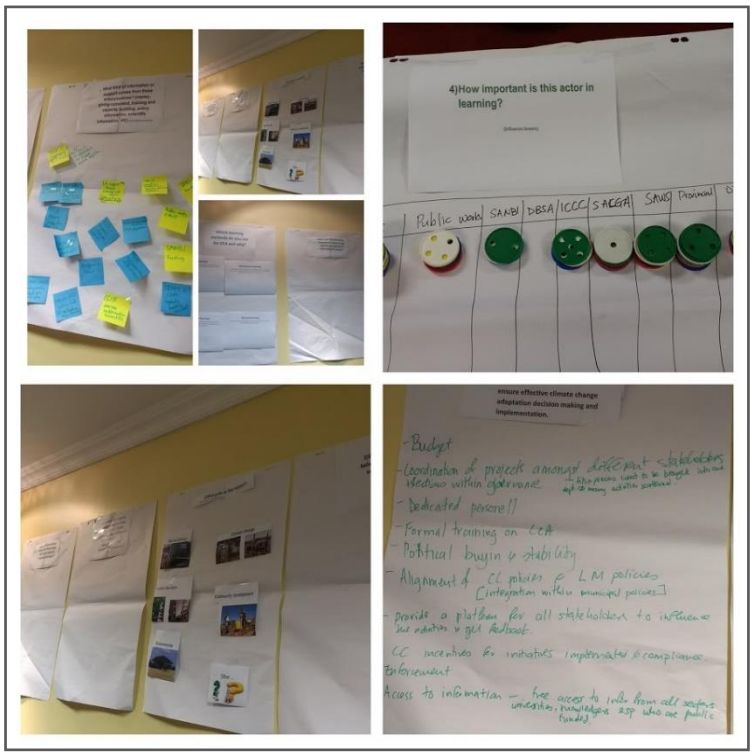


Figure 3. 4: An illustration of the large sheets of paper that were posted on the walls to guide the discussion in workshop 2. The sheets were put on the walls before the discussions to firstly inform participants of the questions to be discussed in the workshop. Secondly, the sheets with the responses captured from the discussions were left on the walls to enable participants to reflect on their contributions and make any further contributions/changes where necessary.

The Net-Map tool has been commended for allowing transparent discussions and creates a common understanding of the links and influence of actors through a visual map (Schiffer and Waale, 2008; Campbell *et al.,* 2014). The low-tech tool and casual discussions during the exercises also create a relaxed environment where participants stay engaged throughout whilst also promoting social learning as learners reflect on their perceptions of the network (Schrötter *et al.,* 2018). The Net-Map tool was used in Costa Rica on a Community Blue Carbon Project to investigate a community-based payment system for ecosystem services where fishermen were paid to restore mangroves and participated in educational work. Similarly, Campbell *et al*. (2014) used the Net-Map tool to evaluate mobile phone intervention amongst healthcare community health workers in two rural districts of Malawi, providing important quantitative and qualitative information at a low cost. Challenges with using the tool include keeping participants focused on the study objectives and discussion as they would often derail from the topic and the process of getting participants back on track can be time-consuming (Schrötter *et al.,* 2018).

3.4.2. Interviews

In addition to the workshops held above, semi-structured interviews were conducted between October 2017 and September 2018 after the two workshops. Semi-structured, in-depth interviews are guided discussions facilitated by an interviewer who uses a set of key questions to solicit information from respondents about the study (Yin 2016). The interviews questions were developed around three key outcomes 1) to establish the flow of information, support and linkages between actors in the social network; 2) to understand the challenges for the effective flow of information to local governments and; 3) to get recommendations on the most effective way to support learning for local governments. Appendix 9 shows how these key outcomes were used to develop the key questions that guided the semi structured interviews and probing was done where necessary to enable participants to share additional information or get clarity where responses were vague.

The interviews were conducted for a period until they reached a point of saturation and no new information was forthcoming from the data (Glaser and Strauss, 1967; Lincoln and Guba, 1985; Eisenhardt, 1989). This point of saturation was reached after twenty-nine interviews with respondents from the local, district, provincial and national departments working in Limpopo, research institutions, boundary organisations, NGOs and academia who support CCA learning in CDM. About forty-five per cent of the interview participants were identified as government actors who make CCA decisions in CDM working in middle and senior management on CCA related projects in sectors such as environmental planning, disaster management, social welfare and health. The participants in this category provided insights on the learning systems and various knowledge flows that informs what they know about CCA and factors that enable and/ or disenable them from playing critical roles in CCA.

Fifty-five per cent of the interview participants were external actors who were selected through snowballing as government actors in CDM identified them in the second workshop to have a role in supporting CCA learning in the district. These included officials from national government departments working on environmental affairs, agriculture, disaster management, scientists and academics from institutions such as SAWS, CSIR, SANBI and the University of Limpopo. The NGO's who took part in the study (e.g. AWARD and Choice Trust) also work with

both local government officials and communities on climate change adaptation, sustainability issues and poverty alleviation in CDM and Limpopo province in general. The inputs from interview participants provided useful insights and validated information from workshop 2 on the interactions within the social network and this was also used to do the network matrix and maps presented in Chapter 6. Figure 3.5 shows the composition of the participants who took part in the interviews.

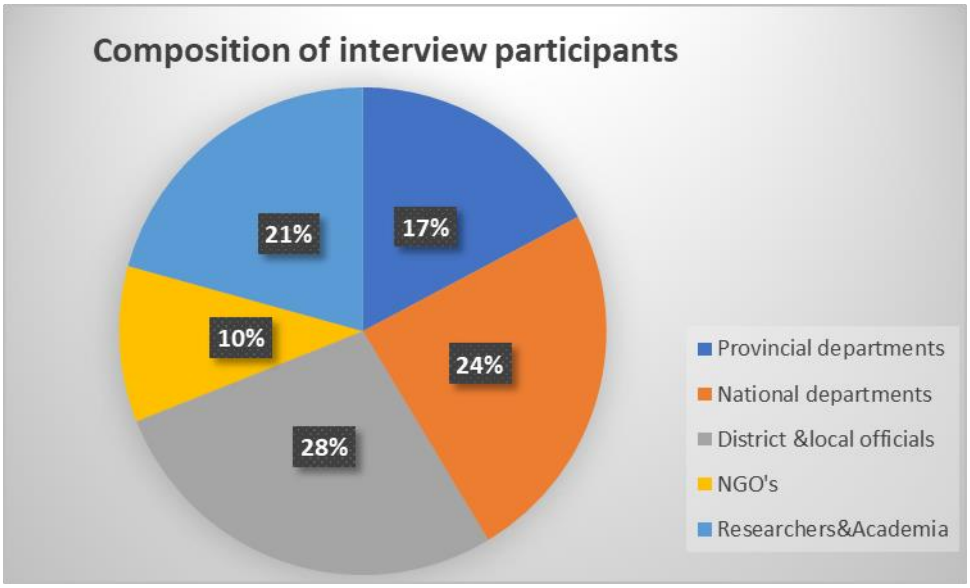


Figure 3. 5: Composition of interview participants between October 2017 and September 2018

The advantage of using interviews in this study was that it also offered detailed and sometimes contradictory information on how local government officials and other key players in their governance network perceived the level of influence that the different learning systems used supported learning. This data collection instrument enabled individual participant voices to manifest as these are often overshadowed by the strong voices that emerge during workshops. Furthermore, by using interviews, I was able to remedy challenges that are associated with groupthink where strong voices are often more dominant in workshops and focus groups. The interviews provided narratives that respond to study objective 3, which seeks to understand the level of learning that has occurred.

3.4.3. Participant Observation

Participant observation is a data collection method used to observe the non-verbal expressions of feelings, how the participants interact with each other during individual interviews and focus groups/workshops and the time spent on certain discussion points (Schmuck, 1997; Kawulich, 2005). Observation is an important learning process and has been used in behavioural and psychology studies such as Bandura's (1977) work on social learning. This method allowed me to observe how participants responded to the narratives when groups or individuals shared their reflections on their experiences on, for example, climate change in their district. As a workshop facilitator, I was also able to note discussion points where participants had common interest or agreement on and where there was a disagreement which was expressed, at times, verbally (e.g. raising a hand and speaking out when given a chance) or physically (e.g. nodding of heads or clapping of hands to support the presenter). Areas of common

interest and discussion included experiences of climate change, sources of CCA information, opportunities and barriers for effective flow of information. I also listened in to the group discussions to get new ideas or areas to probe further in the workshop plenary session as well as the interviews. Notes were taken and the information was captured and analysed together with data collected in the workshops to draw out key themes which have been incorporated into the results chapters 6 (section 6.2) and 7 (sections 7.2, 7.3, 7.4, 7.6 and 7.7).Being a participant observer was a social learning process for me and enabled me to learn about some of the intricate practices and processes that are part of the local government system. This includes, for example, the different actors and their levels of influence in decision-making within municipal administration and its potential impact on the implementation of CCA.

3.4.4. Integrative Literature Review

The study then also employed an integrative literature review to triangulate information gathered using other research methods above. An integrative literature review is a "review that critiques and synthesizes representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated" (Torraco, 2005:356). This involved re-analysing and re-interpreting explicit knowledge in academic literature, newspaper articles as well archival documents available online on the district, provincial and national departments websites, specialist reports (e.g. Limpopo Risk and Vulnerability Assessment Report), strategy documents (e.g. Limpopo Provincial Climate Change Response Strategy) and policy documents (e.g. CDM 2016/17-2021 Final Draft IDP/Budget). A review of the literature was used to provide an overview of the theoretical framework guiding this research, identify synergies as well as gaps in literature based on the thematic reviews that relate to the study objectives. An integrative literature review has been used in other research to generate new knowledge and understandings on studies such as those on organisational development (Weick and Quinn, 1999); sustainable land management (Musvoto *et al.,* 2014) and water use behaviour (Funke *et al.,* 2017). The relevant thematic issues drawn from the literature have been integrated throughout the thesis.

In summary, the various methods used were interviews, focus groups, and workshops which allowed for detailed narratives to emerge from the dialogue with participants and was complemented with an integrative literature review to achieve the research objectives (See Figure 3.6).

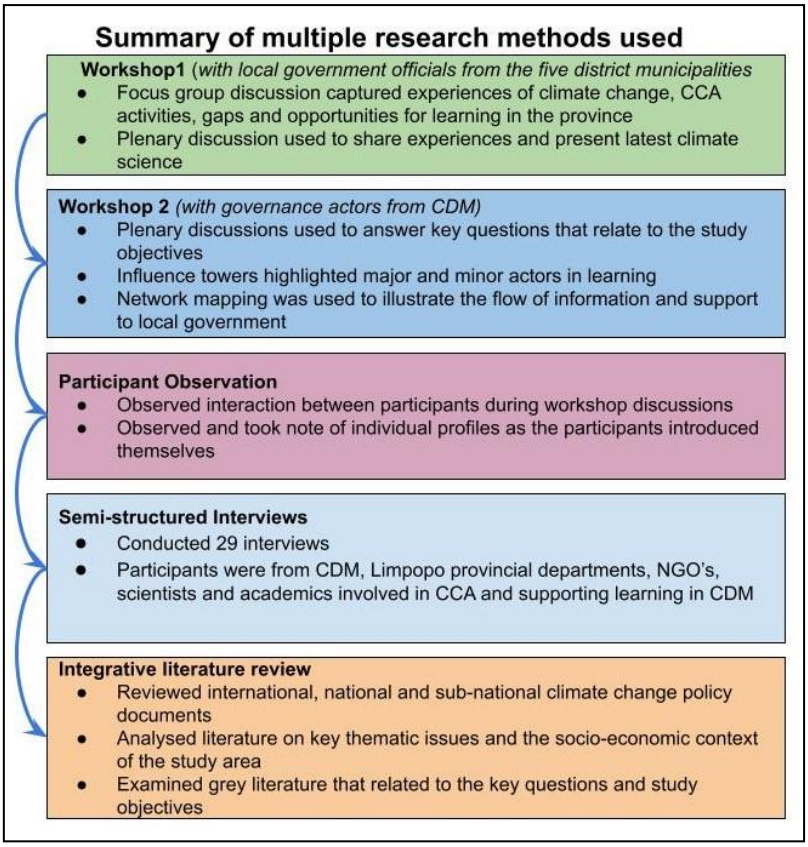


Figure 3. 6: A summary of the multiple research methods adopted in the study to achieve the research objectives

The information that was gathered from the above data collection techniques was analysed making using of the social network analysis and thematic content analysis as discussed in the next section. The findings are presented in Chapters 4, 5, 6 and 7.

3.5. Social Network and Data Analysis

To understand how actors in the governance network interact data that were collected using the Net-Map tool to interrogate the flow of information between the actors was further analysed using social network analysis (Wasserman and Galaskiewicz, 1994). The information from the interviews and the second workshop was used to draw a network matrix illustrating the presence or absence of a link between actors (Schiffer, 2007). To visualise the connections between these actors, the VisuaLyzer software package (http://socioworks.com/productsall/visualyzer/) was also used and includes several network analyses functions to establish the patterns of interaction, linkages and importance of actors(power) in the network using centrality analysis (Schiffer, 2007; Medical Decision Logic Inc; 2014; Hanneman and Riddle, 2019).Centrality analysis comprises quantitative network metrics that are used in social network analysis to illustrate the position and activity of actors in the network (centrality) and their influence in the network with regards to providing information and other support that promotes CCA learning (Wasserman and Faust, 1994; Wasserman and Galaskiewicz, 1994).

Specific metrics analysed were the degree of centrality, closeness centrality, betweenness centrality and nearest neighbour. The social actors are represented in the network as nodes. The degree of centrality illustrates the

number of links an actor has with other actors in the social network and can be used to identify major actors who have the greatest number of links, i.e. a high degree of centrality (Schiffer, 2007; Hanneman and Riddle, 2019). Degree of centrality can also illustrate actors who have the most information because they can connect quickly with the wider network giving them more choices from which to source information and can also be key sources of information for other actors in the network (Hanneman and Riddle, 2019; Cambridge Intelligence, 2020). The results of the degree of centrality were interpreted together with information collected through the influence tower exercise that illustrated officials' perceptions of major and minor actors based on their role in supporting CCA learning. A visual illustration of the connections and direction of links between the actors/nodes (directed graph) was compiled and is presented in Chapter 6.

Figure 3.7 is used to illustrate some of the centrality concepts in social network analysis. The links between actors vary and some links are not always reciprocated, i.e. Actor A may support Actor B, however, Actor B may not provide any support to Actor A. In the directed graph, when the nodes are linked together degree centrality is then used to distinguish between in-degree versus out-degree. The in-degree shows the nodes/actors who are sinks or recipients of information and is illustrated in the social network map by the inbound arrows, and it is also an indicator of prestige (Medical Decision Logic, 2014). The prestige of the actors is evidenced by the number of inbound links as other actors in the network direct their links to them, which is an indication of their importance (Hanneman and Riddle, 2019). In Figure 3.7. Actors D and G have high in-degree as shown by the high number of inbound arrows (n=3).

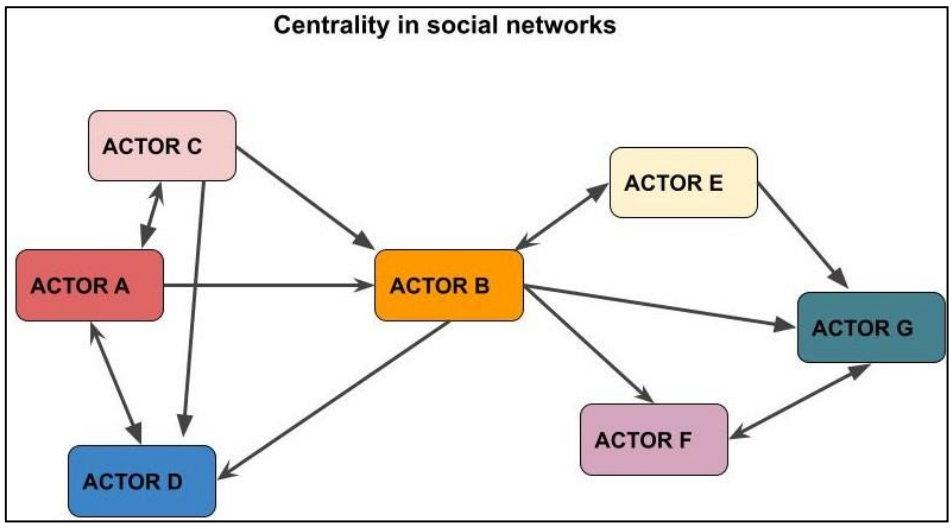


Figure 3. 7: Example of social network illustrating actors in- degree (in-bound arrows), out-degree (outbound arrows) and betweenness centrality (connectors)

Actors who have high in-degree are said to be in a comparatively favourable position as they have many links in the network that allow them to access information from different actors to meet their needs (Mishra, 2017; Hanneman and Riddle, 2019). These actors who have high in-degree may, however, also be overburdened with information, some of which may be contradictory, which will make it difficult to use for planning and decision-making (Medical Decision Logic, 2014). Out-degree, on the other hand, illustrates actors who send out information in the

network and this is shown by outbound arrows to illustrate which actors they provide with information in the network (Schiffer and Hauck, 2010).

Centrality analysis is also used to highlight actors who can reach others in the network quickly with support/information referred to as closeness centrality. The closeness centrality measure is based on the geodesic distance that illustrates the distance between actors in the network based on the farness, i.e. the sum of its distance to other nodes/actors. The sum of the geodesic distance of the actor from others in the network is then transformed into nearness as the reciprocal of farness (Medical Decision Logic, 2014; Hanneman and Riddle 2019). Put differently, closeness centrality calculates the relative length of the path to every other actor in the network and highlights actors who are best placed to influence the network swiftly as they have a short distance to travel to get to actors in the network (Medical Decision Logic Inc, 2014; Zhang and Luo, 2017). While closeness centrality was used to show the distance between all actors in the network, the nearest neighbour analysis was used in VisuaLyzer to illustrate CDM's nearest neighbours who support learning in the district. The nearest neighbours is a more egocentric measure that shows the geodesic distance of actors in the social network to CDM with 1 being the nearest. The measure can help identify the actors whose role could also be enhanced to support social learning in CDM based on their proximity to CDM as the nearest neighbours who can facilitate fast transfer of CCA information or support to the municipality.

The social network analysis tool can also be used to examine actors who play the role of intermediaries and connect institutions that would not otherwise link referred to as betweenness centrality. The betweenness centrality measures "the extent to which an actor falls on the geodesic paths between other non-adjacent pairs of actors in the network*"* (Medical Decision Logic, 2014:79). *Betweenness* can also be used to illustrate actors who influence the flow of information within the local government system, actors who pass on advice, facilitate the transfer of support such as funding to other actors in the network (Schiffer, 2007; Schiffer and Hauck, 2010; Hanneman and Riddle, 2019). In Figure 3.7 Actor B acts as a bridge that connects the left and right side of the network. High betweenness could also identify an actor who has higher authority in a network as other actors connect through them (Cambridge Intelligence, 2020).

Social network analysis has been used in other studies such as those by Haythornthwaite (2000), Palonen and Hakkarainen (2000), Tapola *et al*. (2001) and Russo and Koesten (2005) to understand the linkages between actors within an online learning environment. Centrality measures have also been used to understand the interaction between complex urban networks and information geolocated information related to tourism (Curado *et al.,* 2020). Social network analysis provides information on patterns and structure of connections, power and communication convenience between actors that would otherwise not be possible by other means by looking at actor's centrality and prestige (Russo and Koesten, 2005; Zhang and Luo, 2017). Social network analysis also illustrates the ties that actors have with social capital which is based on the social relations that are used by actors to achieve certain goals such as learning and implementation of CCA or service delivery at the local level. The challenge with using Net-Map tool in a group is that it can be challenging to get participants to agree on the linkages between the actors in the network and control bias when there is conflict (Schötter *et al.,* 2018).

The primary data collected from the workshops and interviews were all transcribed and read interpretively drawing on participant's subjective experiences in response to the research questions to identify a range of themes and abstract patterns. Interpretive researchers posit that reality comprises people's subjective experiences of the outside world, and in so doing, they can adopt an intersubjective epistemology and ontological belief that reality is a social construction (Thomas, 2010). Consequently, coding was done to establish the recurring themes using chunks of text to identify the common words used/meanings that respondents shared in response to key questions of the research (Thomas, 2010). The participant responses (narratives) have been interpreted to inform the structure and content of the research findings chapters of this study (interpretive research). In the following section, I highlight the ethical issues that were considered in the study to ensure the rights and interests of participants were respected throughout the research journey.

3.6. Ethical Considerations

Two ethical applications were submitted for this study with the University of the Witwatersrand and the Limpopo Provincial Research Ethics Committee (Appendix 4 and 5). Permission to conduct the research was granted by relevant provincial authorities, i.e. Limpopo Office of the Premier as well as the Limpopo Province LEDET (Appendix 6). The study complied with the ethical practices from both institutions that included being sensitive to gender, political affiliation and culture, as well as the voluntary participation and withdrawal of respondents without penalties. As such, I did not encourage district and provincial authorities to coerce participants from the local municipalities, civil society and private sector who did not respond to the invitation for the workshop and interviews to take part.

All participants were over the age of 18, and each received a copy of the study background information document and consent form (Appendix 7 and 8). These two documents provided participants with information on the project title and objective, contact details of my supervisors and the Ethics Committee, research procedure (for example duration of the interviews and focus groups discussions), how the information would be stored, and the method in which the information would be disseminated (thesis and academic publication/s). Transparency was emphasized in this research, and participants could seek clarity whenever they wanted, and I ensured that all the research procedures did not infringe any ethical concerns of the research participants for example their identities.

Participants' anonymity in terms of their name, job title and department were a key ethical consideration in this study. Although it was difficult to protect the participant's anonymity in the workshops, every effort was made to protect the participants' identity and their job titles in the thesis and publications emanating from the research. In this thesis, pseudonyms have been used with each participant receiving a code when their narratives were included in the text on some of the verbatim quotes (e.g. Participant 1 or Participant 6). The research participants shared their perceptions in their professional capacity, but their views are not considered to be representative of their organisation and all inputs was valued equally regardless of the participant level of management. The identities of the participants need to be protected so that they cannot be linked to their signature or functional role, especially where there is extreme political tensions or power dynamics (Strydom, 2011). To address this, Strydom (2011)

suggests that because research contexts differ, the researcher can use his/her discretion to determine how the ethical concerns regarding acquiring consent from research participants are managed. The key requirement is to ensure that participants are genuinely informed of the research and are not forced to participate in the study.

In this study, all participants in the workshops and interviews gave consent though some was verbal. Some participants wanted their identities protected so that their participation in the study did not impact on their relationships with their management. Within the workshop participants anonymity and confidentiality is difficult as the participants know each other and work in the same environment however I have ensured that all forms of reporting the results of this study do not include the names of the participants, functional role and any other traits of individuals or groups that make them identifiable in research reports. All workshop transcripts for this research are held securely on my laptop, which is password protected and has cloud backup.

3.7. Researcher Positionality

Finally, a critical dimension of this study is that of my positionality in the research process. Qualitative researchers are encouraged to understand and appreciate their position (*self)* and subjectivity to the social phenomenon under investigation (also supported by Behar, 1994; Kirschner, 1987; Rose, 1997; Throne, 2012). Just as with any qualitative research project where bias is a natural human trait, I have to reflect on my subjectivity in this research. As mentioned earlier, before this study, I had previous engagements with the officials in Limpopo and CDM due to the role I played in facilitating capacity building stakeholder engagement workshops for the South African Risk and Vulnerability project between 2010-2017. I had also been elected to be a member of the Limpopo Provincial Climate Change Working Group to advise on climate change research projects. So, I went into the field with three identities 1) a PhD student from Wits, 2) a researcher from a research institution and; 3) a member of the provincial climate change working group. I also had prior knowledge of the province and the municipality, which created an opportunity for me to use purposive sampling to select a case study for this study. The reflections by local government officials on factors that influence the uptake of CCA have relevance in my current day-to-day work on the socio-economic benefits of weather and climate information. Socio-economic benefit studies seek to, among other things, inform the design of user-inspired products and services that support decision and policy-making in socio-economic development whilst also building resilience to extreme weather events (Borzacchiello and Craglia, 2011; Kruse *et al*., 2018).

Qualitative research includes exploring the specific meanings, behaviours, thoughts and circumstances associated with learning systems used for CCA at the local government level. The dialogic nature of the research reorganised the roles of the researcher and the research participants who were able to engage in the study as knowing subjects and agents of change and improvement. This is different from traditional approaches to knowledge production, where the researcher is a distant observer of a process (McTaggart, 1997). Hence, the qualitative research approach adopted in this study allowed me to utilise my positionality to tap into the subjective social constructs of CCA in the studied community. My positionality was also declared to the participants in the participant information

sheet that provided participants with the project background information, the study aim and objectives and as well as my role.

3.8. Limitations

As in any research, there are always positives and negatives, or aspects that in hindsight could have been improved upon. The research presented here used qualitative approaches which allowed for inputs from different actors who bring with them tacit knowledge and other knowledge (e.g. codified knowledge in documents, databases etc.), to develop local solutions that can be used to enhance effective adaptation. This is done through rich narratives that are context-specific to the studied community, and this can limit the generalisability of the research findings. More so, the small sample size used in the study, which was purposively selected, does not provide for a representative sample of perceptions around the research problem (Hopkins, 2013). A generalisation is also compounded by the differences between the local governments in South Africa with different performances and capacities. Notwithstanding these constraints, and since the research was designed to gather deeper knowledge on the role of learning systems used in CDM, the qualitative approach adopted for the study was considered best suited to garner depth. The strength of this study lies, therefore, in deeply probed insights on the subject, which could be difficult obtain with a quantitative design.

Other challenges with qualitative data collection methods such as interviews and workshops are that they can be time-consuming and collecting large volumes of data (i.e. narratives) takes time to transcribe, clean and analyse (Anderson, 2010). I had to choose themes to use that addressed the study objective and from this huge data sets I selected data to keep for analysis. The process presents biases in terms of data what is included and excluded. To overcome the data selection bias, I had to narrow down responses to those texts that meet the research objectives.

I also asked participants to reflect on the flow of information and factors that enable or disable effective flow, some of which included the influence of power dynamics and management on the flow of information and implementation in municipal operations. As part of the rules of engagement at the onset of the workshop, participants agreed not to disclose names and statements made by fellow participants with colleagues who were not part of the workshop. Nevertheless, in workshops anonymity and confidentiality of participants' responses is difficult to ascertain, hence some participants often made statements that showed that they have to hold back some information for fear of disclosing too much information that could land them in trouble with their superiors. In such circumstances, officials were not forced or probed further so they could continue to participate freely. The interpretations on the role of local municipalities in CDM as a governance actor in CDM shared in this study are based on inputs from local municipal officials from Polokwane Local Municipality only. This is because, although all local municipal officials from the other municipalities were invited to take part in the study, only those from Polokwane showed interest. Ethically the officials could, therefore, not be forced to take part as they are not subjects of research but rather active contributors who should participate freely (Kelly, 2005; Mc Donald, 2012). The learning experiences and challenges for local municipalities who did not attend the workshop were not captured because of the reluctance

of officials to take part in the study, a trait that is not unique to CDM or Limpopo. However, even though the results cannot be generalised they provide a key starting point for efforts to address barriers to learning which include participation fatigue and lack of human capacity also discussed in Chapter 7 section 7.6.

It is also important to acknowledge that the social network presented may not be complete as there may be other actors and links not presented due to the boundary specification problem (Laumann *et al.,* 1983) and inaccuracies in respondent data as this is based on experiences and perceptions (Smith, 2019). Respondents also often share the cognitive networks, i.e. what they think the connections are like rather than the actual interactions (Kossinets, 2003 in Smith, 2019). The social network developed in this research also represents a snapshot of a time when data were collected (October 2017-August 2019) and this may or may not change over time due to changes in relations between actors, organisational structures and policy updates (e.g. the Climate Change Adaptation Strategy and Climate Change Bill drafted after the period of inquiry). The snapshot, however, is valuable to this research as it improves understanding on the actors that support CCA information and the flow of information, whilst also highlighting opportunities or actors within the network that can support learning and integration of CCA into municipal operations. While the objective of this section of the thesis is to illustrate the interaction between actors in supporting learning in CDM, I did not delve into the quantitative algorithms used by VisuaLyzer to compute centrality of the social network.

Lastly, as highlighted earlier, I had prior relations with officials in the study area that empowered me to build trust that is essential in PAR, but this could also create bias and affect responses of participants. However, despite the previously established relationships, I also noted that the municipal context is not very easy to navigate, especially when one needs to collect primary data for research. This is mostly because of gatekeepers present in municipal structures. I had to get the necessary permissions to honour ethical obligations. Accessing municipal managers to get permissions to conduct research in their municipality and engage with administrative personnel working in the various municipal departments proved to be very complex and time-consuming, especially due to high staff turnover in municipalities. The snowballing technique adopted, however, gave me access to participants whom I would have struggled to contact had their contact details not been shared by the participants whom I had established professional relations with. These contacts offered to send an introductory email, but some participants required follow-up emails or phone calls to set up appointments for the interview even after agreeing to take part. The whole process called for flexibility, patience and conscientious negotiations with gatekeepers to ensure due diligence. Even though the CSIR has a close relationship with CDM due to the nature of projects they collaborate on, the potential bias of participants' responses in the study were addressed through interviews with other actors external to the municipality who are familiar with the subject. The triangulation process of including external participants through interviews accentuated the credibility of data gathered during Workshop 2, hence both data (workshop and interviews) was used to generate the social network maps.

3.9. Conclusion

In this chapter, the research approach, methods and reflections have been presented. These were undertaken to investigate and learn more about the role of learning systems in supporting CCA at local government level. As indicated in Chapter 2, the aim of this research was not to probe personal learning but rather to ascertain learning at a collective level, in this case, the municipality. The derived contours of the learning system are thus what emerges in this study. The study also illustrates why I used PAR as a research approach to probe the local government officials' social learning journeys. Chevalier and Buckles (2013) note that the dilemma for scientific knowledge producers in fields such as climate change is whether to continue building ivory towers and serve the interests of the few or to contribute towards society's common good. I took the PAR approach as a way of averting this dilemma for co-generation of knowledge by getting user-inspired contributions, even if amongst small groups, but of actors with sufficient credibility and agency to enable change on how to improve the effectiveness of learning systems used for CCA. The concepts or recommendations developed in PAR are not validated independently and then applied to science; instead, they are validated through practice (Burns, 1996 in Smith, 2012). As such, they may not be generalised but can be adapted to fit the context of its application.

The study also integrated multiple qualitative research methods to explore tacit and explicit knowledge, resulting in narratives that helped in accomplishing the study research objectives. The five explorative questions were interrogated using both primary and secondary data and information collected in this study. The qualitative methods used, such as workshops and interviews, allowed for informal learning for the participants as they reflected and had a greater awareness of how learning takes place in CDM. For me, the study was also a self-directed learning process that was part of my formal learning that would result in an academic qualification but more critically, during this research process, my learning has been enhanced as I reflected on and engaged with the people and the data. The ethical issues, biases and research bottlenecks that I came across are also reflected upon in this chapter.

In the next chapter, the global and national context that influences CCA at the local government level is examined to highlight the contexts in which learning on climate change and CCA are undertaken. This review also illustrates how these policies may anchor, enhance and / or frustrate local municipality learnings and is further informed by the actions in CCA planned for in CDM.

4. Climate Governance Policy Learning and Scene Setting

4.1. Introduction

Since the early 1950s, studies to understand climate change have mostly focused on physical manifestation and its impact on regions such as Africa (Dasgupta, 2014; UN Environment, 2019). The information generated from this research has been used to inform policies and guide country-level responses through publications such as the IPCC reports (Allen *et al.,* 2018, Hoegh-Guldberg *et al.,* 2018). While global research and agreements dictate national climate change responses, sense-making of these concessions within contexts of their application is required for governance actors to operationalise them. The outputs of global research and agreements are presented for domestic operationalisation through different learning systems which actors at local and national level use together with their experiential knowledge for interpretation in adaptation planning and for decision-making purposes (Lave and Wenger, 1991).

Success in the implementation of CCA is, however, limited due to, among other things, the varying understandings that different actors hold. Individual and collective understanding of the climate change phenomenon is socially constructed through a complex interplay of beliefs, values, attitudes, aspirations and behaviours (Hulme, 2009). Actors working on climate change draw information from varying sources, a feature described as bricolage, i.e. "a process through which people, consciously and non-consciously, assemble or reshape institutional arrangements, drawing on whatever materials and resources are available, regardless of their original purpose" (Cleaver and de Koning, 2015:4). Within the context of CCA, sources of information accessible to governance actors include global and national policy reports and research outputs available on online platforms. A review of these materials is critical to understand the information they contain relating to CCA and how it may be accessible to the intended users.

Access to CCA information is linked to learning because it influences how learners relate to learning materials. Four types of learning, i.e. self-directed, non-formal, informal and formal learning, as discussed in Chapter 2, are used in this chapter to examine the typologies of learning fostered by global, national and subnational policies as well as research. After this introduction, the chapter is divided into three sections that focus on, firstly the global policy that influences climate change response in South Africa; secondly, an overview of the national legislative tools and programmes that would ideally inform CCA learning at the local government level; thirdly, a brief synopsis of the provincial and district level climate change-related strategic documents and municipal plans that have been developed to mainstream CCA in CDM. The main finding of this chapter is that most of the global, national and sub-national policy and research outputs on CCA require the learner to take the initiative to access the information. Thus, learning on CCA from these sources requires governance actors to be self-driven.

In this chapter, the climate governance across multiple scales, i.e. global and South African context, is analysed in relation to the study objective on sources of information that support CCA learning at local government level. The actors in various policy contexts and their role in shaping policy at the national and sub-national level outlined include UNFCCC, United Nations Development Programme (UNDP), DEFF, DSI, DALRRD and CSIR. Information used in this chapter was gathered from a review of international, national and subnational climate change related

policy and programme documents as well as inputs from participant interviews who also highlighted examples of the policy documents they use for learning and making decisions on CCA at local government level.

4.2. International climate change governance space

The global climate change discourse has highlighted the physical, social, economic and political issues around climate change and how these would need to be better understood and managed at the local level (IPCC, 2007; Park *et al.,* 2012; Jordan *et al.,* 2018). Policy frameworks that have been developed at a global level to respond to climate change are summarised in Table 4.1, followed by a discussion on some of the challenges that governance actors may experience as they try to access these and learn in local contexts.

The global climate change discourse has been influenced by the UNFCCC ratified in 1992 with subsequent agreements such as the Kyoto Protocol (1997) and Paris Agreement (2015) building onto this. In conjunction with this, the Sendai Framework (2015) has also been established and focuses on disaster risk management as a follow up from the Hyogo Framework for Action (2005), while the SDGs build on the Millennium Development Goals (2000). South Africa has committed to all these global conventions and frameworks. The UNFCCC specifically encourages developed countries to take the lead in reducing greenhouse gas (GHG) emissions as they have contributed more significantly to the emissions. The expectation at the inception of the UNFCCC agreement in 1992 was that by the year 2000, GHG emissions would have been reduced from about 38 billion tonnes recorded in 1990, but the concentrations of GHG such as carbon dioxide continue to rise (IPCC, 2014c; Ritchie and Roser, 2017; Allen *et al.,* 2018).

Subsequent agreements under the UNFCCC have also established goals and rules that member states should meet to reduce GHG and mitigate the impacts of climate change. However, actions taken thus far are not sufficient to reverse or halt climate change (Zangerolame Taroco and Sabbá Colares, 2019). The SDGs, in particular, Goal 13, compel countries to take urgent action to address climate change and its impacts. The SDGs have been criticised though for being too many and too complex with ambitious targets that are focused on short timeframes (i.e. 2015-2030) rather than long-term objectives that would embrace all aspects of sustainable development, including future climate change (Allen *et al.,* 2018). Disasters continue to impact all communities globally, with estimates showing that between 2005 and 2015, more than seven hundred thousand people lost their lives while more than 1.4 million people were injured (UN, 2015). Moreover, about 144 million people were displaced by disasters between 2008 and 2012 and the impacts being more severe amongst women, children and poor communities in developing countries (Ibid).

Table 4. 1: Global conventions influencing climate change adaptation in South Africa and the type of learning required to learn the convention

Convention/Treaty	Description	Type of learning promoted*
United Nations Framework Convention on Climate Change (UNFCCC) (1992)	• It aims to reduce greenhouse gases (GHG) to levels that would *prevent dangerous anthropogenic interference with the climate system* (UN, 1992:4). The framework set non-binding limits for countries that are a party to this convention to reduce GHG but does not enforce these measures.	Decision and policy-makers at sub-national levels, with interest to learn more about the convention, can use self-directed learning and access online on the UNFCCC website https://unfccc.int/process-and-meetings/the-convention/what-is-the-united-nations-framework-convention-on-climate-change
Kyoto Protocol (1997)	• The Kyoto Protocol extends the UNFCCC made it mandatory for developed countries to cut their greenhouse gas emissions while developing countries can voluntarily comply. While the protocol seems biased towards mitigation, it also includes efforts to help countries adapt to the adverse impacts of climate change (UNFCCC, 2019).	Learning about the Kyoto Protocol can be done through self-directed learning on the UNFCCC website at https://unfccc.int/kyoto_protocol
Sendai Framework for Disaster Risk Reduction (2015)	• The Sendai Framework is a non-binding international agreement established to address the multi multiple factors that enhance vulnerability to risks and conflict and seeks to mitigate the existing levels of risks as well as prevent emerging risks. Three main cluster drivers of risk to be addressed are socio-economic factors such as poverty and inequality; political and governance factors at all scales, i.e. local to global to ensure good governance in disaster risk reduction; and environmental factors to improve understanding of hazards and how to prevent, prepare and build resilience (UN, 2015; SSRC, 2017).	The framework can be assessed through self-directed learning on the website of the United Nations Office for Disaster Reduction https://www.undrr.org/
Paris Agreement (2015)	• The agreement seeks to strengthen the global ability to respond to the impacts of climate change by ensuring that the global temperature in this century does not go two degrees Celsius above the pre-industrial levels (UNFCCC, 2016). It also urges parties to persist with measures to limit the temperature increase to 1.5 degrees Celsius (Ibid). • The national or sub-national departments have conducted workshops with local government officials at the sub-national level to deliver and justify the policy preferences adopted by South Africa in line with the Paris Agreement as well as the other agreements discussed above (DEA *et al.,* 2020).	Learners can use self-directed learning to access the Paris Agreement as well as the NDC for South Africa on the UNFCC website https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement / https://www4.unfccc.int/sites/NDCStaging/pages/Party.aspx?party=ZAF
Sustainable Development Goals (SDGs) (2015)	• The 2030 Agenda for Sustainable Development set an international development agenda that calls all countries to coordinate efforts to address key challenges such as poverty, inequality, health, education while also reducing the impacts of climate change (UNDP, 2020).	The SDGs can be accessed online also through self-directed learning on the United Nations Development Programme website https://www.undp.org/content/undp/en/home/sustainable-development-goals.html

*The learning type promoted was derived from information provided by workshop 2 and interview participants on how they learn about these international conventions.

Over and above the information provided in Table 4.1, there are some IPCC specialist reports and summary for policy makers that are developed to provide climate science information based on research by specialists across the globe. The flow of this information to government actors at local government level is done through formal (e.g. short courses and tertiary education), informal (e.g. workshops) and self-directed learning (search on the internet). The IPCC Special Report on 1.5°C (2018) highlights that southern Africa is already experiencing warming that is greater than the global average (Allen *et al.,* 2018, Hoegh-Guldberg *et al.,* 2018). The findings of the report also indicate projected increases in the frequency of droughts and heatwaves towards the end of the century. In addition, the recent IPCC AR6 report (2021) presents the state of science, pathways for adaptation and provides an enormous amount of information that could be useful for policy and decision makers. The conventions, in addition to research by the IPCC, have shaped the global climate change discourse as climate change is presented as a matter of global justice owing to the increasing ecological and social vulnerabilities faced by the global community, especially those in developing regions such as Africa (Doan, 2014). The translation of the IPCC reports for stakeholders at local government level remains limited thus even though there is immense support for global agreements, the responses at the national and sub-national level, however, play out differently as a result of the messy local implementation contexts (Klenk *et al.,* 2017; Mees and Driessen, 2018: Pasquier *et al.,* 2020). Consequently, CCA decision-making is not easy as it takes place in complex environments (Chapter 5); hence global agreements and global recognition of the need for action are often not enough to inspire local action and/or circumvent this messiness.

Given the urgency required to scale up adaptation action, there is a need to optimise the flow of useable information and other resources to support learning and implementation at the local level (UN Climate Change Secretariat, 2018). Local governance actors, for example, can use a combination of learning typologies to learn about CCA, but engagement with the international policy arena is predominantly that of self-directed learning. The majority of the policies (Table 4.1) are available online but require: (i) self-motivated actors/learners, (ii) having access to a computer or smartphone with the internet and (iii) being knowledgeable on how to browse for information (i.e. information systems). In self-directed learning, it is assumed that the learner can comprehend and make sense of the information on their own and relate it to existing information schemes, i.e. cognitive constructivism (Figure 2.3. in Chapter 2). For example, this would require making sense of the Paris Agreement and linking it to IDP priorities. On the contrary, research shows that some of these climate change reports, and related outputs are too technical in terms of the medium of instruction (Timperley, 2015).

It is assumed that when learners in African contexts access websites, they can find the right type of information to inform decision-making for their context and yet this is often not the case. The challenge is also not peculiar to Africa but has also been observed in western countries where despite having Information and Communications Technology (ICT) infrastructure to support self-directed climate change learning, governance actors struggle to get the information they deem relevant (Alexandru *et al.,* 2013; Lorenz *et al.,* 2017). This presents challenges for learners to assimilate (uptake) information, and they tend to focus on areas that they are more skilled at and avoid technical issues in which they are less competent (Murambadoro and Mambo, 2016; Murambadoro and Mambo,

2017a; Kapur, 2018). Furthermore, Thieman (2008) and Kapur (2018) argue that users of internet-based learning systems are prone to distractions (e.g. social media and pop-up adverts) which make it difficult to focus and complete tasks. Learners are required to have the self-discipline to remain focused.

Parallel to this, local officials in South Africa have other service delivery challenges that require their attention that political leaders prioritise (Chapter 5), and there is, in some instances, often little political buy-in for environmental-related issues such as climate change (Pasquini *et al.,* 2015). The trend has also been noted even in larger metros such as Johannesburg and eThekwini, where climate change is not a priority issue for politicians as it is often overshadowed by other factors such as service delivery (Leck and Roberts, 2015; Nana *et al.,* 2019). The current demands from COVID-19 have pushed climate change further down the list, yet these crises can be addressed at the same time (SAIIA, 2020; UNECA, 2020).

With these thoughts in mind, the UNFCCC agreements and Conference of the Parties have recognised the need for international cooperation to support developing countries with resources to adapt to the impacts of climate change and reduce GHG emissions. In the South African context, multilateral development funders such as the GIZ have played a role in supporting national and sub-national departments in responding to climate change through, for example, technical and financial support to conduct vulnerability assessments and develop climate change response plans(DEA *et al.,* 2012; DEA *et al.,* 2020) as discussed later in this chapter and Chapter 6. The reality of having all the necessary learning of the global policy framework through self-directed learning makes this very unlikely in local contexts, given the immediate development pressures requiring some investment into other strategies to support implementation. Andersson and Keskitalo (2018) suggest that adaptation efforts should be constructed through social processes for them to bring about change to the existing institutional and incentive structures to help define actions that also address immediate developmental needs.

Learning can also occur through informal and non-formal learning, whereby the national or sub-national departments can conduct workshops with or without the epistemic community to deliver and justify the policy preferences adopted in line with global policies ratified. How this learning takes place and to what extent local actors are empowered through the learning to take action is variable across the country, with little being known of how this occurs and is aligned to local policies in the relatively smaller metros and municipalities such as CDM. Undoubtedly, some learners will grapple with processing complex ideas, particularly when there are different worldviews on the topic as well as possible contradictions with one's value systems, as these impact how they make sense of the global policies and perceive them fit for domestic purpose(Averchenkova *et al.,* 2019). Be that as it may, global policies also influence national climate change programmes and policies, hence there are actors at the national level who play a key role in empowering decision-makers at the sub-national level to make sense of the global policies for domestic interpretation and implementation.

In the following section, I highlight some of the national policy and legislative environment that guides CCA in South Africa and includes the initiatives to help local government engage with this policy.

4.3. National Climate Change Governance: Legislative and Policy Framework for Adaptation in South Africa

The complexity and cross-cutting nature of climate change is a complex, wicked problem (Rittel and Webber, 1973; Levin *et al.,* 2007; FitzGibbon and Mensah, 2012) that cannot be addressed by a single level of government or sector (DEA, 2011; Arnell *et al.,* 2016). The climate change governance space has evolved from dominance by international actors as local actors are also increasingly influencing National Climate Change Policy. Furthermore, some private and civil society organisations are also shaping their operations as well as services around this (National Business Initiative, 2017; Setzer and Nachmany, 2018). DEFF (formerly DEA) is mandated to lead and coordinate climate change response in South Africa (DEA, 2011). Other sector departments, however, also have a role to play in ensuring their sectors respond to climate change. For example, the Department of Cooperative Governance and Traditional Affairs (CoGTA) supports local governments as part of their mandate, while the Department of Agriculture engages in agriculture-related climate change response initiatives.

One of the key policy documents guiding climate change response in South Africa is the National Climate Change Response Policy (NCCRP). The NCCRP has adopted the principles of cooperative governance and intergovernmental relations to promote coordinated climate change action at all three spheres of government, i.e. national, provincial and local government (DEA, 2011). Further to this, the Durban Climate Change Adaptation Charter for Local Governments adopted at COP17 in Durban in 2011 also commits local governments to mainstream climate change in municipal planning and programmes. Adaptation requires adjustments of vertical and horizontal social, political as well as economic structures and processes to build the resilience of communities (Giordano *et al.,* 2011). Taylor *et al.* (2014:10) note that these structures and processes influence the ability of local government officials to "implement international climate change prescripts and domestically formulated climate change policy".

At a national level, the South African government has committed to responding to climate change and achieving sustainable development. This is well articulated in the National Development Plan, Disaster Management Act, the National Climate Change Policy of 2011 and the recent draft National Climate Change Adaptation Strategy, among other policy documents (DEA, 2019b). Although these commitments are made at a national level, they depend on lower levels of government, private sector and civil society to be realised. Government departments have relied on the epistemic community and intermediaries to support the development of policies, implement programmes and projects aimed at capacity building, providing climate information and awareness-raising at the national and sub-national level, as discussed later in Chapter 6. A few of the national policy documents, programmes and initiatives that currently guide local government CCA in South Africa are presented below to provide the adaptation policy landscape for the country. However, the lack of expertise, financial and human resource capacity hamstrings local and provincial government to respond effectively to this policy landscape. Rural municipalities, for example, make little or no revenue from the provision of basic services such as water and property rates levy; hence, they depend more on national government grants (National Treasury, 2011; StatsSA, 2014; OneWorld *et al.,* 2018).

4.3.1 National Climate Change Response Policy (2011)

The NCCRP highlights the need for the country to have an "effective climate change response and the long-term, just transition to a climate-resilient and lower-carbon economy and society" (DEA, 2011:5). The NCCRP was influenced by, among other factors, the global policies such as the UNFCCC and information from international and national research, e.g. the IPCC Third Assessment Report (Green, 2008; Parliamentary Monitoring Group, 2012). Policy and decision-makers who want to learn about the NCCRP can access it on the DEFF website by following the legislation tab and link to the white papers. Alternatively, learners can use the Google search engine and navigate through the multitudes of results that include electronic copies of the strategy, Microsoft PowerPoint presentations as well as journal articles referencing the strategy.

The policy acknowledges the role of the three spheres of government in climate change response and the need for coordination within and across all sectors. Section 10.2.6 of the policy specifically identifies the key constitutional mandates of local government that are critical in climate response, i.e. planning and urban development; municipal infrastructure and services; water, energy and waste demand management; and local disaster response (DEA, 2011; SALGA, 2015). However, the policy also acknowledges that the mandate for local government on some climate change actions is not always explicit; consequently, all levels of government need to coordinate efforts to ensure effective implementation at the local level.

The NCCRP also highlights the challenges faced by rural settlements, such as the CDM, with regards to climate change which include high vulnerability due to, among other things, high levels of poverty, limited capacity of municipalities to adapt and poor representation in the climate monitoring network (DEA, 2011). The Limpopo Province, for example, is projected to experience more droughts (Hoegh-Guldberg *et al.,* 2018; SAWS, 2019b) affecting the small scale and subsistence farmers who depend on dryland food production. To respond to these challenges, the policy commits to adaptation initiatives such as designing and implementing livelihood diversification programmes to support rural households and building the resilience of the most vulnerable rural communities. Resilience, however, should not be assumed to be the recovery from shocks and bouncing back to the current normal state because for many poor communities, the current state is not viable, and neither is it stable (CARE International, 2016). In South Africa, a significant proportion of the rural settlements include former homelands that have never been stable as the areas are densely populated, agricultural productivity is poor, and there is a high dependence on social welfare and urban remittances (DEA, 2011; National Development Agency, 2014; David *et al.,* 2018). There is also an increase in unplanned rural settlements that are dispersed, and the cost of extending basic and social services to these areas to make them more accessible is astronomical, especially where there is poor road access (DEA, 2016a). Therefore, adaptation efforts in rural areas also need to ensure that the communities are integrated into municipal planning and decision-making so that their needs and aspirations are not left out and/or left behind.

While the NCCRP has been commended for being a solid policy to guide the country's climate change response actions, its implementation has been slow because of limited capacity by key actors. The NCCRP, for example,

required that by October 2013, all government departments should have reviewed their policies, strategies, legislation, regulations and plans to fully align with the policy. However, the policy does not specify this as a requirement for local governments; hence it has resulted in this activity falling off the radar in most municipalities. The ministerial political (MINMEC) and technical (MINTECH) have also been set up to support coordination across all spheres of government. These structures operate at a high level and have been criticised for failing to effectively influence coordination at lower levels of government (DEA, 2011b). The policy has also faced resistance from actors who are responsible for emitting the most greenhouse gases in South Africa (e.g. members of Business Unity South Africa a coalition of private sector organisations), and this is because there is no legal enforcement (Fakir and Upadhyaya, 2018; Averchenkova *et al.,* 2019). Policies are however not meant to be legally enforced but form a basis for bills and acts that are the legal instruments that are enforceable. As such, some of the current shortfalls can be addressed in the upcoming Climate Change Bill that includes specific directives for local governments to bind both the public and private sector to comply.

4.3.2 Climate Change Bill (2018)

Another key policy informing climate change response in South Africa is the Climate Change Bill which was published by DEFF for public comment in 2018. The Bill was developed with technical and financial support from GIZ for public consultation across the country (GIZ, 2020). Climate Legal was the consultant appointed to support DEFF in developing the Bill. Stakeholder engagement workshops in Limpopo were organised through LEDET and were facilitated by the consultancy company in July 2018 (DEA, 2019a). The Bill seeks to "build South Africa's effective climate change response and the long term, just transition to a climate-resilient and lower carbon economy and society in the context of an environmentally sustainable development framework; and to provide for matters connected therewith" (DEA, 2018a:2). It is divided into four broad areas: (i) policy alignment and institutional arrangements, (ii) responses by provinces and municipalities, (iii) national adaptation strategy, and (iv) the management and curbing of greenhouse emissions.

The Bill has been developed to strengthen legal enforcement and implementation of the NCCRP whilst also helping the country to meet its ambitious commitments made at the Paris Agreement as well as the NDCs. Of importance to this study are Chapters 2, 3 and 4 of the Bill that address policy alignment and institutional arrangements, provincial and municipalities responses and the national adaptation strategy as discussed below. Chapter 2 of the Bill calls for the alignment of laws and policies at all spheres of government to support the transition to a climate-resilient and lower carbon economy and society. Further to this, it also promotes the vertical and horizontal coordination between government departments through the development of a Ministerial and Provincial Committee on Climate Change to coordinate efforts under the NCCRP and the NDCs. Provincial committees need to provide progress reports to the Ministerial Committee and share lessons learnt across and within government departments. Monitoring and reporting on progress could link to the last phase of the adaptation action cycle on MEL (section 2.3.3). However, this coordination has been lacking to date and has resulted in challenges with the design, development, implementation and monitoring of CCA initiatives at the provincial and local government level.

Chapter 3 of the Bill focuses on climate response by provinces and municipalities. It requires that the Member of the Executive Council (MEC) for the environment in every province or mayor of a municipality should undertake a climate change needs assessment for their province or municipality within one year of the passing of the act. Added to this, they should develop climate change response implementation plans within two years of the passing of the Bill and review these plans every five years (DEA, 2018a). While this may address the current organisational gaps in terms of a lack of political leadership to champion CCA at the municipal level, what is still not clear is the support that would be offered to municipalities to achieve this.

Chapter 4 focuses on the development of the national adaptation strategy, which has already been approved and is discussed further in the next section. The chapter adds value to the NCCRP as it mandates the development of national adaptation objectives that would guide the country's adaptation actions. Adaptation actions have to date been done haphazardly with no common objective or indicators to monitor the progress that would link to the MEL phase in the adaptation action cycle (Ziervogel *et al*, 2014; Averchenkova *et al.,* 2019). At the time of submitting this thesis, the Bill was yet to be approved and adopted. Nevertheless, time will tell how well the Bill will address some of the current gaps, which include poor coordination between municipal sector departments and *ad hoc* implementation of climate change initiatives to support the country to meet its climate change response goals (Averchenkova *et al.,* 2019; Le Roux, 2021). Learners can access the Bill on the DEFF website under the legislation tab and then follow the link to various bills. The self-directed learning process of following tabs and links on departmental websites may not be easy for some learners hence other platforms such as departmental workshops can support government actors with learning about the Bill.

4.3.3 National Climate Change Adaptation Strategy (2020)

In addition to the above, South Africa has also developed the National Climate Change Adaptation Strategy (NCCAS) which was approved on 18 August 2020. The strategy was developed with support from GIZ with technical support from a consultant (i.e. Pegasys, a private sector climate specialist consultancy). The NCCAS presents a shared vision for the country to reduce greenhouse gas emissions and minimise average global temperature increase to 1.5°C whilst also building the resilience of the country to projected changes in climate through priority areas (DEA, 2019b, c). The strategy provides a common reference point for adaptation that has long been missing. To address this gap, the strategy recognises that climate change is one of the biggest threats to achieving the national development goals articulated in the National Development Plan as well as the internationally agreed SDGs. The National Development Plan's chapter 5 focuses on climate action, however implementation of the plan has been fragmented and ineffective as key issues such as poverty, unemployment and inequality persist. The COVID-19 pandemic will no doubt also slow implementation as the focus shifts to the wellbeing of all citizens across the country and the province, the renewal of a paralysed economy etc., eclipsing immediate climate change needs.

Governance actors who are motivated to learn about the strategy can find it online (self-directed learning). When I visited the DEFF website, it was not easy to find the document using the documents and legislation tabs on the

departmental website, and I had to use the search option on the website to find the strategy which is embedded in the media article *South Africa's National Climate Change Adaptation Strategy approved* (Figure 4.1). When using the Google search engine to find the *National Climate Change Adaptation Strategy,* the results include several other unrelated documents, and a learner also has to choose between the several versions of the strategy available, e.g. an October 2017 version (DEA, 2017); October 2018 version (DEA, 2018), May 2019 version (DEA, 2019b); and final version November 2019 version (DEA, 2019c). The learner maybe unaware of the differences between the versions, and there is no immediate support available to guide the naïve learner.

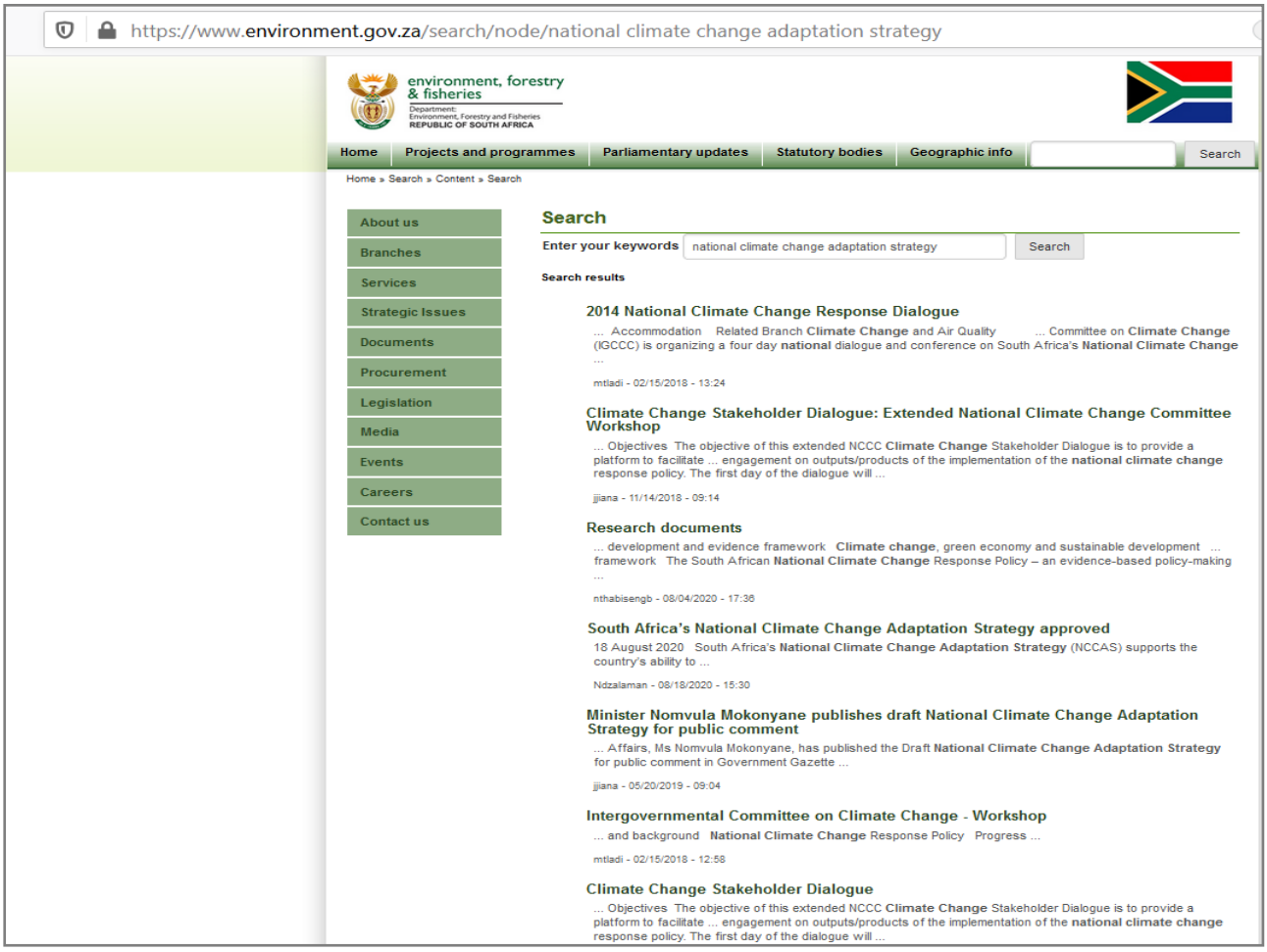


Figure 4. 1: Search results for the National Climate Change Adaptation Strategy on the DEFF website (Source: DEFF, 2020)

The success of this strategy depends on, among other things, the ability of governance actors to be self-driven individual and collective learners who can engage in learning initiatives to ensure they understand and play their role effectively. More so, it depends on the availability of adequate funding to implement actions, increased capacity of actors such as local governments to ensure proper and efficient climate action and ensuring other policies do not undermine the strategy (Citizens Report, 2019). The National Treasury budget for Climate Change Management, Air Quality and Sustainable Development for the 2019 financial year was set at R450 million, but 77% of this budget was allocated to the South African Weather Service (SAWS) and Sustainable Development sub-programmes (National Treasury, 2019). The SAWS receive a considerable component of the budget because

it is the custodian of weather and climate information in South Africa as stipulated in the SAWS Act (Act No. 8 of 2001), as amended through the SAWS Amendment Act (Act No. 48 of 2013).

Only 33% of the reserved funds are allocated for climate change-related sub-programmes, and this is not sufficient to meet the needs across the sectors at various scales. Added to this, the focus is on mitigation rather than adaptation for example, energy efficiency with an estimated R200billion having been invested between 2011-2018 (Ebrahim, 2018). There are calls to leverage the private sector for additional investment in adaptation (DEA, 2018b; Ebrahim, 2018). Further to this, environmental stewardship projects are often taken as once-off projects that are not aligned with corporate strategy; hence financial gain is prioritised over voluntary climate change actions (Shu and Schroeder, 2010).

Policies such as the draft Integrated Resource Plan published in (Department of Energy, 2018) may also undermine adaptation efforts as it illustrates the government's reluctance to move away from coal-powered energy, which is one of the country's main contributors to greenhouse gas emissions (Citizens Report, 2019). Adaptation action at the local government level is inconsistent because most municipalities are under-resourced and lack the necessary skills to integrate climate action into development planning. It is anticipated that the strategy will ensure that sufficient resources are channelled through to support those municipalities that are behind and ensure their adaptation action ground is levelled (Chersich and Wright, 2019). Further to the policies above, several other national policies could influence local government adaptation activities. A sample of these is provided in Appendix 11.

As shown above most of the international conventions and national policies maybe learnt through self-directed learning however, participants indicated that there are other social learning initiatives at district and provincial level e.g. forums and networks are used to support knowledge sharing on these policies (see section 6.3.1). These initiatives enable collective learning, but the learner does not always have control of the content that is shared and may have to make requests for specific information to be shared or discussed in detail. This then requires the learner to be self-driven to identify their knowledge gaps and have the confidence to ask for help from internal and external actors.

4.4. National Actors, Programmes and other Initiatives Supporting Adaptation in South Africa

At the national level, several programmes and projects have been initiated by national departments as well as research institutions to support local government climate change responses. Such programmes have focussed on the provision of local climate change information, awareness-raising and capacity building, as well as the development of climate change response plans (Table 4.2). Even though non-governmental actors are involved in CCA programmes, this study primarily focused on the public sector hence examples provided here are of programmes and actors from government. Of interest to this study is the content and learning that is supported in each of these programmes and initiatives, i.e. *what is learnt* and learn how it is learnt?

Table 4. 2: Sample of national programmes and other initiatives that support CCA learning at local government level

Programme or initiative	Objectives
South African Risk and Vulnerability Atlas (SARVA) Department of Science and Innovation (DSI)	SARVA was developed under the Global Chance Grand Challenge Programme that is part of the DSI Ten-Year Innovation Plan (2008-2018) that seeks to improve scientific understanding of global environmental change. The risk and vulnerability datasets are aimed at providing climate change information that can be used for planning and decision-making. The main objectives of the Atlas were to firstly improve scientific understanding of global change in South Africa and the region; secondly, equip decision-makers with information on the impact and risks associated with global change; and lastly, provide easily understood global change sensitivity and vulnerability information at regional, national, provincial and municipal levels (DST, 2010)
Risk and Vulnerability Science Centres (RVSC) Department of Science and Innovation (DSI)	The RVSC were established at three previously disadvantaged universities, i.e. the University of Fort Hare, Walter Sisulu University and the University of Limpopo. The science centre's support students with formal qualifications whilst also building their capacity to conduct local-level research and production of transdisciplinary information for the key sectors that would be disseminated on the SARVA portal. The science centres also provide local government support by playing a key role in the science-policy interface as well as assist in the interpretation of data in the South African Risk and Vulnerability Atlas to the local government and communities. Besides, they also seek to establish local and international collaborations with other universities and research institutions to build the capacity of students, local government and communities in climate change (Personal Communication with Key Informants at Science Centres at University of Limpopo, University of Fort Hare and Walter Sisulu University (2016); Mambo and Murambadoro, 2017)
Let's Respond Toolkit and Local Government Climate Change Support Programme (LGCCSP) DEFF, CoGTA, SALGA & GIZ	The DEFF established the LGCCSP in partnership with the GIZ to build the capacity of local governments to identify their key climate risks and develop context-specific responses that will be mainstreamed into IDPs using tools such as the Let's Respond Toolkit. The Let's Respond Toolkit was developed to introduce municipalities to climate change and assist in integrating climate change response into municipal planning and is available as a hard copy or online. Additionally, the LGCCSP has developed the vulnerability assessment to provide a step by step guide for local governments to conduct climate change vulnerability assessments and Climate Change Response Plan templates (DEA *et al.,* 2012; DEA *et al.,* 2020)
Long-Term Adaptation Scenarios Flagship Programme (LTAS) DEFF, GIZ	The Long-Term Adaptation Scenarios Flagship Programme was developed by the DEFF as one of the initiatives to foster from the NCCRP Paragraph 8.8 by providing adaptation scenarios for the country. The programme collated some of the key findings in reports to inform policy from climate science in terms of trends, projections under four possible futures of Hot-Dry, Hot-Wet, Warm-Dry and Warm-Wet. Further to this, the LTAS also highlights the impacts on key primary sectors such as agriculture, health, forestry, water and biodiversity and suggests possible ways, which the primary sectors could adapt (DEA, 2013a, b, c)
Climate Change Adaptation Training Programme (CCATP) Department of Rural Development and Land Reform (DRDLR)	An initiative by the DRDLR (now DALRRD) to train local government officials in rural municipalities on the theory and practice of CCA (DRDLR, 2017)
The Green Book Council for Scientific and Industrial Research (CSIR), the National Disaster Management Centre	The Green Book provides downscaled climate change projections, trends and adaptation strategies currently used in the country and elsewhere that could build the resilience of human settlements in the 205 local municipalities (CSIR, 2017). The book has three main components, i.e. firstly, a series of interactive national story maps which a user can browse to learn more about the research methodology, key findings, recommendations as well as technical and interactive datasets; secondly, it provides an interactive risk profile tool shows the socio-economic profiles of municipalities with respect to vulnerabilities, demographic projections, exposure to hazards and the impacts on some of the key resources. This analysis provides a basis for the adaptation process to be grounded with scientific evidence on the projected risks faced by each municipality under climate change scenarios by 2050; and lastly, the book has an Adaptation Actions Tool which is an interactive platform where users can access information to support adaptation planning (NDMC, 2019)

Hence the discussion following Table 4.2. examines in detail the programmes and initiatives by the different actors supporting CCA learning who are operating at the national level that are also part of the CCA polycentric governance network.

4.4.1. Department of Environmental Affairs, Forestry and Fisheries

DEFF, as the department mandated to lead and coordinate climate change and climate change response in the country (DEA, 2011), is playing a leading role in developing programmes and projects to support CCA at the sub-national level. DEFF established the Local Government Climate Change Support Programme (LGCCSP) in partnership with the GIZ to provide municipalities with technical support and guidance on CCA, and CDM was one of the municipalities supported since 2014 (DEA, 2015). The programme was also supported by Urban Earth (i.e. a private sector climate change and sustainability consultancy) to provide local governments with training workshops on behalf of DEFF, which promoted non-formal learning (Urban Earth, 2020). Under this programme, DEFF has collaborated with other national departments, multilateral institutions (e.g. GIZ, UNDP) and research institutions (e.g. SANBI), who are part of the CCA polycentric governance network to support municipalities with information, technical support as well as capacity building. In 2011, the DEFF partnered with the Department of CoGTA, the SALGA, and with funding from the GIZ, developed the Let's Respond Toolkit (Table 4.4).

A team of consultants from Sustainable Energy Africa and Palmer Development Group were contracted to provide technical assistance, including training of local government officials and developing the toolkit incorporating feedback provided by officials from the pilot workshops, a process that also facilitated non-formal learning (DEA *et al.,* 2012; SEA, 2020). The toolkit provides a series of practical steps that align with the IDP process and is informed by climate information from research (e.g. SARVA). Externally driven initiatives such as the LGCCSP and the Let's Respond Toolkit are often criticised for failing to provide learners with information to meet their developmental needs; hence the information provided is not fit for the context of the application (Dunlop, 2009). Other products developed from this initiative include a website with project tools and maps as well as a Vulnerability Assessment Tool that assists governance actors with the first phase of the adaptation action cycle. The Vulnerability Assessment Tool has information on how to conduct a risk and vulnerability assessment, and governance actors' access this through the Let's Respond Toolkit website (DEA *et al.,* 2020). Besides this, the DEFF also provides support to district municipalities with an Assistant Director who provides peer to peer learning through technical support to ease the integration of the DEFF mandate (e.g. air quality management and climate change) into municipal operations (Participant 16, 2018).

Some of the participants I interviewed shared that, although CDM organises forums and workshops with external stakeholders to support the uptake of the Toolkit, few officials attend. Moreover, some of the governance actors who attend the workshops and forums do not actively participate in the learning event as they would have attended in compliance with a directive from their superior (Participant 4, 2017; Participant 8, 2017). In tandem with this, applying the learning gathered in the training workshops and peers from DEFF has been a difficult process for governance actors who struggle to effectively integrate the toolkit as a result of the perceived different temporal

scales of planning for adaptation *vis à vis* municipal planning cycles. Climate change response requires a combination of both short-term interventions and long-term investments which go beyond the five-year election and IDP cycle. The co-benefits of CCA, therefore, need to be well articulated to encourage integration into short term planning by addressing pressing issues such as poverty and unemployment (Beylanda *et al.,* 2018).

Long-term planning is also currently hindered by the Municipal Finance Management Act as it prohibits municipalities from having public contracts of more than three years. However, there are certain exceptions, which many municipal financial officials are not too keen to delve into and get approval from National Treasury as this process is cumbersome (Participant 8, 2017; Participant 18, 2018). Owing to this, governance actors neglect such initiatives because it is also not a key performance area, and they focus more on what they are assessed on (Participant 18, 2018). Efforts are being made by the National Treasury to assist officials in orbiting through these issues to improve long term climate change planning. Lastly, other entry points for mainstreaming climate change into municipal operations need to be explored. These include examining the potential to use the municipal development finances, e.g. Intergovernmental Grant System, to fund long term projects. Municipalities are acquainted with this system and currently use it to apply for municipal infrastructure development grants and neighbourhood development partnership grants, for example, to develop a mixed-use town centre (National Treasury, 2008). CCA responses can be integrated into these infrastructure and neighbourhood development projects, and treasury could add climate change as one of the key performance areas in these projects as an incentive for local actors to act.

In addition to the Let's Respond Toolkit above, DEFF has also developed the Long-Term Adaptation Scenarios Flagship Programme in partnership with the GIZ and SANBI (DEA, 2017). The reports from the LTAS programme can be accessed on the DEFF website and in hard copies, however as mentioned earlier, self-driven learning requires the learner to take the initiative to access and use these sources of information to meet individual learning goals. At the same time, the LTAS reports provide sector-based additional information on climate change under different climate futures and possible adaptation strategies that could be adopted at the municipal level. The reports have, however, been criticised for failing to integrate the social, political and economic factors that mould the context in which adaptation takes place (Ziervogel *et al.,* 2014). Transformative adaptation, for example, requires changes to occur in the social, economic and political systems to facilitate effective long-term adaptation approaches, yet the reports have still not been able to provide guidance on the institutional structure that would sustain adaptation in the local government context. Consequently, climate change and CCA remain a marginal issue, which requires administrative and political champions to facilitate its mainstreaming into all sector departments (Participant 1, 2017; Participant 5; 2017; Participant 24, 2018).

4.4.2. Department of Science and Innovation

Another national department that has been supporting local governments with CCA is the DSI (former Department of Science and Technology) through the Global Change Grand Challenge Programme (GCGC). The SARVA and Risk and Vulnerability Science Centres (RVSC) (done in partnership with the National Research Foundation (NRF))

are two key projects under the GCGC that target local governments. The Council for Scientific and Industrial Research (CSIR) was contracted as the implementing agent for this project between 2009-2018 and was responsible for stakeholder outreach and capacity building workshops promoting non-formal learning. The CSIR worked in partnership with the South African Earth Observation Network (SAEON) and was responsible for developing and managing the web-based electronic spatial database.

The Atlas project was implemented in phases from 2010. The first phase of SARVA produced the architecture and infrastructure of an online platform based on electronic spatial and non-spatial data. The information on the portal was organised in themes such as agriculture, biodiversity, forestry, weather and climate, mostly at a provincial level. The second phase focused on, among other things, the development, population and outreach of the Atlas through workshops where I was directly involved in stakeholder outreach activities to introduce local government officials to the hardcopy and online Atlas portal through workshops however officials from CDM did not provide any inputs into the information on the portal which was based on science from scientific and academic institutions. The third phase of the Atlas is focusing on developing improved theme-based atlases, indicator datasets, decision support tools, response tools and system dynamics extensions for computing complex interactions between variables (SAEON, 2019). Presentations from SAEON on SARVA are currently shared with local governments as part of the National Framework for Climate Services (NFCS), a collaborative project between the DEFF and the SAWS where learners at local government learn through non-formal learning. The NFCS seeks to improve the development and integration of science-based climate information and projections into planning, policy and practice.

From these two phases that I participated in and the current third phase, the Atlas has connected to a wide range of stakeholders through its thousands of freely available global change data resources, workshops and business breakfasts where both self-directed and informal learning plays a key role in supporting learning (Mambo and Murambadoro, 2017b). It was anticipated that stakeholders who attended the workshops or received a copy of the Atlas as well as the link to the online portal, would start using the information in the Atlas for planning and decision-making. The Atlas is proposed to be one of the best and most practical ways to bridge the divide between scientists and policy/decision-makers by providing global change sensitivity and vulnerability information at regional, national, provincial and municipal levels. Ambitious targets were set for the Atlas, and of importance to this study is the one on ensuring 75% of municipalities use SARVA information for planning and decision-making at the end of the ten years (DST, 2009). However, its target users from local government failed to fully use this information, including through self-directed learning and informal and non-formal learning types, for various reasons.

Although this has yet to be rigorously interrogated, possible reasons for the failure of uptake include scaling issues and the fact that this information is at the national or provincial level and cannot be applied at the local level with certainty. Secondly, such products have tended to be conceived and produced in the traditional way of producing knowledge (e.g. Mode 1; Gibbons *et al.,* 1994) that uses a linear science production model (science transfer to the user) rather than the Mode 2, where users at the local government are part of and engaged in the knowledge production process. In Mode 2, knowledge production users of the information help to define the problem

statement, objectives and outcomes. However, the GCGC Programme, in general, has been criticised for failing to allow for the co-production of knowledge by the users to address a real-world and complex problem (Swilling, 2014).

As a result, many research institutions and scientists were not involved, and there was limited involvement of the policy community while civil society and the private sector were completely left out (Swilling, 2014). Most of the information produced in the Atlas has been developed without a full understanding of the users of the information, hence its uptake has been poor. Such efforts to enhance learning and understanding of complex problems such as climate change among government officials, if not well administered, can result in fear amongst the learners who may not want to experiment with things they do not fully understand (Murambadoro and Mambo, 2017a,b).

In addition to the Atlas, the DSI and the NRF have also established three climate change science centres at three previously disadvantaged universities. Of importance in this study is the climate change science centre at the University of Limpopo as it is in the CDM. Research at the University of Limpopo based science centre is conducted as part of formal postgraduate degree programmes as well as through collaborations with other research and academic institutions such as the University of Nagasaki, University of Gottingen and the World Agroforestry Centre (Personal communication with academic at the University of Limpopo, 2016; 2018). The science centre, on request, also offers short courses to local government officials in climate change. A significant amount of research has been conducted at the science centre on new crop varieties for small holder farmers, climate-smart irrigation, waste minimisation and human health and has resulted in student theses and scientific publications which local government officials can access(for examples see Kephe *et al.,* 2021; Ayisi *et al.,* 2018).

Research performed by the university is focused on agriculture, yet climate change affects a wide range of sectors that also need attention to support municipal operations; hence officials from other sectors currently perceived them to be a minor actor in learning. Little to none of the research done by the science centre has been channelled into the SARVA, hence the gap in accessing local-level information persists. Further to this, there is a need to strengthen the relationship between the local government in Capricorn District (as well as the province) and the science centre so that the research that is conducted by the science centre is co-generated with local government actors to address their knowledge gaps (Mambo and Murambadoro, 2017b). Given the challenges with learning through self-directed learning and limited internet coverage in the district and the province (Chapter 5 section 5.2.5), there is the need to consider other mechanisms to support learning and dissemination of this research other than searching for it online and assuming an automatic transmission of theses and academic publications to end-users.

4.4.3. Department of Agriculture, Land Reform and Rural Development

In parallel with the programmes above, the Department of Rural Development and Land Reform (DRDLR), before its merger with the Department of Agriculture Forestry and Fisheries in 2019, developed the Climate Change Adaptation Training Programme specifically targeted at capacity building of governance actors in rural municipalities on the theory and practice of CCA. The training programme was an externally driven initiative that

was also facilitated by Urban Earth in 2017, who, on behalf of DRDLR, developed a training manual as well as an interactive website and videos (Urban Earth, 2020). Attendance at these workshops was poor, resulting from a lack of political support within the municipal structures and participation fatigue (Participant 17, 2018). As can be seen from the programmes presented thus far and those below, several national departments, scientific institutions and provincial departments were running parallel climate change initiatives between 2016-2017, which could have resulted in information overload and fatigue, hence poor attendance in some events.

Beyond this initial training by the external service provider, learners can read the study guide on how to mainstream CCA into rural settlements as well as watch illustrative videos demonstrating how to develop a CCA plan by using the online interactive learning aid which officials can access on http://www.climatechangetraining.org (DRDLR, 2019). Alongside this, the CCATP also includes self-tests for learners to test their knowledge after completing a set of lessons and provides learners with links to other sources of climate change information such as the Let's Respond Toolkit, Paris Agreement and SAWS(Ibid). This learning system provides users with some of the essential information needed to support adaptation in rural settlements. However, like other web-based products, the learner needs to have internet access to engage with the learning programme. A significant proportion of rural municipalities in South Africa, including Limpopo, do not have access to computers and reliable internet to access such learning systems, hence do not benefit from such well-intended initiatives (Sartorius and Sartorius, 2015; CDM, 2019a). There is need, therefore, to look at other learning systems that can be used to share this knowledge with rural municipalities so that they do not get left behind.

Meanwhile, the former Department of Agriculture Forestry and Fisheries had several programmes such as LandCare that was introduced in 1997 to support the sector in implementing CCA at the local level. LandCare, for example, is a community-based programme that focuses on addressing land degradation, sustainable use of natural resources leading to greater productivity, job opportunities and food security (DAFF, 2016). Through the programme, the provincial departments provide capacity building initiatives and implement sustainable land management projects, including removal of alien plants, rehabilitation of degraded land and promotion of conservation agriculture. Although the programme has been able to make significant contributions to CCA through community-driven management, learning has been constrained by cases where the initiatives fail to integrate the community needs as well as coordinate with other sector departments at district and local government level, which affect the long term sustainability of projects (Brent and Mulder, 2005; Termeer *et al.,* 2018).

4.4.4. Council for Scientific and Industrial Research and National Disaster Management Centre

One of the most recent initiatives developed to support decision-makers, such as local government officials with CCA, is the Green Book. This is a collaborative initiative by the CSIR and the National Disaster Management Centre with co-funding from the Canadian International Development Research Centre that was launched in 2019. The Green Book was also developed with inputs from an interdisciplinary process that embraced inputs from more than 50 researchers from demography, climatology, disaster risk science, economics, anthropology, hydrology and

many others (CSIR, 2019). Dissemination of the information in the Green Book is being done through avenues such as the NFCS workshops, where I managed to participate as a presenter sharing information on behalf of the SAWS. The SAWS is a partner in the NFCS and supports DEFF with facilitating the workshops; hence I was able to use the engagements as a platform to gather feedback from local government officials on how initiatives such as the Green Book can support their learning. Learners can access it on the Green Book website as well as through the DEFF National Climate Change Information System portal. Information in the book is at a local municipal level and allows district officials to have an overview of the local municipalities in their district, which is an improvement from information initially provided through SARVA. However, this was raised as a shortcoming during the NFCS workshops by district officials who felt that the tool should provide them with district-level information before disintegrating it into local municipal level because they operate at different levels and have varying mandates (SAWS, 2019). Like the other sources, the book is also internet-based; hence participants criticised it for being inaccessible. Participants in the NFCS workshops have also highlighted the need for this material to be shared using varying local languages other than English and for the updated versions of the book to integrate indigenous knowledge, which is currently missing (Ibid).

4.5. Maximising opportunities to strengthen the role of policies and programmes to support learning at local government level

From the brief analysis of the plethora of policies, programmes and other initiatives presented above, one can assume that most of the learning promoted will be self-directed and non-formal learning. The RVSCs, however, are one of the initiatives that can offer learners with multiple learning types, including formal learning. Formal learning, when used in this instance, can provide learners with the theoretical framing of the policies developed at multiple scales. Theoretical knowledge on its own is also not adequate to support everyday municipal activities without practice, reflection and correction of error, i.e. learning by doing.

The actors at the national level have also promoted non-formal learning by incorporating the services of scientists and consultants to support their programme objectives which include training of officials at local government level. The scientists and consultants bring with them a wealth of climate information and tools, some of which are derived from global research to support learners at the local government level to update their knowledge and skills. The decolonial lens, as it applies to knowledge and learning, has, however, criticised this knowledge production process, firstly because dominant learning systems and knowledge (i.e. codified knowledge) are amplified to the detriment of other learning systems and knowledge types (i.e. indigenous and experiential knowledge), hence the need for decoloniality (Ndlovu-Gatsheni, 2013; Heleta, 2016). Secondly, decolonial scholars argue that information needs to be communicated in a language that does not promote professional or social exclusion for non-academic learners as African knowledge and languages are often side-lined in knowledge production and dissemination (Popa, 2011; Ndlovu-Gatsheni, 2013). Some learners may struggle to learn from differently situated and experienced others who have a limited understanding of the complex planning and decision-making environment, culture and language of the learners which they are trying to influence (Doan, 2014). Collective learning and action

are therefore more impactful when done in an environment that is flexible enough to allow for collaboration with other social actors and knowledge types to enhance the skills, capacities and resources required to be innovative and experiment with CCA (Doan, 2014; Menelisi *et al.,* 2020; Pereira *et al.,* 2020).

Besides this, non-formal learning requires learners to be motivated to participate, and this is also influenced by learners' perceptions of the value or usefulness of the learning event and the level of trust with the organisation that organises or facilitates the learning event (Popa, 2011). More worrisome still is the concern that in non-formal learning, the content is designed by an external stakeholder, i.e. scientist/consultant with inputs from the contracting parties, for example, DEFF or DSI. Learners have little or no contribution in designing the learning objectives, hence have no sense of ownership. Most of these externally driven learning events, such as the NFCS workshops are determined by political commitment and availability of resources to sustain them otherwise they become once-off activities. It is critical for learning initiatives to be sustained in the future as CCA requires governance actors to continuously learn and adjust their knowledge and skills to respond effectively. Informal and non-formal learning, therefore, need to create opportunities for governance actors to collectively design policy actions that suit their context and share practical implications of the policy or programme based on their experience and needs.

Added to this, learning of policies and programmes have also promoted self-directed learning where it is assumed that learners can take charge of the learning process and determine their own learning goals and objective as well as decide what information is useful and meaningful to learn. As highlighted above, an inexperienced learner may struggle to navigate through all the information, hence there is a need to look at other pathways to support learning for local government officials, especially those in predominantly rural municipalities who do not always have access to global literature or websites and yet also need to start implementing CCA actions. Social learning (Chapter 2) is one of the approaches that can be used to address some of these challenges and support learners with sustained science-policy-practice interactions (Lotz-Sisitka and Kronlid, 2009; Cundill *et al.,* 2014; Pelling *et al.,* 2015; Vincent *et al.,* 2018; Menelisi *et al.,* 2020).

4.6. Learning through strategic documents and integration of CCA into CDM planning documents

Climate change and CCA are cross-sectoral issues that can impact the implementation of public policies that address issues such as environmental management, service delivery and economic development. As such, it should also be mainstreamed by local governments into their sector plans as well as the IDP. The sections above have highlighted a wide range of global and national CCA policies and programmes that influence provincial and local government climate change actions in Limpopo. In this final section of this chapter, I review the provincial and district level policies and plans that were developed in response to global and national climate change imperatives to understand how well governance actors in Limpopo and CDM specifically make sense of and enact CCA. Specific climate change response related projects as well as other initiatives implemented in CDM are presented in Chapter 7 and are linked to some of the policies highlighted in this section.

A comprehensive MEL assessment for the case study municipality is not undertaken because the climate change response strategy for the municipality which could be used as a baseline to assess progress made towards achieving the adaptation outcomes is yet to be finalised and adopted. As such, adaptation actions currently being undertaken are generally *ad hoc* and are continually shifting in response to emergencies or influence of external actors, making it difficult to establish the appropriate objectives and measures. As a result of this, the study focuses on the climate change-related policies that have been developed to support CCA in CDM and highlight some of the adaptation-related initiatives implemented in CDM between the period 2013-2019. This was done by reviewing the municipal IDP, annual budgets for this study period as well as a subjective assessment of information from interviews with local government officials who make decisions on climate change initiatives at the district level that will be thematically analysed. More so, the assessment was conducted together with the learner to establish their ability to conceptualise key climate change concepts shared within the different learning initiatives and how they enact them in their municipal operations. Thus, evaluation in the adaption cycle as it pertains to this study is two-pronged; (i) it looks at how the learning tools are accessed and used for learning (i.e. sources of information), and (ii) how learners make sense of CCA content.

In 2013, the LEDET Environmental Research and Planning sub-directorate developed the Green Economy Strategy for the Limpopo Province (LEDET, 2013). The strategy was anticipated to augment the implementation of the Limpopo Employment Growth and Development Plan (2009-2014). It also included the first version of the provincial climate change response strategy, which was later updated in 2016. Ultimately, the Green Economy Strategy has been influenced by national policies such as the NCCRP (2011), Green Economy Accord (2011), as well as principles and guidelines by international organisations such as the United Nations Environment Programme (UNEP). The motivation for the green economy includes the need to protect the environment while meeting the basic needs and reducing the vulnerability of the economy to extreme weather events resulting from climate change (Ibid). When I searched for the provinces' Green Economy Strategy, I could download it from the search results that provided a link to the DEFF website, while a search on the LEDET website yielded no results. Despite this, the goals identified under the green economy key focus areas for Limpopo which also contribute towards CCA include water management, resource conservation, green buildings and sustainable agriculture production (Ibid).

A review on how well the green economy has been adopted in Limpopo provided by the Human Science Research Council (2014) indicates that there is a general awareness of the concept amongst the provincial, district and local municipal officials in the province. However, some challenges constrain the implementation of green economy initiatives, including lack of information on what constitutes a green economic activity or green decent jobs, limited expertise and skills to operationalise the strategy for example in wastewater treatment, no capacity building initiatives (through formal, non-formal and informal learning) to build the skills required by local actors and lack of funds to implement the identified activities (Nhemachena *et al.,* 2015; Aoyi *et al.,* 2016). During the interviews, one official expressed that:

'*When it comes to topical issues such as climate change or transitioning to a green economy, there is more interest at provincial and district level than at the local municipal level. LEDET is pioneering some work on these key issues as a directive from the political leaders ….most of these documents are done for compliance with national government requirements …'* (Participant 1, 2017).

The remark by Participant 1 highlights perceptions on the objective of the strategy, i.e. to meet expectations of a broader social system - a trend that has been noted in subsequent documents reviewed below. The implementation of strategies, however, depends on the municipality and its actors, also referred to by Bourdieu (1990) as the habitus (see my discussion in Chapter 1). Drawing on institutional theory, one can deduce that, as organisations such as municipalities implement sustainable development initiatives, they will encounter some challenges in the habitus, which they should overcome. These challenges include path dependence, i.e. the influence of history on the current status of the municipality, fit between policy imperatives and local needs, impacts of national and regional regulations at the local level (i.e. issues of scale). Additionally, organisations also must address issues that arise from the interplay of interactions between actors at the sub-national and national level who have different interests and mandates (Bernt and Görg, 2008; Borsdorf *et al.,* 2014). The response by Participant 1 above reflects on challenges with institutional fit as there is incongruence between national and sub-national priorities. More so, no funding has been provided for catalytic high impact projects at a local level to demonstrate the potential of a green economy in creating decent jobs, reducing poverty as well as how this contributes to climate change response, i.e. move from theory to practice (AFRICEGE, 2015; Nhemachena *et al.,* 2015).

Following on from the Green Economy Strategy, LEDET developed an updated version of the Climate Change Response Strategy in 2016. The process of developing this strategy was externally driven by Pegasys, a private development impact consultancy that had been subcontracted by DEFF and GIZ as part of their Climate Change Support programme, rendering this a typology of non-formal learning. Global, national and sub-national policies that influenced the development of the strategy include the Paris Agreement (2015), the NCCRP (2011) and Limpopo Green Economy Plan (2013). Learners who want to learn about the Limpopo Climate Change Strategy can access it online by scanning through the search results on Google that provide a link to the LEDET website where the document auto-downloads when clicked. Finding the document directly from the LEDET website is, however, also not easy as one would need to know under which of the nine tabs the document would be found. Interestingly, I could not find the document under the resource centre tab where other strategic reports and annual reports are kept. Rather the climate change strategy document can be found under the Programmes tab/ Environmental Affairs/Integrated Pollution and Waste Management, and there is a link to the document titled *Climate Support Programme Climate Change Adaption Strategies*. Alternatively, one can find climate change strategy on the LEDET website by using the search function (highlighted in orange in Figure 4.2), where only one result pops up for the *Integrated Pollution and Waste Management Directorate*. One has to click the *Read more* tab (circled in red in Figure 4.2), which takes the reader to the *Integrated Pollution and Waste Management directorates* page, and then follow the process as above.

A review of the strategy highlights that the province anticipated that within one year of the development of the strategy, the priority adaptation measures would be integrated into the IDPs and that funding would be secured to facilitate implementation continuously. However, an official I interviewed expressed that implementation of the strategy has been constrained because '*officials working at provincial and district level are overcommitted and there is low staff morale hence people are not able to take on additional work from national departments*' (Participant 18, 2018).



Figure 4. 2: Example of how to access the Limpopo Provincial Climate Change Strategy on the LEDET website. (Source: LEDET, 2020).

Additionally, participants highlighted the failure of the strategy to provide action plans, assign responsibilities to governance actors and provide an indicative budget for the recommended interventions. Consequently, this provides leeway for inaction as actors cannot be held accountable during their individual and departmental performance assessments. Furthermore, the strategy recommends that when there are limited resources, the province could pilot the recommended adaptation interventions for periods between 1-3 years and then re-evaluate for longer-term implementation, but there has been no clear strategy to secure climate change finance to support the pilot programs within the province (DEFF *et al.,* 2020). With the national budget having been put under further constraint by the COVID-19 pandemic (SA National Treasury, 2020), it is unlikely that more resources will be made available soon to support climate change initiatives.

At the district level, CDM conducted a risk and vulnerability assessment and developed a climate change response plan in 2016 (CDM, 2016). The CDM developed the response plan in partnership with DEFF, GIZ, SALGA, LEDET. Urban Earth was subcontracted to provide technical support. The consultancy (i.e. Urban Earth) facilitated two workshops with local government officials and other stakeholders from the district to provide inputs into the climate change strategy and build capacity on how to integrate climate change into the IDP process using the Let's

Respond Toolkit, which supports non-formal learning. Governance actors can learn on their own by accessing the CDM response plan online by using the Google search engine. From there on one must search for it from the multitude of results and use the link to the Let's Respond Toolkit website to access it. Alternatively, learners who were part of the LGCCSP and Let's Respond Toolkit workshops who would still recall how to access the programme website can also go through several tabs on the website to locate the CDM response plan (DEA *et al.,* 2020).

As I reviewed the response plan, I noted that it also includes targets and a budget indication, but the suggested budget for the actions was made with limited understanding of the cost of some of the interventions, especially when external consultants/ researchers are contracted to do the work. For example, the estimated budget for research to improve understanding of climate change impacts on grain production and research on climate change impacts on biodiversity are R100 000 and R200 000[3] respectively, which is not very much (CDM, 2016). These funds may prove to be inadequate, and there is a need for the municipality to be able to apply for additional climate finance from funding institutions such as the Adaptation Fund to support these initiatives. Discussions with officials on how well the response plan is being implemented revealed that uptake of the prioritised actions for the district and the provincial strategy has been slow and some actors have rejected or ignored some of the recommendations (Chapter 7 section 7.7.1). Interpretive frameworks such as Diffusion of Innovation theory attribute rejection of scientific recommendations by potential users to the uncertainty of the credibility, admissibility and world views that informed this knowledge (Tonn *et al.,* 2001). In the case of this study, reasons for the lag in the implementation of the district response strategy will be discussed in Chapter 7 when I present the challenges that officials face with enacting CCA in CDM.

In addition to the above, the CDM also developed the CDM District Rural Development Plan (DRDP) in 2016 as part of the national DRDLR's Comprehensive Rural Development Programme. The DRDP was developed to facilitate sustainable development in rural areas and also seeks to support the transformation of rural economies, as is proposed in the National Development Plan (Vision 2030). The plan was developed with technical support from Ditau Geo-Informatics Solutions (i.e. a town planning and spatial planning consultancy) who incorporated inputs from multiple stakeholders from the district and province compiled through workshops (non-formal learning) (DRDLR, 2016). A review of the DRDP indicated that it has been developed to complement existing district plans such as the IDP, Local Economic Development (LED) strategies and the Comprehensive Rural Development Programme (CDRP). One of the ways to access the DRDP is to search for it online, and it is available on the DRDLR website.

Finally, one of the most important municipal policy documents is an IDP which can be accessed on the CDM website and discussed/presented in municipal forums. The IDP is a five-year plan that is reviewed annually to provide the strategic operational plan of the municipality and development priorities. Spending of the municipal budget, including the Municipal Infrastructure Grant is also informed by the IDP (Department of Provincial and

[3] About US$6 593- 13 186 using the 1:15,17 exchange rate on 15/01/2021

Local Government, 2006). The Municipal Systems Act (Act No. 32 of 2000) states that all municipalities in South Africa should develop an IDP that aligns with planning instruments in other spheres of government (e.g. National Development Plan and Limpopo Development Plan). Developing an IDP is a coordinated process that is led by the municipality and integrates sector plans from sectors such as health, human settlements, water, transport and environment. The process also includes community participation to ensure that their needs are incorporated and addressed by prioritised projects; hence this priority list reflects what is important at the community level. The top three development priorities for CDM are basic services and infrastructure (water and sanitation); roads and stormwater; and roads and public transport (CDM, 2019a). The common development priorities across the local municipalities also relate to basic services such as water, sanitation education, transport and housing.

Ensuring environmental sustainability, including managing environmental threats, is another task that municipalities have been mandated to oversee and should, therefore, develop and enforce relevant environmental plans and policies, including climate change response. Although the 2016/17-2020/21 IDP has integrated the climate change vulnerability risk profile for the municipality, there is no explicit reference to CCA in the document, and, as shown above, it is also not a top priority for the municipality. The period post-apartheid has been engulfed with concerns regarding environmental management and distribution of risk among the poor and marginalised members of society which both tend to lose out in favour of development (Patel, 2009). As a result, the relationship between development and environment is rugged due to misconceptions that assume environmental management is pitted against development in priority planning, yet these are co-dependent (Leck and Simon, 2018). The clear lack of explicit climate action in strategic documents such as the IDP (Jacobs Mata *et al.,* 2018; Leck and Simon, 2018) remains a concern, which will be returned to in Chapter 7. More so, any direct CCA activities, if lower on the priority list, will receive low attention from officials in their day-to-day work and also in terms of allocation in financial budgets.

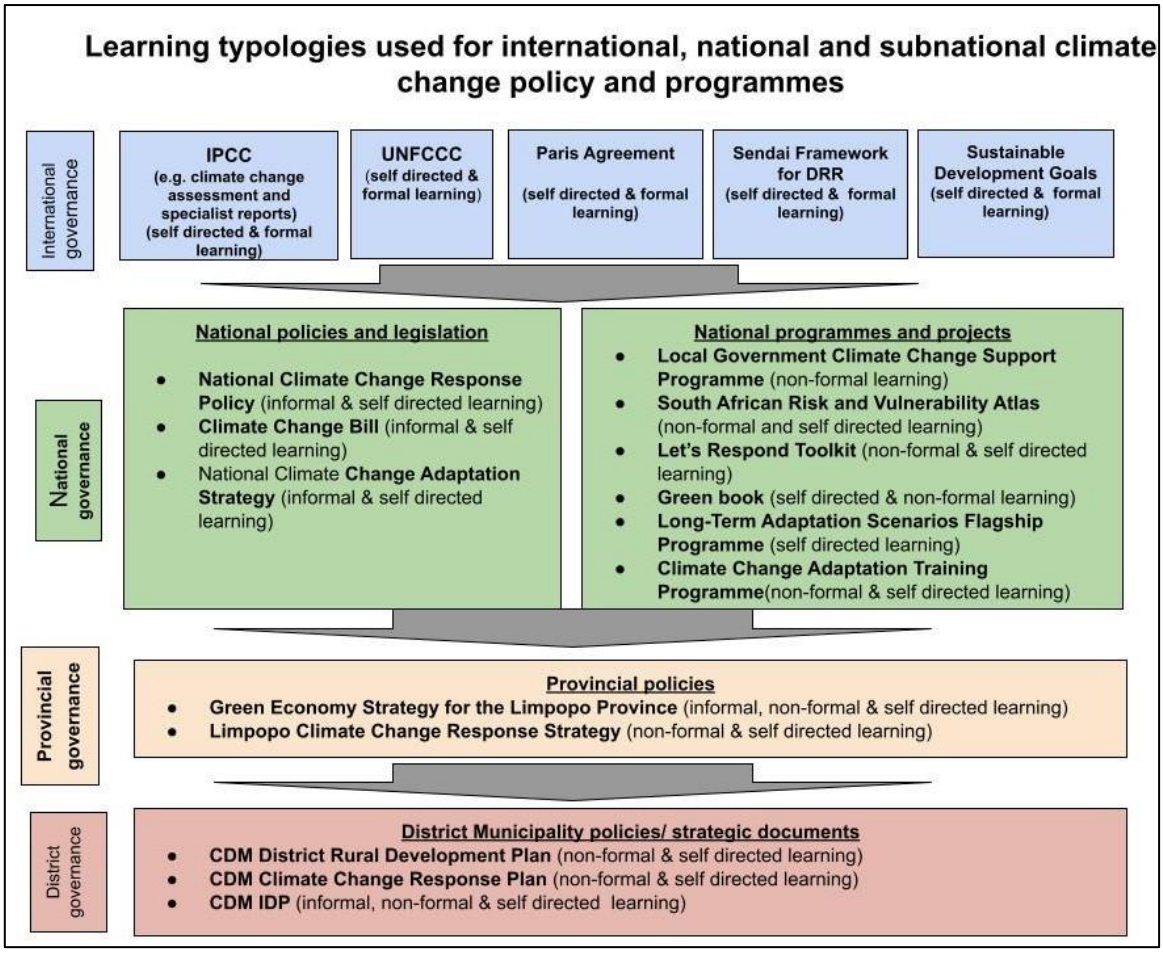
A review of the municipal IDP and discussions with officials shows that the implementation of some of the climate change-related provincial and district strategies to date have been uncoordinated. Moreover, the initiatives undertaken are not in line with the priorities identified in the strategy (section 7.6). While the IDP can support the mainstreaming of climate change into municipal operations, further work is required to ensure that sector plans also integrate CCA. This was highlighted by Participant 28 (2018) who said that:

> 'T*he IDP highlights what sectors have prioritised and if climate change is not already mainstreamed in the sector plans then it's a challenge'* (Participant 28, 2018).

Failure to integrate CCA into municipal sector plans highlights the need to support officials within sector departments to understand the relationship between climate change and planning for their respective sector and existing tools such as the Spatial Planning and Land Use Management Act 16 of 2013 (SPLUMA) which have a strong emphasis on multisectoral spatial planning can be used to enhance this integration. Furthermore, it is further motivation for the need for an overarching policy, i.e. Climate Change Bill, to ensure alignment of all policies and enforcement of climate change response at all spheres of government.

4.7. Conclusion

In this chapter, I explored the global, national and sub-national policy frameworks that influence learning, and governance of CCA at the local level. The learning typologies used for these sources of information has been summarized in Figure 4.3 below.



4. 3: Summary of learning typologies used by governance actors to learn about CCA from international conventions and IPCC scientific publications, national and subnational policies, programmes and projects.

Three key issues emerged from this analysis. Firstly, the chapter established that several global policy frameworks have been developed and are influencing the climate change discourse. Examples include the UNFCCC (1992) and Paris Agreement (2015). However, these global resources are mostly available on online platforms, thus require a learner to be self-driven and knowledgeable in information systems to access them. Owing to this, self-driven learning using internet-based policies and related products in local contexts such as CDM, where there is limited ICT infrastructure, results in limited uptake. It is crucial, therefore, to facilitate multiple learning platforms where other typologies of learning are utilised, for example, workshops and forums, to foster facilitated collective learning on these policies.

Secondly, the chapter highlighted how these global policies have been domesticated at the national and sub-national level. National departments such as DEFF, DSI, DALRRD have used research institutions and consultancy companies to develop and provide CCA information and products to support learning at the sub-national level.

Furthermore, GIZ is one of the international development agencies that is playing a key role in the process of domesticating these global and national policies by providing funding and technical support through DEFF. Learning at the sub-national level has largely been an externally driven process, and external actors have prioritised CCA policies, programmes and projects at that level of governance, however, this is not always the same at the sub-national level (Setzer and Nachmany, 2018).

Lastly, it emerged that governance actors at provincial and district level strategies have been developed to support climate change response. However, this has largely been in response to directives from DEFF, hence there has been little to no implementation thereafter. Apart from the workshops organised by external actors to share information, governance actors must take the initiative to search for these sources of information online, and this process, as noted above, has its challenges. Owing to this, these externally driven learning initiatives and sources of information have been criticised for being inaccessible to users at local government level and for failing to integrate the user needs. Actors supporting learning at the sub-national level, therefore, need to explore the opportunities that can be used to co-design and co-produce user-inspired products and information that are accessible. In addition, more work is required to mitigate some of the challenges that learners face when using the different learning systems and typologies, as this also influences the implementation of CCA at the local level. The next chapter presents a profile of CDM as the local context in which adaptation takes place. It highlights the governance context, climatic and non-climatic stressors that governance actors need to address as part of their mandate to achieve national and sub-national development goals.

5. Local Scene-Setting: Profiling Capricorn District Municipality Case Study

Vision: *'Capricorn District, the home of excellence and opportunities for a better life.'*

Mission: *'To provide quality services, in a cost-effective and efficient manner, through competent people, partnerships, information and knowledge management creating sustainability of economic development in the interest of all stakeholders'* (CDM IDP, 2019:16)

5.1. Introduction

The above vision and mission statement for the CDM articulates the goals and aspirations for the municipality. These goals are set in intrinsically complex socio-ecological and socio-political systems where emergent challenges of poverty, unemployment and inequality arise from various social and political processes (Ndou, 2015). During the interviews, research participants who make decisions in CDM and those supporting learning in the district were asked to identify some of the immediate challenges faced by the CDM and not only focus on climate change. The responses confirmed some of the complex, intertwined human and environmental challenges above, which have also been documented in the various municipal reports presented in Chapter 4. Further to meeting the demands of a growing population, Leck and Simon (2018) illustrate that municipalities in post-apartheid South Africa must also address historical and deeply entrenched practices that perpetuate poverty, unemployment and inequality. Further to this, the district is characterised by a service-based economy (community services, trade and finance), a significantly large rural population that depends on climate-sensitive sectors such as agriculture and tourism, the prevalence of non-communicable diseases and uneven development. Given the importance of tracing the drivers of complex and 'messy' contexts in the Municipality, a separate chapter has been included here to add and provide rich context of the local setting.

The CDM currently experiences extreme weather events such as droughts, floods and heatwaves which affect social and economic development in the district with the frequency and intensity of such extreme weather events likely amplified by climate change. Climate change is, therefore, a threat multiplier that will aggravate the existing multiple stressors (social, economic and political), resulting in a situation of increased municipal vulnerability as food and water insecurity, poverty and unemployment and other current development challenges become more pronounced (IPCC, 2014b; Allen *et al.,* 2018; Hoegh-Guldberg *et al.,* 2018). Global research and policy documents recognise that local governments, like other organisations, need to develop the capacity to navigate through these challenges and adapt to changing circumstances to achieve these development goals (Deri and Alam, 2008; DEA, 2011a; Blanchard, 2014; Pasquini *et al.,* 2015; Leck and Simon, 2018; Setzer and Nachmany, 2019). In almost all these documents, the need to be very mindful of local context and how this may shape emerging climate change approaches and responses is clear.

Given that climate change is a major foreseen driver of these changing circumstances, climate change response needs to be integrated into the municipal development agenda to promote building climate-resilient communities. However, this is dependent on the adaptive capacity of social actors, which is influenced by factors such as access

to and understanding of technology, education and training of human capital, social and institutional networks and political will of governance (Smith *et al.,* 2003). Socio-economic conditions coupled with poor governance structures and management can, therefore, severely limit the adaptive capacity of governance actors to mitigate the impacts of climate change and related extreme weather events. Moreover, governance actors and communities hold diverse and plural value systems and interests that influence how they ascribe value to physical phenomena such as climate change, and these often exist in conflicting ways (Balvanera, 2016). For example, there are diverse discernments on the risk posed by climate change, which influences how actors contextualise and prioritise risks as well as put measures in place to respond to anticipated risks (IPCC, 2014c; Granderson, 2018). Risk is subjective and is not necessarily only influenced by facts (e.g. scientific knowledge) but also by the value placed on those facts. People also tend to offset these risks by worrying less about risks that are perceived as further into the future (Ropeik, 2010).

CCA, therefore, requires governance actors and municipal structures to adapt to new experiences and knowledge through an iterative social learning process that is cognisant of how this information transitions into the policy and application space (Davis and Vulturius, 2014). To deepen the understanding of the current CDM context, which is vast and complex, two thematic areas are explored and are presented in two sections based on information gathered from a review of literature such as municipal policy documents, research and scientific publications with a focus on Limpopo and CDM. The governance context is first articulated, including both formal and traditional actors and builds on the national governance context presented in Chapter 4. The second section deals with the biophysical risks (climate as a hazard) and the underlying, enduring social drivers of risks, including persistent poverty and poor access to basic services such as risk reduction, including the contextual environment in which early warning systems (EWSs) try and operate. As will be argued, assessment of the governance system, including social, economic and biophysical attributes provides insights into issues that can make the governance of CCA difficult to gauge and manage while also hindering adaptation planning and implementation.

5.2. Cooperative governance context

The concept of governance has been defined as the directed actions by government as well as non-government actors to address a specific issue. In the South African context, the term cooperative governance has been adopted in the constitution (Chapter 3; RSA, 1996) to allow for all three spheres of government (national, provincial and local government) to work together to meet development goals which include responding to climate change. In this section, I give a brief overview of the governance structure in CDM, highlighting actors who engage in decision-making in terms of municipal administration and governance of communal areas as well as the challenges with the socio-political-cultural governance structure, which can be a barrier to CCA. Leadership plays a key role in mainstreaming and implementation of CCA, hence it is important to examine the governance actors who play a key role in the implementation of globally negotiated solutions on climate change, e.g. the Paris Agreement at the local level (Pasquini *et al.,* 2015; Bourne *et al.,* 2017). The management practices of governance actors shape the socio-ecological and socio-political systems with consequences on the ability to adapt to climatic stressors.

5.2.1. Capricorn District Municipality governance architecture and governance actors

Organisational learning within local government contexts is influenced by, among other things, the structures of governance, interests of governance actors and distribution of power. The governance structure of CDM comprises a council of the municipality which is the highest decision-making structure with fifty-six seats of councilors elected following the 2016 local government elections. The African National Congress (ANC) has the most seats (thirty-five seats), followed by the Economic Freedom Fighters (EFF), who have sixteen seats and lastly, the Democratic Alliance (DA) with five seats. The councilors represent the local municipalities as well as the district council. The council make decisions such as approval of budgets for their respective municipality, as well as policies and by-laws. To enhance administrative and operational efficiency as well as decentralise power, the council has an approved delegation system where power is delegated to the executive mayors, speaker, Mayoral Committee, portfolio committees and administrative components who are responsible for decision-making and municipal operations (CDM, 2019b).

Powers have also been delegated to the six executive managers who lead departments and report to the municipal manager who oversees the work of the municipality, recruits' staff (local government officials) and co-ordinates them to implement all programmes approved by the council. Illustrating and understanding this complex governance architecture, political structure and composition are important to this study as it highlights the socio-political context in which CCA learning and decision-making occur.

Relational and political tensions have been reported between councilors from the different political parties, municipal executive and the municipal speaker as a result of political differences, unclear definition of roles, perceptions of marginalisation and lack of transparency with impact on service delivery (Hungwe, 2017; CDM, 2020). Within the municipal council, political allegiances influence collective decision-making and collective action, such as the integration of climate change into municipal operations (Pasquini and Shearing, 2014). Changes within this executive structure often have repercussions on the senior management and municipal manager, who have to constantly adapt to the prominent political agenda (Hungwe, 2017). Figure 5.1 shows the top executive structure of the CDM. The structure in Figure 5.1 shows that decision-making at the municipal level is not an easy and straightforward process as multiple government and political actors influence the process and outcomes. In the context of CCA, local governments have been identified in the NCCRP (DEA, 2011a, Chapter 4) as one of the key actors in climate change response at the local level, but this is a heterogeneous group made up of several structures. The municipal administrative staff, although they are not part of the executive structure, play a key role in the implementation of projects and programmes to meet the municipal vision and mission.

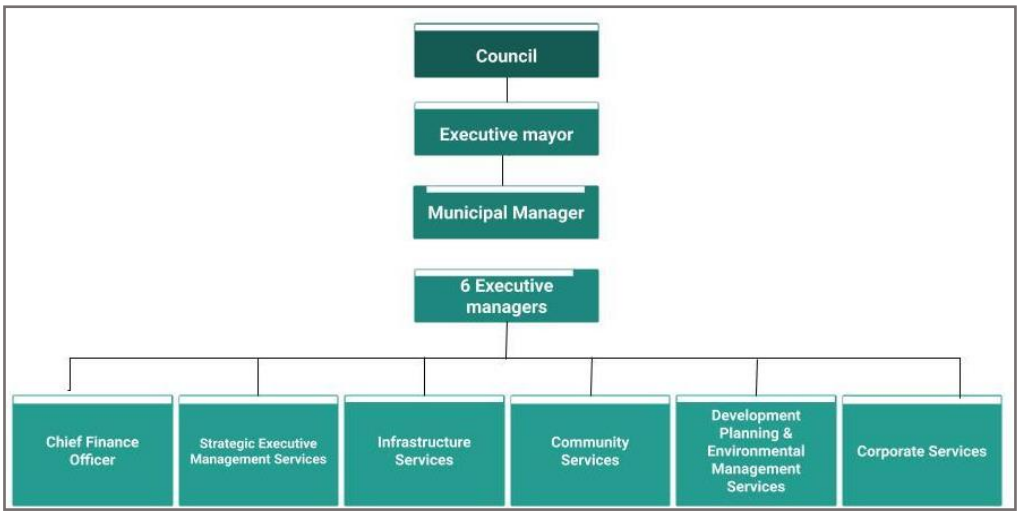


Figure 5. 1: Top executive structure of CDM illustrating some of the key governance actors making decisions in the district (Source: CDM, 2019a).

The officials identify projects to be implemented, and these are approved by the municipal executive for implementation by administrative staff. One official shared that:

> *'As a department, we identify projects based on information we gather from communities when we have our stakeholder meetings during the IDP process'* (Participant 2, 2017).

There are instances, however, where the process is a mix of bottom-up and top-down influences where the executive can identify and recommend projects that should be implemented by an administrative staff that are a result of pressure from communities as expressed by an official who said that:

> *'Communities at times put pressure on councilor's and influence areas and projects that are prioritised'* (Participant 6, 2017).

Additionally, decisions on municipal projects or programmes are also influenced by other external actors such as national and provincial departments as well as multilateral funding institutions. The LGCCSP, for example, has been driven by DEFF, funded by GIZ and facilitated by LEDET (chapter 4). An output of this includes the municipal adaptation strategy, which administrative staff contributed to. Local government officials and their executive can, therefore, play two roles in polycentric climate governance by firstly developing regulations that direct climate change response actions as well as influence the behaviour of others within their jurisdiction (Setzer and Nachmany, 2019). For example, councilor's and administrative staff lead awareness-raising campaigns to influence the behaviour of community members, including school children, as part of their municipal responsibilities (e.g. Wildlife and Environmental Society of Southern Africa (WESSA) Eco-Schools programme) on various topics, including climate change. Secondly, they can also mobilise other government and non-state actors to get involved in CCA that align with the set regulations or meet the set objectives (Ibid). The CDM, however, struggles with high staff turnover, high vacancy rates in strategic positions (CDM, 2019a), as well as tensions resulting from political meddling into the municipal administration, which affect municipal operations (Beyers, 2015). These issues also pose challenges for the integration of CCA into municipal operations due to limited human resource capacity.

Further to this, the effectiveness of adaptation actions taken by the municipal administration depends on actions and support by other actors who are part of their socio-political arena e.g. traditional leaders, communities, provincial and national departments. One official explained that:

> *'The challenge for us is that climate change is not a priority for our communities and so going to them to say here is a climate change adaptation project or mitigation project, they are not interested in that, people want houses and other services……. the budget allocated to our department is decreasing every year and it becomes a political issue when people want just the basics and everything else becomes a luxury'* (Participant 3, 2017).

The response by the official above corresponds with what has been noted in other studies at local government level that highlight that climate change is not on the public official's priority radar, hence it is trivialised during budget allocations (Roberts, 2008; Pasquini *et al.,* 2013; Leck and Roberts, 2015; Patel *et al.,* 2015; Nana *et al.,* 2019). The needs of the community are real issues that also, in turn, drive their vulnerability to climate change. Adaptation, therefore, requires governance actors at local government to build transformative capacity to enable greater social inclusivity by addressing issues of socio-spatial inequality to ensure that the needs of the poor are addressed by addressing the drivers of vulnerability (Ziervogel, 2019). Studies in urban climate change refer to this as transformative capacity, i.e. "…the capacity of individuals and organisations to be able to both transform themselves and their society in a deliberate, conscious way. This includes the capacity to imagine, enact, and sustain a transformed world and a way of life that is in balance with the carrying capacity of our earth, and where all life flourishes" (Ziervogel *et al.,* 2016:2). To achieve this, local government should have a better understanding of the needs of the poor, support intermediaries who share pro-poor goals and be flexible to engage in new modes of governance which allow learning, inclusive adaptation planning and partnerships with diverse actors (Ziervogel, 2019). As will be shown, in this chapter, however, the wide and deep understanding that is needed of this landscape, including identifying and understanding various governance architectures and social contexts and everyday living experiences, makes CCA extremely difficult. Several actors can influence and enhance the understanding of the context in which actions are and can be taken, including traditional leaders, civil society, community-based organisations etc.

In the municipality, as in many cases in the country, decision-making for actors in rural municipal structures is not only influenced by science and municipally elected officials. In many cases, the role of long-held belief systems and traditions that form part of a people's culture also influences how people make sense of their environment and manage their daily lives, including those decisions linked to natural resource management (IPBES, 2016; Musarandega *et al.,* 2018). Here actors such as traditional leaders also play a key role in decision-making as they are the custodians of indigenous knowledge systems, which includes knowledge on past climate-related events, seasonal forecasts and adaptation to extreme weather events (Mapara, 2009; Musarandega *et al.,* 2018). Land in CDM is governed through a dual system of modern and traditional land-use systems, with more than 70% of the population governed by traditional leadership. Traditional leaders are not elected but rather inherit a title when born in a lineage of royalty and succession versus municipal councilor's who are elected. The traditional leaders reside

at the level at which the impacts of climate change are mostly felt; hence their role is at the frontline of climate action that needs to be augmented. More so, traditional leaders are also responsible for the management of communal resources as well as reconciliation on conflicts to deal with water and land shortages, which are likely to be exacerbated by climate change. Indigenous and traditional knowledge held by traditional leaders is a useful source of information on adaptation interventions that are cost-effective and can be used as a basis for community-based adaptation (Raygorodetsky, 2011).

As part of cooperative governance, the CDM council has also appointed ten traditional leaders (five *Kgoshi/*males and five *Kgoshigadi/*females) to serve on the council. Traditional leaders support the municipal administration in governance issues in line with the Traditional Leadership Governance Framework Act (Act 41 of 2003). Traditional authorities can be found in all four local municipalities, and one of the six kings in Limpopo, King Maleboho, is in Blouberg local municipality. Cooperation and coordination between local municipal authority and traditional leaders face challenges, which affect planning and decision-making, especially in communal areas due to contestations of power (Hungwe, 2017). The municipality has insufficient land for development as most of the land is either state land managed by traditional authorities on behalf of communities or private land, and it is difficult to get the necessary authorisation required for the municipality to use that land (DRDLR, 2016). Parts of the communal areas in the district, therefore, have unplanned settlements mushrooming as traditional authorities distribute land without taking cognisance of the municipal planning documents (e.g. SPLUMA) and increase pressure for municipal service delivery (CDM, 2019a). Conflicts also exist within traditional systems of governance due to disagreements on the succession, marginalisation of some minority ethnic groups, among other things (Bekker, 2008; SAFLII, 2018; 2019). The conflicts, at times, result in illegitimate leaders capitalising on this and claim independence by claiming positions of power (headman or chief) and allocate land in parts of the communal areas to get the support of community members, resulting in unplanned settlements (Weeks, 2019).

The success of cooperative governance in CDM is therefore influenced by, among other things, how well the different governance actors coordinate to implement the new District Development Model as well as a range of other policies (Chapter 4) to achieve the development goals, which include climate change response. There is also a need to support governance actors in leadership positions through learning systems such as networks and forums to build their capacity to initiate and guide adjustments in human and natural systems to reduce the sensitivity to actual or potential risks while also taking advantage of the beneficial opportunities (Pasquini and Shearing, 2014).

A key starting point at the very local level to respond to climate change is understanding the dynamics of the vulnerability context because engaging in climate adaptation with a limited understanding of the socioecological and political context can result in failure and can increase sensitivity to and heighten risks of climate stresses (Cork *et al.,* 2007; Lonsdale *et al.,* 2015). The dynamics include the multiple *climatic* (hazards, e.g. droughts) and *non-climatic* stressors, i.e. the socio-political and economic drivers such as population growth, poverty levels, access to basic services and main economic activities, which are discussed briefly in section 5.3. The vulnerability of CDM

is thus critically influenced by a range of social, economic, political and physical factors which determine the systems' sensitivity to climatic stressors. In the next section, I explore the socio-ecological context, including climate and non-climate risk drivers in the district.

5.3. Socio-ecological context: climate and non-climatic drivers

In this section, the socio-ecological and environmental context in the district is described. The climate and physical hazard context are first outlined, followed by the socio-economic and environmental context in the district.

5.3.1 Weather and climate context: Climatic stressors

The CDM, in general, has a subtropical climate with very hot summers, rains between November and March and mild winters as well as frost in Blouberg. There are seasons of varying weather conditions in CDM's four local municipalities that make up the district (Table 5.1). The district is located south of the Tropic of Capricorn. Rainfall in the district is highly variable and unreliable, which is also a similar trend in the wider Limpopo province. Climate change projections indicate that the future climate in Limpopo will generally be drier and warmer (Table 5.2; Table 5.3). The projections presented here are for the Limpopo province rather than the CDM due to the limitations with data availability, computational resources and the skills for dynamical downscaling.

Recent studies also indicate that the southern African region, including the interior parts of South Africa where Limpopo is located, is warming faster with increases of up to 2°C, which is higher than the global rate of 1.5°C (Hoegh-Guldberg *et al.,* 2018). For the period 2036-2095, the province is likely to have an increase of between 1.5°C - 3°C in Representative Concentration Pathway (RCP) 4.5 and can in that same period experience increases of between 2°C and up to 5°C in RCP 8.5 as well as more incidences of heat waves (SAWS, 2019; Mbokodo *et al.,* 2020). Projections for rainfall under 1.5°C show that the province will also have decreases in rainfall between 10-20% as well as an increased number of consecutive dry days (Davis *et al.,* 2015; Hoegh-Guldberg *et al.,* 2018). The projected changes in temperature and rainfall are expected to have impacts on several sectors, including human health, agriculture, water, biodiversity and human settlements and will exacerbate some of the current development challenges that the municipality is currently faced with, such as service delivery backlogs and water shortages.

Table 5. 1: Summary of weather and climate in CDM's local municipalities

Local Municipality	Rainfall	Temperature
Polokwane LM	• Summer rainfall region • Most rains received between October-March • Peak rainfall season: December-January • Average rainfall: 478mm/annum • Driest month: July (DRDLR, 2016)	• Average summer temperature 28,1°C • The maximum temperature recorded 39°C (October 2019 • Average minimum temperature of 17°C (DRDLR, 2016; SAWS,2019)
Molemole LM	• Summer rainfall region • About 86% of rains received between October-March • High rainfall variability: Western parts of the municipality prone to droughts and receive 300-500mm/annum • Eastern parts receive up to 1000mm/annum (Molemole LM, 2019)	• Average daily minimum and maximum • temperatures are 29.9°C and 17.9°C for January and 22.4°C and 4.9°C for July • Eastern parts generally cooler • The maximum temperature at times exceed 35°C • Mild and dry winters • 5-10 days of frost between mid-June-late July (Molemole LM, 2019)
Blouberg LM	• Summer rainfall region rain falling between October -April • High rainfall variability varies between 380-550mm • Average rainfall 410mm/annum (DRDLR, 2016)	• Dry cold to frosty winters • Average minimum & maximum temperature 5ºC and 30ºC respectively (Stronkhorst et al., 2010)
Lepelle-Nkumpi LM	• Dry savannah subregion • Summer rainfall with a mean annual rainfall of 474mm/annum • Higher rainfall in the northern parts between 800-1200mm/annum • Southern parts average rainfall is between 400-600mm/annum (Lepelle-Nkumpi,2019)	• Average max temperature is 24°C and min is 10°C • The northern half of the municipality is cooler than the south with an average temperature between -2 and-25°C • The southern Parts average temperature ranges between 2°Cand 31°C (Lepelle-Nkumpi,2007) • Dry mild winters

Table 5. 2: Near-surface temperatures future projections for Limpopo (Source: SAWS, 2019b).

Medium-to-low concentration pathway (RCP 4.5)	+1.5ºC to +2.5ºC (2036 – 2065: centre 2050) +2.0ºC to +3.0ºC (2066 – 2095: centre 2080)
High concentration pathway (RCP 8.5)	+2.0ºC to +3.0ºC (2036 – 2065: centre 2050) +4.0ºC to +5.0ºC (2066 – 2095: centre 2080)

Table 5. 3: Future rainfall projections for Limpopo for December, January February (DJF); March, April May (MAM); June, July August (JJA) and; September, October and November (SON) (Source: SAWS, 2019b).

Medium-to-low concentration pathway (RCP 4.5)	Annual: Below-average: 0%- 15%drier. Seasonal: DJF = 5%wetter in the west and 5%dryer in the east / MAM, JJA, SON = < 20%dryer.
High concentration pathway (RCP 8.5)	Annual: Below-average: 0%15%drier in the west / up to 25%drier in the east. Seasonal: DJF = 10%wetter in the west and 15%dryer in the east / MAM, JJA, SON = < 50%dryer.

To demonstrate the trend of droughts and rainfall for the province, the National Integrated Water Information System illustrates high rainfall variability between 2014-2020 and fluctuations between wet and dry seasons (Figure 5.2; Figure 5.3).

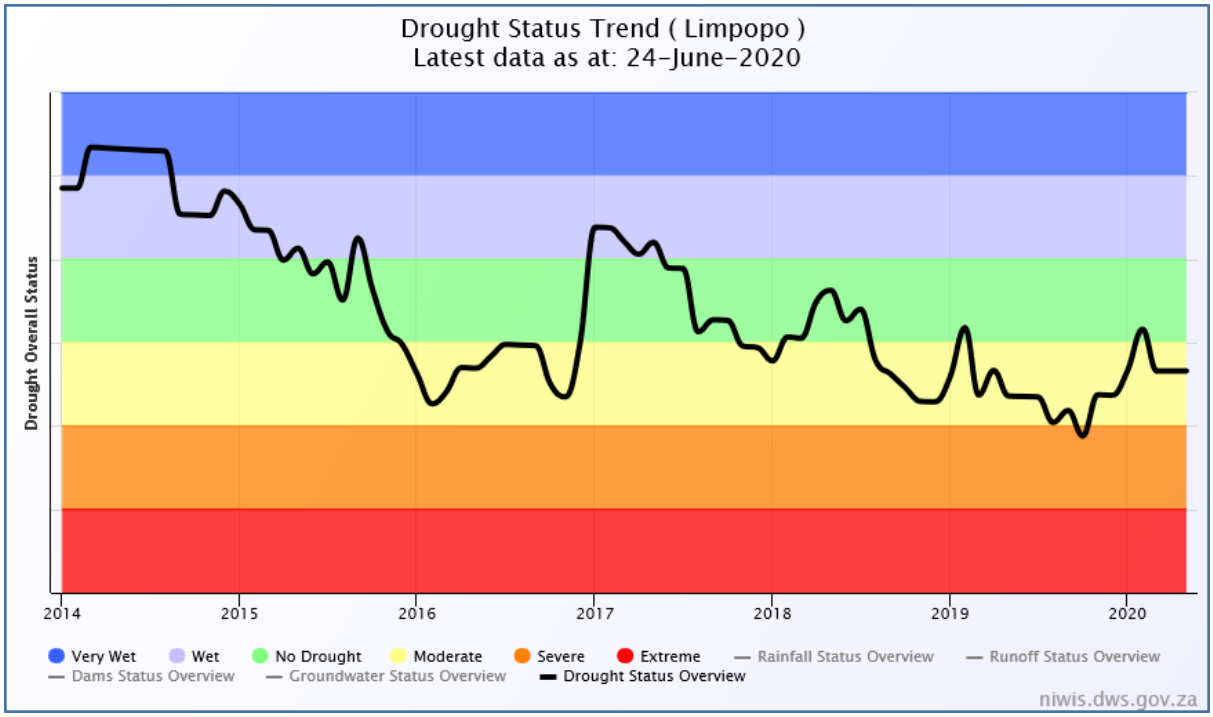


Figure 5. 2: Drought trends in Limpopo from 2014-2020 illustrating fluctuations between wet (blue) and moderate drought periods (yellow) (Source: Department of Water and Sanitation, 2020).

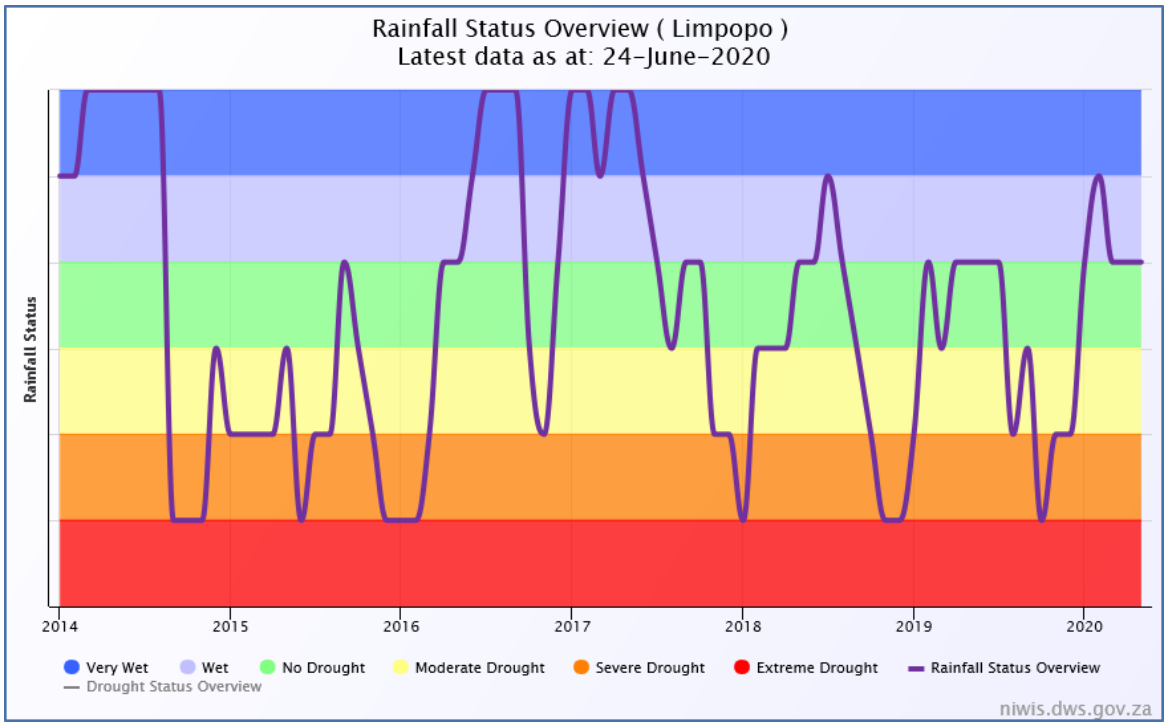


Figure 5. 3: Rainfall variability for Limpopo Province illustrated by the fluctuations in rainfall status, which include wet, no drought period, moderate and severe drought periods between 2014-2020 (Source: Department of Water and Sanitation, 2020).

The vulnerability of sectors and communities across the district to extreme weather events such as droughts and floods is not evenly distributed spatially and socio-economically (Vincent *et al.,* 2010; Quinn *et al.,* 2011; Mpandeli,

2014; Shackleton *et al.,* 2015). For example, not all communities will be equally sensitive and exposed to the decline in rainfall as some communities currently have challenges with water availability and quality, and this is likely to be exacerbated by climate change. Extreme weather events usually have negative impacts on the economy and can result in loss of income and increased unemployment. Of greater concern perhaps than the exposure to the hazard is the underlying, prevailing environmental and socio-economic vulnerability of the community to climate stress. The intersection between climatic stressors with the socio-economic, environmental and political attributes of CDM contribute to the social vulnerability of the municipality. Such interactions are exceedingly complex and are often not well documented. This complexity adds further additional layers to the learning environment that may be needed to understand and probe when assisting in the development of local, robust CCA planning (Park *et al.,* 2012).

5.3.2 Environmental drivers of vulnerability

Vulnerability to changes in climate can be exacerbated by exposure and sensitivity of the natural environment to climate change and variability. CDM consists mostly of the savanna (65% grassland biome (19%), azonal (11%) and forest (4%) biomes) (CDM, 2016; LEDET, 2018). The district has undulating plains, bushveld and mountains with a mix of vegetation which includes savanna bushveld, sweet grass, shrubs and thorn trees. The Long-Term Adaptation Scenarios Report on biodiversity indicates that the grassland biome is one of the most vulnerable biomes to changes in temperature and rainfall under all scenarios; hence it has been identified as one of the biomes which requires the highest priority for action (DEA, 2013a). Plans that have developed to protect biodiversity in the district include the Bioregional Plan and Environmental Management Plan.

The district, however, already has several environmental challenges identified in the IDP and other policy documents (DRDLR, 2016; CDM, 2018; CDM, 2019a) that increase the sensitivity and exposure to the impacts of climate change. These challenges include deforestation for income generation and firewood in areas such as Chueniespoort, Moletjie, Donkerloop and Malebogo. Continuous changes to land use patterns have also resulted in the loss of grasslands due to overgrazing, land-use change and a lack of public awareness of environmental matters. Overgrazing due to overstocking is more pronounced in areas such as Donkerloop, Maja along the Sand River, Mafefe and Endermark (CDM, 2019a).

Veld fires, bush encroachment and invasion of alien plants by species such as *Dichrostachys cinerea* (sickle bush), *Acacia* species*, Opuntia engelmannii* (prickly pear) and *Dodonaea viscosa* (sticky hop bush) also threaten ecosystem function and composition in CDM (DEA, 2019d). Bush encroachment is notable in the savanna and grassland biomes by the increase in woody vegetation, which is not palatable for some of the herbivores. Alternating periods of high rainfall and droughts have further promoted bush encroachment as grass cover is depleted, especially in communal grazing lands that are overstocked, small protected areas and land under commercial tenure (O'Connor *et al.,* 2014). Climate change has also enhanced the growth and development of alien species whilst also reducing the resilience of indigenous species to biological invasions (IUCN 2020). More so, extreme weather events such as droughts have also resulted in the loss of livestock and wildlife in small game

reserves as well as large protected areas such as the Kruger National Park, which impacts livelihoods due to loss of income (Swemmer *et al.,* 2018). The district also has challenges with soil erosion resulting from overgrazing and deforestation, evidenced in areas such as Chueniespoort, Olifants river catchments, Maja, Molep, Endermark and Opersant (CDM, 2019a). A significant proportion of the population depends on groundwater, however this has resulted in the overutilisation of groundwater resources (CDM, 2019a; CoGTA, 2020a). Implementation of environmental programmes and projects in the municipality has been constrained by limited budget allocation for waste and environmental functions. Governance issues such as poor enforcement and policing of environmental by-laws have resulted in a surge in illegal sand mining, destruction of wetlands and illegal waste disposal (CoGTA, 2020a).

The biophysical environment is not static, and various additional risks are added and removed from the system every day. The different social and economic clusters in CDM also have different strengths and weaknesses, which influence their resilience versus vulnerability to changes in climate. The recent incidents of climate-related extreme weather and projections, together with the growing COVID-19 challenges, aggravate and will continue to enhance the exposure of CDM to climate change and variability. To understand the wider sensitivities to risks, which include the socio-economic and socio-cultural dimensions in CDM, some of the current developmental challenges that governance actors in CDM must grapple with are examined below. To begin, I examine some of the human pressures in CDM.

5.3.3 Human dimensions as drivers of vulnerability

The human dimensions, including gender, age, migration and access to basic and social services, are all additional drivers that influence decision-making and change in the local CDM context. Overcoming South Africa's historical injustices that resulted in a divided and unequal society requires that some considerable attention be paid to addressing issues such as access to land, basic and social services (Gibson, 2009; Govender, 2016; Adam, 2020). These social and development issues are also some of the priority issues for communities and municipalities, as shown in the municipal IDP, with significant budget allocations channelled towards them compared to climate change (CDM, 2019a). The human dimensions influence the community's ability to cope with and recover from the impacts of climate change, with some people disproportionately vulnerable. Population structure, composition and migration patterns, for example, all compound and contribute to pressures on the livelihood systems in CDM. Issues of gender, including increasing threats of gender-based violence (Vincent *et al.,* 2010; Tibesigwa *et al.,* 2015; UNFCCC, 2019) and the differential social roles in deriving a livelihood, are critical to understanding when designing adaptation interventions. The following section explores these drivers in more detail.

To begin, several studies on gender and climate change have highlighted that communities are not a homogenous group. Rather, women are shown to be disproportionately vulnerable to climate change-related disasters compared to men, inevitably exacerbating gender inequality (Enarson, 2000; Twigg, 2004; Vincent *et al.,* 2010; UNDP, 2012; Tibesigwa *et al.,* 2015; Gender CC, 2020). This is a result of the different social roles and responsibilities whereby cultural norms constrain women's access to funds or information to implement adaptation technologies (UNDP,

2012) as well as reliance on subsistence agriculture and wild natural resources (DEA, 2011b; Tibesigwa *et al.,* 2015). In Limpopo, climate change is projected to affect rainfall with adverse impacts on rainfed agriculture, availability and distribution of natural resources, all impacting the livelihoods that depend on such resources (Vincent *et al.,* 2010). In CDM, about 53% of the population in the district is female, and 49% of households are female-headed (StatsSA, 2018; CDM, 2019a), many facing challenges of gender-based violence. The COVID-19 induced lockdown has also escalated social tensions and collective anxiety, resulting in increased cases of gender-based violence (CDM, 2020; IOL, 2020b; News24, 2020). Adolescent girls and young women in the district are vulnerable to HIV infections, with 2019 rates reported to be about 2000 new infections for these two clusters weekly (CDM, 2019a). Efforts to reduce infection and prevalence rates in the district need to take note of the interplay between HIV/AIDS, poverty and food insecurity as these are key factors that governance actors need to tackle to mitigate the girls and young women's vulnerability to extreme weather events such as droughts (Shackleton and Shackleton, 2012). Adaptation interventions, therefore, need to consider the gender-based vulnerability to contribute towards gender equality whilst also empowering women to take part in climate change response (UNDP, 2012; Gender CC, 2020).

The age of local citizens can also enhance or constrain the ability to cope with and adapt to climate stresses such as floods, heatwaves and drought (Stephenson *et al.,* 2010). More than 70% of the population in CDM is in the young (0-14) and youth (15-34) age groups, while about 8% of the population is over the age of 65 years (Figure 5.4).

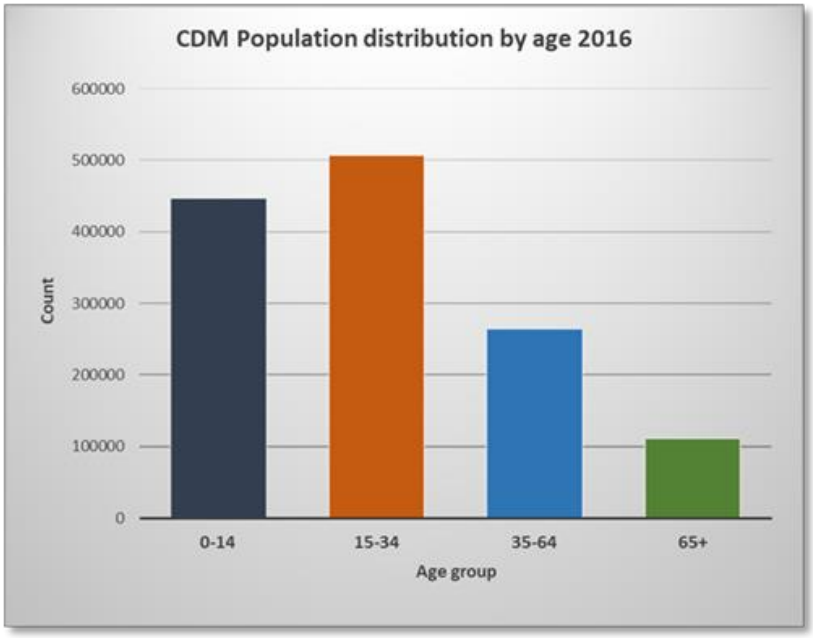


Figure 5. 4: CDM population by age group in 2016 (Source: CDM, 2019a).

Both old and young people have different capabilities and capacities in living with risk (Twigg, 2004). Older people, for example, are often more vulnerable as they are also susceptible to health problems and their ability to respond

in an emergency is reduced, as being shown by the progressing COVID-19 pandemic (WHO, 2020). Older people also have indigenous knowledge systems that help them have a better understanding of their environment, the hazards and relevant coping and response strategies, e.g. seasonal forecasts and knowledge on drought-resistant crops, which can be a very useful resource that local officials can draw on when managing and reducing climate and other risks (Twigg, 2004).

The CDM's largely young and youth age group also has implications on policies that focus on government services, highlighting the need to facilitate rapid economic growth so that this age group can in the future be absorbed in the workforce to reduce unemployment and the dependency ratio (Limpopo Treasury, 2018). The municipality's efforts to address malnutrition assessed by the Systems Heath Trust shows that severe acute malnutrition (SAM) fatality for children under five years in CDM has declined from 45% in the 2014/15 to 16% in 2018/19 (Systems Health Trust, 2020). SAM refers to the "proportion of deaths in children under the age of five as a proportion of the total number of children with SAM in health facilities" (Massyn *et al.,* 2020:42). In 2018/19, CDM had the highest rate of fatalities for children under five years (8,4%) due to pneumonia. This stagnates progress towards achieving the SDG goal of reducing child mortality for children under the age of five years, highlighting the need for further reductions in the district. The main cause of death for children under the age of 14 in the district is communicable diseases combined with maternal, perinatal and nutritional causes (Massyn *et al.,* 2020).

At the provincial level, 37,9% of disease incidence for children under the age of 13 in Limpopo can be attributed to a combined influence of temperature and rainfall. The increase in temperature was noted as one of the leading causes for diarrhoea, meningitis, asthma and malaria in the province (Thompson *et al.,* 2012; Ikeda *et al.,* 2019). The impacts of increasing temperature have also been noted to affect the health of learners in schools that have classroom structures made from prefabricated asbestos and corrugated iron roof as well as converted ship containers resulting in poor ventilation (Bidassey-Manilal *et al.,* 2016). The recent outbreak of COVID-19 has also enhanced the vulnerability of young children with underlying health conditions such as pneumonia and asthma. As the government moves into and out of various lockdown phases, some schools in Limpopo and CDM specifically are ill-prepared to re-open due to inadequate water supply and sanitation. For example, Letsoaka Primary School and Mphela High School have intermittent water supply while Seshego High School does not have water at all (IOL, 2020a). The increased spread of the virus poses more pressure on the health care system.

Non-communicable diseases have been identified as the main cause of death for both males (63%) and females (73%) over the age of 50 years in CDM. About 42% of the proportion of young adults aged 15 and older in CDM are obese or overweight (42,2%), and the prevalence of diabetes among adults (15 years and above) is about 8% (Systems Health Trust, 2020). The projected changes in climate have the potential to increase the risk of non-communicable diseases, particularly due to increases in temperature and extreme heat events (DEA, 2013b; Prüss-Ustün *et al.,* 2019). There is still the need for further research to understand context-specific drivers and impacts. However, studies to date indicate that the impacts will be more severe on those members of the community with pre-existing health conditions and the elderly (WHO, 2013; DEA, 2013b; Campbell-Lendrum and Prüss-Ustün, 2018).

Like the younger age group, older people with co-morbidities such as heart disease, hypertension, diabetes, chronic kidney disease, HIV and obesity also form part of the population most vulnerable to COVID-19 (COVID-19 South African Online Portal, 2020). Although the virus occurred after I had concluded fieldwork in CDM secondary, materials, including social media and newspapers, reported that in the first week of July 2020, Limpopo had more than 1700 reported cases of COVID-19 and 27 deaths. The numbers rose to 12 762 infections and 179 deaths in the last week of August 2020, and by mid-January 2021, the number had escalated further to 43737 infections and 713 deaths, with models suggesting that the cases would continue to increase amidst the second wave (COVID-19 South African Online Portal, 2020; Review Online, 2020). The prevalence of pandemics, such as COVID-19, coupled with projected drying trends, will increase the vulnerability of many individuals and households as it exacerbates the current challenges with water security and an inadequate health care system.

Lessons can thus be drawn from the current COVID-19 outbreak whereby the epistemic community has taken heed to the need for clear, concise, context-specific and usable research outputs which informed decisions taken to put the country under lockdown to give governance actors time to prepare and manage the spread of the virus. Supporting policy and decision-making in CDM, therefore, needs to go beyond just highlighting climate change risk but also provide solutions-oriented knowledge that also contributes to the municipal development goals, such as meeting water needs for all residents (Rouhad, 2020).

Trends in migration also influence vulnerability to climate change as they may force people to settle in environmentally sensitive areas which are vulnerable to extreme weather events. Limpopo as a province also holds the third-highest number of international migrants due to its proximity to neighbouring SADC countries such as Zimbabwe and Mozambique. Similarly, in CDM, about 85,6% of international migrants in CDM were from SADC countries (StatsSA, 2018). Polokwane, as the capital, also has high levels of rural-urban migration due to it being the economic hub in addition to increasing pressure from migrants to be absorbed into the economy. The increasing number of people in urban areas is also associated with the urbanisation of poverty as not all people are absorbed into the formal and informal economy. The challenge with rapid urbanisation is that it has congestion effects whereby the rate of urbanisation surpasses the ability of public investments as local governance actors will also be responsible for the migrants, resulting in overburdened water supply and inadequate housing, which ultimately increase the vulnerability of the urban poor (Arndt *et al.,* 2019). The effects are evidenced in CDM land use and land cover change due to the increasing number of unplanned settlements in Polokwane Local Municipality and Lepelle-Nkumpi (CDM, 2019b). Informal settlements have, however, also been vulnerable to fires, as shown in Figure 5.5, causing damage to and loss of property and personal belongings.



Figure 5. 5: Disteneng residents busy rebuilding their shacks that were destroyed by a fire in 2013 (Source: Capricorn Review 2013).

Further to the increased risk of fires in informal settlements, governance actors in Polokwane struggle to meet the demands from EFF councilors and residents in informal settlements that are mushrooming in areas not owned by the municipality, such as Juju Valley and Kwena Moloto (Review Online, 2019). The EFF uses these service delivery gaps by the ANC led council as political leverage to gain community support, and this perpetuates the tensions between political parties (Mbete, 2015; Mabasa, 2019). The climate change vulnerability assessment for the district highlighted that climate change may contribute to increased migration to urban and peri-urban areas. Unsustainable population growth contributes towards increased consumption of resources as well as greenhouse gas emissions which are some of the key drivers of changes in climate (Centre of Biological Diversity, 2020). As evidence in the narrative above shows, the risk environment in which CCA has to be considered requires a broad, synoptic but also deeply sensitive understanding of local context if we are to be successful in managing both climate stress and other stresses (e.g. COVID-19). Such learning thus places immense stress and expectation on overworked and often under-resourced local government personnel. Notwithstanding these pressures, it is the local citizenry that often faces the most risk and stress, as the next section illustrates.

5.4. Livelihoods in Capricorn District Municipality: Failed access to basic livelihood resources

Despite some opportunities for formal employment, most people in CDM like other parts of the country have little access to such opportunities and the chance to secure a livelihood (Maja, 2019). Livelihoods in CDM and Limpopo are thus not only driven by the need for formal employment but are also dependent on a range of other activities that households engage in to sustain their livelihoods to reduce food insecurity and poverty (e.g. need for basic services such as water and waste removal and energy provision). Activities that sustain rural livelihoods outside

the formal sector include small scale and subsistence farming, domestic work, as well as informal trading (Turpie and Visser, 2013). In the following section, some of the main economic activities and the state of poverty and unemployment in CDM that influence the ability of households, communities and sectors to build adaptive capacity to climate change are highlighted.

The district has a diversified economy comprising mostly of community services, as the main economic activity contributing 32,4% to the provincial GDP followed by trade (21,2%) and finance (19,9%). Other sectors include mining (7,8%), transport, (6,5%), construction and manufacturing (each contributing 3,9%), electricity (2,6%) and agriculture (1,8%). The formal economy currently employs almost three quarters of the working population while the remainder of the working population is employed in the informal sector and is split across different sectors as shown in Figure 5.6.

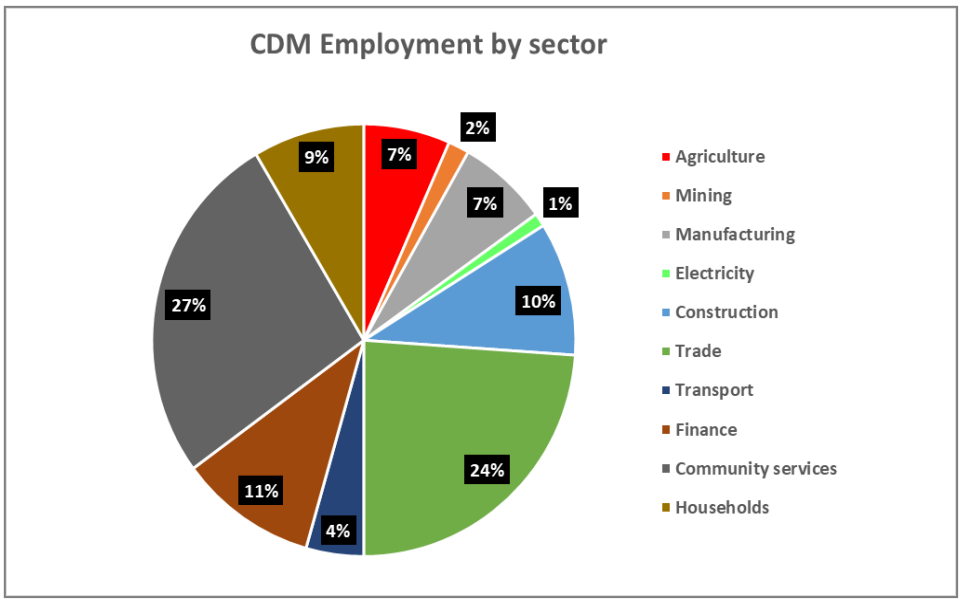


Figure 5. 6: CDM's proportion of workers employed in the key economic sectors (Source: CDM, 2019a).

The growth of other sectors such as mining, agriculture and electricity can be constrained by, among other things, the current water challenges, which are likely to be worsened by climate change. There is potential economic growth in the mining of platinum and iron ore in Blouberg and Molemole that could ease unemployment through increased job opportunities for semi-skilled workers (CDM, 2019b). Mining activities, however, may exacerbate water shortages as water is diverted for mining activities and affects water quality, as has been noted in other districts in the province (Odiyo and Makungo, 2012; Edokpayi *et al.,* 2018; AWARD, 2020b; AWARD, 2020c). Additionally, several provincial and district planning and policy documents have acknowledged agriculture as one of the key drivers of economic growth in the district (CDM, 2016; CDM, 2019a).

Available statistics (CDM, 2019a) show that currently about 7% of the population are employed in the sector while others engage in subsistence agriculture to supplement their household food needs. The CDM agriculture development strategy, for example, has identified agricultural activities that could support the growth of agriculture which include implementing the Glen Alpine Irrigation scheme to support tomato production on 1000ha of land in

Blouberg LM (CDM, 2019). Agriculture, however, is a climate-sensitive sector and officials reported that the sector is currently facing climate-related extreme weather events, which are evidenced by an increased incidence of pests and diseases, changes in the onset of rainfall season and droughts. Climatic projections also highlight that agriculture in CDM will be affected by increased exposure to pests, changes in crop production areas and changes in grain production areas with implications on livelihoods and food security (IPCC, 2014; CDM, 2016). Adaptation of climate-sensitive economic sectors to current and future climate requires coordinated efforts from governance actors and other internal as well as external actors who can support, with context-specific interventions to meet the development aspirations for each sector.

Despite the wide range of economic activities as highlighted above, growing poverty, inequality and unemployment are some of the immediate, additional and often overwhelming challenges faced by households in the district because of a complex mix of factors, including historical injustices of apartheid, periods of policy and political uncertainty post-apartheid, and the scourge of COVID-19. A combination of global factors and national issues has contributed to a decline in the growth of the economy, widening the gap between the rich and privileged and the poor and disenfranchised, resulting in South Africa being one of the most unequal societies (Matsau, 2019). Poor, unemployed and disenfranchised households in municipalities such as CDM are more vulnerable to climatic stressors because they have limited assets and adaptive capacity to respond to the impacts of climate change without external support (Maponya, 2012; Shackleton and Shackleton, 2012; Spires and Shackleton, 2018; Rankoana, 2020). Implementing CCA in a context where there are competing developmental challenges affecting households and communities differently, is difficult, with climate change perpetuating and exacerbating these challenges (Nana *et al.,* 2019; Rankoana, 2020). Governance actors at local government, therefore, need to take deliberative action to improve the governance system such that as they address the triple challenge through service delivery and land use planning, they also reduce the vulnerability of communities to shocks and stresses such as the impacts of climate change.

Statistics on the levels of unemployment vary, with some reports indicating that general unemployment is about 24,3% (CoGTA, 2020b) in the district. COVID-19 is also projected to add further strain as unemployment rates are expected to increase as a result of economic recession, forcing sectors such as agriculture and telecommunications to shed more jobs (Aljezeera, 2020). StatsSA reported that in the third quarter of 2020, the number of unemployed in South Africa had increased by 2,2million (StatsSA, 2020). Linked to unemployment, it is estimated that about 28,4% of the population in CDM live below the food poverty line and do not have adequate income that allows for enough basic nutrition (now R561 per person per month) (StatsSA, 2019). About 86% of the population in CDM live on a monthly household income of R3200 and below, while approximately 12,3% of the population in the district ran out of money to buy food in the 12 months preceding the community survey (StatsSA, 2018). The burden of poverty is even worse for households in areas such as Setloking village, where households have to purchase water from donkey cart water vendors because the municipality has failed to provide them with water (Figure 5.7).

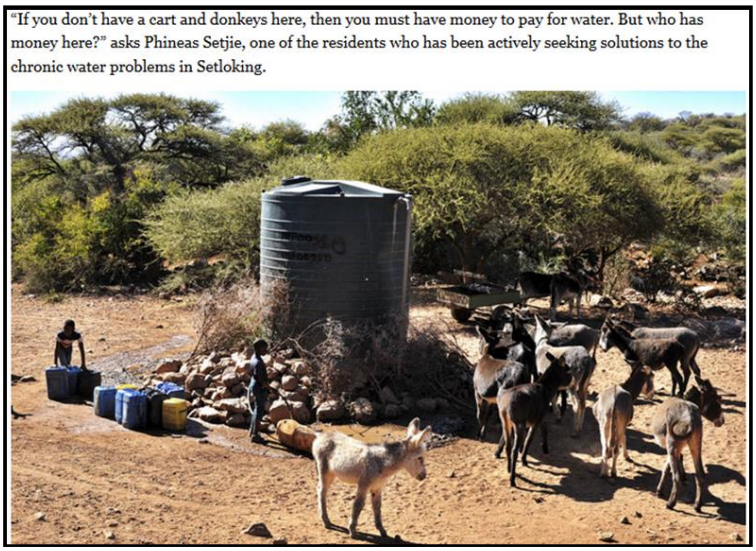


Figure 5. 7: Young boys take turns to fill up containers with water at one of the water stations in Setloking (Source: Ledwaba/Mukurukuru media, 2020).

Vendors charge R175 for a 25l litre drum of water, and on average, a household spends about R700 per month on water. The amount is significant for households in Setloking who depend mostly on social grants, remittances and seasonal profits from subsistence farming (Ledwaba, 2020). Setloking is one of the villages that illustrate how the poor in CDM, like many other municipalities in the country, are forced to buy water as the municipality has failed to provide them with water, and many households struggle to put food on the table. These challenges will be amplified by climate change and may trigger new vulnerabilities that will disproportionately affect the poor, yet they have contributed the least to climate change and have limited adaptive capacity (WMO, 2019a). There is a need for coordinated efforts between the public and private sectors to create opportunities for diversification of economies/livelihood options to address the triple challenge as this plays a significant role in reducing vulnerability to climate change (IPCC, 2014).

Poor and marginalised communities in Limpopo and CDM specifically are also increasingly engaging in service delivery protests to highlight their disgruntlement with poor levels of service delivery which have become more glaring during the COVID-19 crises. Municipal reports indicate the progress made in service delivery for basic services such as housing, water, education, sanitation, transport, social grants, and Table 5.4 provides a snapshot of the current status of service provision in CDM. What is interesting to note for this study are some of the social injustice issues around equitable access to basic and social services, which are required to reduce vulnerability to climatic stressors. These will be discussed briefly below to highlight key areas that governance actors need to consider as they meet the development goals, as they are also critical in mitigating the impacts of climate change for these communities at risk.

Table 5. 4: Snapshot on the current status of service delivery in CDM (Source CDM, 2019a).

Basic /social service	Status of service provision in CDM
Housing	• Formal dwellings 94,7%; Informal dwellings 3.5%; Traditional dwellings 1,7%
Electricity	• 96% of households have access to electricity while 4% use gas, paraffin, candles & solar
Water	• 76% of the households have access to water through pipes (tap) water either inside their dwelling, inside the yard or a community tap
Sanitation	• 61% have access to adequate sanitation facilities
Refuse removal	• 30,8% have access to refuse removal
Telecommunications	• 87% of the population has access to mobile phones
Education	• 18% of the population have no schooling; 47% have attained grade 8-12 • 4% have a diploma and 2% a bachelor's degree or higher
Social grants	• 44,8% of the population receive social grants • (Old-age 43,7%; Child support 39,9%& disability grant 10,2%)

The government has been trying to reduce poverty by issuing social grants. At the end of March 2020, about 18.3 million beneficiaries received social grants (Hall, 2020). The need for social grants during the COVID-19 pandemic heightened as more households were food insecure. During the recent drought (2016-2019), the stable food basket price increased, and regrettably, the pandemic has also increased the price of basic food items such as rice, flour, sugar, bread, cabbage and cooking oil and households spend at least 30% more on food, putting more strain on poor households (BFAP, 2016a; BFAP, 2016b; Business Tech, 2020). In the face of more droughts and more pandemics, food security becomes a real issue (Bureau for Food and Agricultural Policy, 2016; Peinaar and Boonzaaier, 2018). Social grants play a key role in supporting adaptation, especially for the health sector, by reducing food insecurity (Chersich and Wright, 2019).

The old-age grant amount of about R1860 is not enough for some households facing unemployment and malnutrition as they have to limit the consumption of basic needs, including food (Devereux, 2017; Molelekwa, 2018; Webb and Vally, 2020). This is even worse for communities such as Setloking, Ga-Kobe and Klipheuwel in CDM that have to buy water using this same grant. Increases in child support grants have not kept up with inflation in food prices which was at its peak in 2016 at 12%, whilst the former rose by just 6%, contributing to persistent child malnutrition (Devereux, 2017; Webb and Vally, 2020). Grants play a part in reducing poverty and food insecurity in South Africa, however there is the need for a more comprehensive approach that integrates the multiple dimensions of poverty faced by communities in rural areas, such as water shortages in CDM (Devereux, 2017). Poverty is another example of one of the complex, wicked challenges that government officials have to grapple with when trying to create appropriate climate adaptation approaches, at the same time also trying to learn from experience, past successes and failures.

5.5. Accessible good quality water: a fundamental human resource

Water in this part of South Africa, as highlighted in the previous sections, is an extremely critical resource not only for food production and securing a livelihood but also for basic and essential human life. Water has thus been isolated for particular attention and treatment here. Availability of water for irrigation has been identified as a key factor constraining agriculture in municipalities such as Blouberg and Polokwane (CDM, 2016; CDM, 2019a). Water shortages are an already existing sore point and a key driver of the community protests in areas such as Mankweng and Zebediela (Capricorn Review, 2015), something that the recent COVID-19 in early 2020 has brought again to the fore. Residents in Letswala, Pax, Essorinca and Uitkyk 1and 2 in the Blouberg LM are some of the residents struggling with water shortages and rely on rivers and springs, increasing the health risks associated with unsafe water (Matlala, 2019). Many households in CDM have been left even more vulnerable to the virus, as they still do not have water to wash hands to stop the spread of the virus. In June 2020, at the peak of COVID-19, communities engaged in delivery protests as they reiterated the need to ensure equitable access to water for all communities to reduce the risk of spreading the virus. The municipality has provided schools and communities such as Gakobe in Blouberg with access to water (CDM, 2020), but water is one of the key sectors that are currently strained and needs sustainable interventions to mitigate future impacts due to projected drying.

Water availability, especially in rural communities, together with limited financial resources, have also deferred the provision of waterborne sanitation systems to collect, convey and treat wastewater (CDM, 2019a). Poor management of wastewater has adverse impacts on the environment due to pollution and increases the risk of waterborne diseases within communities. The provision of and access to water are thus critical, however, governance actors in CDM currently struggle to meet these demands because of challenges with the operation and maintenance of bulk water infrastructure as well as ageing infrastructure. Additionally, water quality and quantity, particularly in the Olifants catchment, have been deteriorating as a result of mining, industry, inadequate wastewater treatment, urbanisation, agriculture as well as the spread of alien invasive plants (AWARD, 2020b; AWARD, 2020c).

Climate change will aggravate these challenges, as will the projected increase in the incidence of extreme weather events. Increasing temperature will, for example, result in increased evapotranspiration that will increase the demand for water by farmers for irrigation. A decrease in rainfall affects water availability and water quality for household use, economic activities and can predispose the communities to waterborne diseases (Thompson *et al.,* 2012). At a national level, South Africa is considered a dry and water-scarce country, while water demand is increasing with economic growth, increased urbanisation and higher standards of living. The World Economic Forum 2018 report ranked the water crisis as the second-highest risk for doing business in South Africa in 2018, resulting from general aridity and extreme weather fluctuations (WEF, 2018). The first and third risks were unemployment and the failure of national governance, respectively (Ibid).

5.6. Living with risks: The role of access to information and policies to support disaster risk reduction and CCA implementation

Limpopo in general is considered one of the provinces most at risk in South Africa with projections suggesting that by 2050, nine out of the ten most at risk cities and towns will be in this Province (Le Roux ,2021). Growing cities such as Polokwane are under pressure to meet the social-economic demands of an increasing urban population due migration of people from rural areas and neighbouring countries as well as managing the impacts of climate change. Governance actors are therefore urged to integrate CCA and early warning information into municipal planning and operations. One of the challenges and misperceptions in adaptation efforts is that EWSs and climate information are considered as the *add on* that can save local communities (DEA, 2016b; WMO, 2019a). An effective EWS can provide communities at risk with information to prepare for and reduce the social and economic impacts of disasters related to extreme weather events (OECD, 2018). The need for information is important, but as will be shown in this thesis, the enabling environment and learning environment in which such information is produced, understood and indeed embedded is also critical for effective adaptation.

The SAWS is mandated to provide all citizens with timeous and accurate impact-based early warning, alerts and advisories to safeguard life and property against the impact of weather (SAWS, 2020). Access to and effective use of an EWS, either for climate risks and other risks such as the recent COVID-19 pandemic, is marred by several challenges linked to *access* issues such as telecommunications and education (Goldstein *et al.,* 2021). The capability's approach highlights that people's needs differ because of variations in social conditions such as ethnicity, class and gender (Sen, 1999). Provision of services such as telecommunications should therefore also examine the underlying factors that influence citizens' capacity to use the service/resource based on their social and economic conditions. Poor people, for example, may struggle to effectively use telecommunications that support EWSs because of the cost of the service and the inability to interpret and act on warnings and climate information because of the language used. As such, the provision of resources and services may not result in improved human wellbeing and resilience to shocks and stresses such as climate change unless people can fully comprehend how to utilise them in their local contexts to achieve these goals.

As shown in Chapter 4, telecommunication services and the internet are part of the ICT products that play a key role in the dissemination of CCA information and disaster risk management at global, national and sub-national level. ICT has improved the role of weather forecasting to support disaster preparedness as well as climate change modelling, which is critical to reducing casualties (Twigg, 2004; Alexandru *et al.,* 2013; Bueti and Faulkner, 2013; Patterson, 2015). The information is not always easy to access or conceptualise for learners as it is not always translated and packaged to meet different user needs (Chapter 6 section 6.4.1). While ICT facilitates the use of smart technologies which support sectors such as agriculture and health, access to the internet in CDM and most of the rural areas is still very low due to the high costs of data. Poor internet access in CDM, like many other rural areas in South Africa, reduces the connectedness of local government officials as well as low-income households and their access to early warning and climate information.

In addition to ICT, language also plays a key role in influencing access to and usability of weather and climate information presented in multilingual organisations (Hillier, 2003). Language is taught through social learning processes within cultural groups as well as informal learning systems where languages such as English may/ may not be used as part of a curriculum. Language also influences social relationships as well as human-nature relationships based on meaning and value attached to the environment (Agha, 2006). CDM has multiple languages, with Sepedi (89%) as the most spoken language followed by Afrikaans (2%), Xitsonga (1,7%), English and IsiNdebele (both 1%). Climate change information is disseminated through different learning systems, including workshops, scientific reports and websites which are mostly presented in English (Chapter 4).

The English language has become a *lingua franca*, i.e. common business language in many South African organisations to streamline communication, establish proficiency standards as well as widen accessibility to markets (Gerritsen and Nickerson, 2009), even though there are ten other official languages. This can be evidenced in outputs of national programmes, international climate change research, sub-national policies and reports that would influence local level CCA that are mostly presented in English, yet only 1% of the population in CDM, for example, have English as their first language. Within the municipal context, there may be an expectation to have English used as the professional language, given that most municipal reports are also in English. However, communication and knowledge exchange between local government officials (and communities) often taps into multiple other indigenous languages. As such, learning systems should consider how using language as *lingua franca* affects acceptability, usability and the risk of loss of meaning during translation when designing and disseminating CCA information through the different sources of information in this learning system. Using English as a *lingua franca* for non-English native speakers may also pose a challenge for them to effectively communicate on technical and scientific topics such as climate change and CCA (Gerritsen and Nickerson, 2009).

Apart from communication issues, how information is constructed, appropriated and used is a very important dimension that is gaining justifiable attention both globally and locally (Lotz-Sitiska, 2010; Anderson, 2012; The Commonwealth Education Hub, 2015; Ledley *et al.,* 2017; Lotz-Sisitka *et al.,* 2017; Rhodes University ELRC, 2020). The changes in human systems required to respond to climate change are linked to factors such as value systems which influence individuals to have concern for environmental problems such as climate change (Anderson, 2012). Education plays a key role in achieving Goal 13 on climate action as responding to climate change is a reiterative learning process whereby value systems are adjusted so that everyone gets involved. The risks posed by climate change requires governance actors and communities to be proactive as learning from experience may be too late, hence projections provide information that can be used to act (Ledley *et al.,* 2017). Education systems at all levels provide platforms for formal and informal learning and social learning approaches about climate and responses, although gaps persist on how best to integrate this with indigenous knowledge (Anderson, 2012; Ledley *et al.,* 2017).

Improving access to education in disadvantaged and marginalised groups also addresses social injustice by empowering them to become informed citizens who can hold politicians to account to address issues such as service delivery (Freire, 1972; Sen, 2003; Lotz-Sisitka, 2010). Moreover, education can help to facilitate informed

decision-making as communities and governance actors adopt pro-environmental behaviour and implement adaptation actions (Ledley *et al.,* 2017; O'Neill *et al.,* 2020). Details of the important education and social learning connections are not examined specifically in this thesis, for this is an area requiring a much deeper investigation that falls outside the scope of this research as described here. The growing research interest in understanding and enhancing the integration of social learning and transformative learning in CCA by for example, the Rhodes Environmental Learning Research Centre, could be supported further to continue exploring this work with suitable partners.

5.7. Conclusion

This chapter has set the scene for the deep and wide context in which adaptation and adaptive capacity has its roots and can take place in CDM. It provides insights into the institutional and political structure of the CDM in the context of cooperative governance. The municipal council, municipal administration (including administrative staff) and traditional authorities are the key governance actors who play a key role in planning and decision-making within the district may influence the integration of CCA into municipal operations. Initiatives to support CCA in CDM, therefore, need to include and cater for the wide range of actors within the governance structures who may have varying needs in terms of the preferred learning typologies and sources of information, i.e. learning systems (Chapter 6 section 6.4.1). Meeting the different needs can support coordination and uptake of climate change information which is currently constrained by the diverse value systems and limited understanding of how to integrate adaptation within the wider development context. Further to this, the chapter provides an overview of some of the multiple social, economic, political and climatic stressors that drive municipal planning and decision-making as governance actors thrive to attain the municipality's vision and mission.

The chapter also provides an overview of the weather, climate and projected changes which highlight a general drying trend and increase in temperature. The climatic stressors, when coupled with social vulnerability aspects, are the driving factors that necessitate effective CCA to build the resilience of sectors and communities to climate change and variability. The climate change dialogue in South Africa, however, needs to be framed around the developmental benefits and opportunities to leverage buy-in and effective participation at all governance levels (Averchenkova *et al.,* 2019). Alleviating the non-climatic stressors prioritised by communities during the IDP process can, for example, contribute towards adaptation with short-term and long-term benefits (Adger *et al.,* 2004). By using the adaptation action cycle approach (Chapter 1, Figure 1.2), the provincial and district efforts appear to have taken intentional adaptation actions that link to the second and third actions in the adaptation action cycle. This includes taking part in different learning typologies used to detect, define and frame the climate change problem in documents such as the provincial and district climate change response strategy as well as the IDP. The learning here, as will be shown in subsequent chapters of this thesis, has also been informed mostly by non-formal learning systems that are evidenced by the presence of the epistemic community (consultants) who are commissioned to facilitate and justify climate change policy preferences.

Having outlined the wide range of intersecting social, economic and cultural factors that shape the context in which climate stress occurs in this chapter, the next chapters present findings on *who learns* about CCA in CDM, whom they learn from and how the learning takes place.

6. Governance Actors and Adaptation Learning Process in Capricorn District Municipality

6.1. Introduction

Governance of climate change at the local government level requires actors within the municipality to actively integrate and sustain CCA within municipal operations. It entails developing an understanding of the local context (municipal structures, processes, norms and values) to transform the existing practices that constrain CCA (Nana *et al.,* 2019). Governance of wicked problems such as climate change is, however, exceedingly complex. Varying actors with different expertise, interests, resources and level of authority are often drawn into CCA governance, creating a polycentric governance network. The focus of this chapter is to offer an assessment of the adaptation learning process of actors within CDM to ascertain the sources, flow and uptake of CCA information at the local level.

In Chapters 4 and 5 of this thesis, I pointed out that climate change governance operates through multiple centres at the global, national and sub-national level with policy and decision-making capabilities (see also Abbot, 2019). Within the global arena, agreements and research such as the Paris Agreement and IPCC reports, have shaped the climate change discourse and influenced governments to commit to taking actions at national and sub-national levels to advance CCA. In the context of South Africa, the DEFF coordinates the National Climate Change Policy and action by tracking the progress of sub-national players and reporting as part of the UNFCCC process. Meanwhile, at the local government level, CCA is often considered an appendage to service delivery, hence it tends to succumb to competing priorities facing municipal authorities (IPCC, 2007; South African Cities Network, 2014).

Climate change is a dynamic phenomenon that requires actors to stay abreast of the issues contributing to climate change and vulnerability as well as develop appropriate response actions. Scholars such as Singh *et al*. (2017) and Leck and Simon (2018) argue that access to CCA information is crucial for governance actors so that they can proactively plan and respond to climate risks. Hence learning is central in CCA governance, and there is growing interest to understand adaptation learning processes available to governance actors.

In Chapter 2 of this thesis, I argued that learning is situationally determined and enhanced by the exposure and engagements with others, self and the content of the subject within context (Jonassen, 1991). Sense-making of climate change and implementation of adaptation is, arguably, dependent on and established through social interactions between subjective actors within formal and informal structures such as municipal organisational structures, institutions of higher education, forums and networks (Orsato *et al.,* 2017). These formal and informal structures play a role also in curating learning objectives and processes that can inform knowledge generation and facilitate current and future learning. Schiffer and Hauck (2010: 232) highlight that "the involvement of multiple actors who are linked by formal and informal structures makes it difficult for outsiders to understand the complexity of governance issues… it is often these structures that determine the success or failure of policies, projects, or

management of natural resources". Thus, knowledge generation for CCA governance actors is a process that does not exist outside of the learner, but is developed through experiential learning, collaborative interactions and revision of existing knowledge within context (Kolb and Kolb, 2005).

Social constructivist theorists such as Vygotsky (1978) point out that learning is an active process through which learners (in this case, actors) create meanings about the subject matter by linking the emerging ideas with pre-existing knowledge. Knowledge generation is intrinsically linked to action (behavioural activities) because people create knowledge in interaction with others and their environment. Learning occurs when knowledge is not only assimilated but transformed and recreated by the individual learner, which suggests that a process of learning, unlearning and re-learning occurs. In this chapter, I attempt to answer three questions raised in Chapter 2: who learns, learning from whom and how does this learning take place? Addressing these questions attends to the knowledge gap identified by Wolfram *et al*. (2019) on the need to understand the actors involved in adaptation governance and how they learn.

Data used in this chapter draws from the perceptions of research participants gathered in the interviews and workshops as well as a review of secondary literature such as national policies on climate change, among others. After this introduction, the chapter is divided into four sections. Section 6.2 highlights the governance actors involved in CCA decision-making and learning within CDM. Section 6.3 analyses how governance actors acquire knowledge (i.e. learning systems), whilst section 6.4 assesses the flow of information from different actors who support CDM's adaptation learning process. The key finding of this chapter is that, apart from policies presented in Chapter 4 of this study, governance actors use varying sources of information to learn about CCA, ranging from municipal reports to forums and experiential knowledge. In this respect, adaptation learning processes availed to governance actors ought to accommodate different forms of knowledge outside of the scientific community.

6.2. Government actors who make decisions on climate change adaptation in CDM

In South Africa, the policy and decision-making as well as implementation process in general and including that of CCA is done through several rounds of deliberations by actors whilst also considering the principle of public engagement enshrined in the constitution (Teisman, 2000; Taylor, 2017). From workshop 2, five institutional actors were identified to be currently making decisions around CCA in CDM, as illustrated in Figure 6.1. The actors identified in the workshop are the DPEMS, Limpopo Department of Agriculture and Rural Development (LDARD), Limpopo LEDET, the Limpopo Department of Cooperative Governance, Human Settlements and Traditional Affairs (CoGSTHA) and the local municipalities who form part of the CDM and whom the district works with as part of cooperative governance. The actors identified above operate at varying levels of government, namely provincial, district and local municipality and in these three-tiers of governance, each entity has independent decision-making powers. In addition, these actors have policies and strategies for their respective jurisdictions in relation to CCA, which inform the governance actions they pursue to satisfy the needs and well-being of their constituencies. There are, however, other government departments, non-government actors from civil society and private sector (e.g.

AWARD and private farmers) who also help local government officials to make decisions on CCA in CDM. Such actors were identified in the interviews and participants indicated these actors assist CDM with technical support and information.

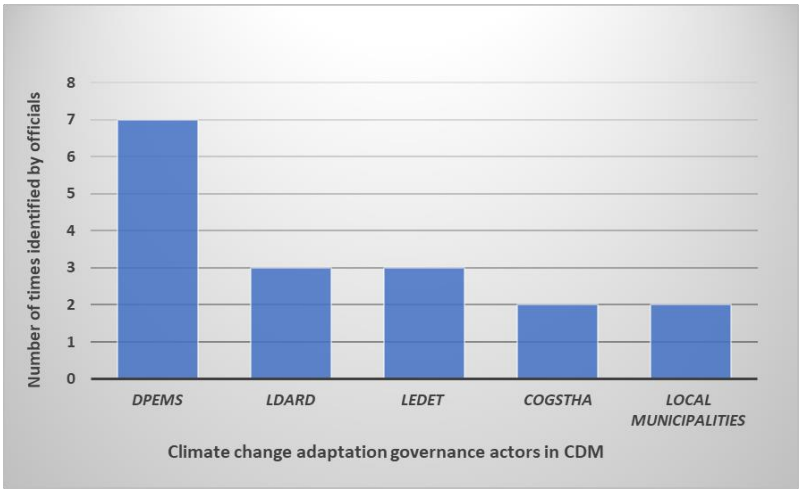


Figure 6. 1: Actors making decisions in CDM and the number of times they were identified by officials in Workshop 2, October 2017.

The following sections provide a brief overview of the governance actors indicated above, bringing to the fore governance structures, programmes and activities that inform decision-making in their constituencies.

6.2.1 CDM Department of Planning and Environmental Management

The CDM DPEMS was identified by seven respondents in workshop 2 as a governance actor who makes CCA decisions in the district. The department is charged with coordinating sustainable environmental management to support the districts' key economic sectors such as agriculture, tourism, mining and manufacturing. DPEMS is also responsible for LED planning and coordinates the IDP and budget process (CDM, 2014). The DPEMS is part of the municipal administration whose role extends to facilitating and coordinating climate change and CCA adaptation projects through programmes such as the Expanded Public Works Programme (EPWP).Two interviewees from the DPEMS shared that:

> *'We often sit and make decisions as a team from the CDM Environmental Management Services on which projects to implement on CCA, but these are implemented in partnership with local municipalities such as Polokwane Local Municipality'* (Participant 3, 2017).
>
> *' .. we make decisions as a team working within the Environmental Management Services section. I have also played a role in writing business plans that we present to our principals for approval and funding'* (Participant 11, 2017).

The CDM Environmental Management Services in a unit within the municipality that is led by a Head of Department and a District Municipal Manager who oversees the implementation of programmes and projects by local government officials with approval from the council. Drawing on the above narratives of officials from the DPEMS

and a review of the municipal documents, it is evident that the structure of governance within the municipality is multi-layered and varying actors have decision-making powers**.** In this respect**,** administrative officials in the middle and senior levels within the tiers of municipal administration prepare business plans and identify CCA projects. These are then presented for approval by the Head of the Department, district municipal managers and councilors who are part of the municipal executive structure, which Participant 11 referred to as the principals. In terms of the municipal executive structure indicated in Chapter 5 of this thesis (Figure 5.2), the council includes political actors whose interests, however, may be different from the CCA projects presented by administrative staff. An interesting feature of the principals highlighted by Participant 11 is that, although they wield decision-making power that influences the actions of the municipality, when offered they often do not take part in the learning initiatives targeted at governance actors within the municipality. Arguably, the exclusion of principals has contributed to a lack of political champions for CCA at municipal level and an appreciation of the urgency with which climate change should be prioritised, as discussed further in Chapter 7 of this thesis.

Notwithstanding the critical role and influential governance position the DPEMS occupies, with regards to CCA, there is no evidence that political officials have shown much interest in prioritising CCA within municipal operations to support its implementation. This is despite actions that would suggest otherwise, for example, that they have endorsed the undertaking of climate change vulnerability studies, the development of adaptation strategy and forums for CCA learning as recommended in international and national policies presented in Chapter 4. This apparent contradiction is a trend that has also been noted in larger metropolitan municipalities such as the Cities of Cape Town and Johannesburg (Taylor, 2017; Nana *et al.,* 2019). It can be argued, therefore, that decision-making on CCA projects is complex because it requires buy-in and collaboration from many actors that include local municipal officials, civil society, private sector, traditional leaders and communities in the district. The existence of multiple actors creates a chain of correspondence in decision-making that creates challenges for administrative officials in coordinating and implementing CCA actions when they lack the support of other key actors in their constituency. Furthermore, these key actors are not being included in adaptation learning initiatives, and this could contribute to a deepening rift among actors in the decision-making space.

6.2.2 Limpopo Department of Agriculture and Rural Development

During second workshop, three participants identified the LDARD as a key actor involved in decision-making on CCA within the municipality, especially on agriculture-related matters. The role of LDARD is to mobilise, distribute and utilise resources equitably and efficiently to support the agricultural sector to contribute towards economic growth and empowerment, job creation as well as poverty alleviation (LDARD, 2012). Highlighting the role played by LDARD in CCA decision-making, one official shared that:

> *'…the department selects projects based on needs on the ground and some of these are identified by our LandCare officials and extension officers'* (Participant 7, 2017).

The LandCare Programme, indicated by Participant 7 above, is one of the national programmes that seek to address natural resource degradation and enhance drought resilience in high-risk areas, as already discussed in

Chapter 4. LDARD as a provincial department is headed by a MEC and includes a Head of the Department, eight chief directorates, thirty-four directorates and a staff complement of about two thousand five hundred (LDARD, 2018). Decision-making within and between the directorates is a process that involves several individuals and similarly requires approval from the executive structures, i.e. chief directors, Head of the Department and the MEC. A review of LDARD documents shows that the department facilitates implementation of national programmes at lower levels using officials such as agriculture extension officers, but this also requires buy-in from and partnerships with local as well as district municipalities, traditional authorities, NGOs and community members (especially farmers). Hence, the LandCare officials and extension officers identified by the participant are key actors that help with the flow of information from the local communities to the department, which in turn influences the decisions and programmes that administrative officials develop to benefit the community. Similar to DPEMS, decision-making involves a chain of actors at varying levels of the society, however, the LDARD has to rely on other actors at district, local municipal and community level to implement CCA projects. Some challenges have been observed relating to the coordination of initiatives and decisions between these actors, as noted in Chapter 5 (section 5.2).

6.2.3 Limpopo Economic Development, Environment and Tourism

The Limpopo LEDET was identified by three officials in workshop 2 as a governance actor who also makes decisions on CCA in CDMLEDET operates at the provincial level coordinating sustainable use of the environment, economic development and tourism growth in line with the Limpopo Development Plan. In terms of the governance structure, the department is led by a MEC, head of the department, general and senior managers (LEDET, 2015). LEDET's work entails creating an enabling environment for the growth of sectors such as mining, agro-processing, manufacturing, tourism and transitioning to a green economy (LEDET, 2015). Concerning CCA, a review of municipal documents and interviews revealed that, LEDET is mandated to ensure sustainable development in the region through proactive responses to climate change, including creating green jobs (LEDET, 2015). One official during the workshop engagements shared that:

> *'LEDET has several climate change workshops where we are invited to take part and they also guide climate change initiatives at district and local municipal level'* (Participant 5, 2017).

This indicates that the department plays a coordinating role in channelling the flow of information and climate change initiatives. As discussed in Chapter 4 of this study, LEDET has contributed to the development of the provincial climate change strategy. More so, it coordinated the development of the district and local municipality adaptation strategies as part of the LGCCSP (i.e. a DEFF and GIZ initiative). LEDET has a provincial representative at the Intergovernmental Climate Change Committee (IGCCC) who represents the province and brings new information that is shared within the province through forums, emails and newsletters.

Several participants in the study criticised LEDET as they perceived that the department had not prioritised climate change in provincial strategic and planning documents, even though there is vast evidence of the impacts of climate change on the province. The perception was also shared by a participant working outside the province who supports learning in CDM:

'LEDET doesn't seem like they are doing much work to prioritise climate change adaptation other than the workshops with DEA' (Participant 21, 2018).

The sentiments of participants indicated above were seemingly informed by their observation that LEDET did not have its own CCA initiatives, except for those driven by external actors such as GIZ and DEFF. This indicated a lack of domesticated or homegrown initiatives that integrate local needs and interests.

6.2.4 Limpopo Department of Cooperative Governance, Human Settlements and Traditional Affairs

Two participants from the second workshop identified the Limpopo Department of CoGHSTA as a governance actor involved in CCA decision-making within CDM. Like the LEDET, CoGSTHA is a provincial department that is led by a MEC, a Head of the Department, chief directors and managers who supervise four main departments, i.e. administration, human settlement, cooperative governance and traditional affairs (CoGSTHA, 2015). In addition, CoGSTHA has programmes that focus on local government CCA support and development planning and extends this support to traditional leaders in line with cooperative governance. The rationale in this regard is that traditional leaders are the closest link between the municipal structures and rural communities. Thus they are both enablers of climate change buy-in at this scale and the most sensitive to community climate change needs. This was confirmed by Participant 5 (2017), who shared that:

'We engage with traditional authorities and they help us when we have environmental and climate change awareness days within communities'.

The above remark indicates that the governance of CCA is not just limited to the government but involves a diverse group of stakeholders such as traditional authorities mentioned above. Governance involves the management of state business and building relations between the state and citizenry.

CCA related decisions made by CoGSTHA for its constituency include disaster response and management and the upgrading or removal of informal settlements in high-risk areas. Disaster management initiatives by CoGSTHA are largely reactionary rather than proactive because disaster risk reduction has not been fully integrated into the service delivery projects, they administer to minimise the impacts of disasters. This raises difficulties when non-climatic stressors such as lack of water and other basic services are needed to orchestrate and accelerate climate change response given the current and projected impact of disasters in CDM. Climate change is however often relegated behind the more urgent challenges of infrastructure and service delivery a point that was emphasized by Participant 1 (2017) and Participant 14 (2018) among others and noted in other municipalities of South Africa (Nana *et al*, 2019).

6.2.5 Local municipalities: Polokwane, Blouberg, Molemole and Lepelle-Nkumpi

Local municipalities such as Polokwane, Blouberg, Molemole and Lepelle-Nkumpi were identified by two participants to be governance actors involved in CCA decision-making. In terms of the governance structure, local

municipalities represent government as public actors responsible for steering decisions and actions to achieve public value (i.e. meeting societal needs). Local municipalities make decisions on spatial planning, land use management and development as articulated in Chapter 3 of the Constitution (RSA, 1996) and the Municipal Structures Act (Act 117 of 1998). This tier of government also has an executive and administrative structure that makes decisions with inputs from communities through public participation processes. National climate change policies and programmes presented in Chapter 4 (e.g. Climate Change Response Policy and DEFF's Local Government Climate Change Support Progamme) have highlighted the role of local governments in climate change response hence the need for learning to support decision making. Representative officials from all four local municipalities in CDM have participated in the DEFF LGCCSP in 2016 where they contributed to the development of the CDM climate change response plan as stakeholders who make decisions on CCA in their respective municipalities (DEA *et al*, 2020). To further illustrate the role of local municipalities in steering decision-making in their constituencies, two public officials interviewed in this study shared that:

> *'As a municipality, we identify projects based on information we gather from communities when we have our stakeholder meetings during the IDP process but most of the projects are around awareness-raising'* (Participant 8, 2017).

> *'Local municipalities identify projects that they would like to implement based on various things such as resident's needs'* (Participant 13, 2017).

The responses shared by the officials above shows that there is an additional group of actors, i.e. communities, who influence municipal activities during the public participation process. Communities although they had not been identified as a decision maker are key actors in CCA response at the local level (Granderson, 2014; Khatibi *et al.,* 2021). Local municipalities are mandated by policies such as the South African Constitution and the Municipal Systems Act (Act 32 of 2000) to engage communities to facilitate the integration of inputs by interested and affected parties. In fulfilling their governance role at the local level, municipalities therefore derive their mandate from both the state and local communities, which tends to present this actor as a weak player when it fails to meet the competing demands on service delivery and CCA. This challenge was expressed by Participant 7, who shared that:

> *' We find it difficult to get buy-in when the initiatives we propose to meet CCA targets are not recognised as important for the local community as they want the municipality to firstly provide houses, water and roads'* (Participant 7, 2017).

The comment by Participant 7 above shows that CCA decision-making and actions prioritised at the local government level are informed by inputs from stakeholders outside the municipal structures who have different interests and priorities. Consequently, decisions on CCA may not be prioritised due to a lack of buy-in and collaboration from actors such as communities and traditional authorities who, as pointed out above, seem not to have a full understanding of the relationship between climate change response and development. The response also indicates a gap in learning from local authorities and the inability to recognise that CCA is aligned to the way

they provide basic services such as housing, water and electricity. Additionally, current legislation has also not provided a clear description and mandate on the role and responsibilities of local municipalities in addressing climate change which has also contributed to lack of agency at this level of government and this gap could be addressed by the Climate Change Bill.

Fukuyama's (2013) deliberations on governance as a measure of a state's scope and strength helps to understand the functions of governance actors and how their context might influence their ability to implement this function effectively. Governance actors identified by all participants tend to have a broad scope (i.e. function, authority and responsibilities to meet their mandates) but limited strength, i.e. capacity to plan, implement and assess the impact of their initiatives. As such, there is evidence of decision-making, however the implementation thereof is not meeting the expected outcomes, a key challenge also noted in municipalities such as eThekwini (Leck and Roberts, 2015) and the City of Johannesburg (Nana *et al.,* 2019). Decision-making on CCA in all constituencies, as discussed above, is a complex process and has implications on learning as this involves multiple actors some of which have misconceptions about CCA and how it should implemented. Actors have dynamic relations within and across the three tiers of governance, and this creates a mix of bottom-up and top-down decision-making processes that are often difficult to manage. Furthermore, this makes it difficult to predict how these actors respond and integrate climate-related information that requires them to change systemic issues such as municipal norms and practices. The complex relationships outlined here illustrate that public policy and development challenges are governed through a network of independent as well as autonomous actors, i.e. local, district and provincial departments, traditional leaders and communities who have an established continuing relationship as required in the constitution. The dependence between these three spheres of government and the need for public participation provides a framework for coordination between state and non-state actors to support poverty alleviation, social and economic development as well as learning as part of the governance network. In the next section, I discuss how learning on CCA occurs within this network of governance actors.

6.3. Sources of information used to support learning

To understand the adaptation learning process, I had to first answer the question: W*ho learns* about climate change? The previous section pointed out DPEMS, LEDET, LDARD CoGSTHA and local municipalities as governance actors involved in CCA decision-making. In so doing, I was able to contribute towards addressing the knowledge gap identified in Chapter 1 by drawing from Fünfgeld (2015) and Wolfram *et al.* (2019) on the need to understand the governance actors who make decisions and participate in CCA learning. Following from this, I also explored a further gap identified by Fünfgeld (2015) and Wolfram *et al*. (2019) relating to how these actors learn and from whom. In this section, I attend to the latter gap on whom they learn from by focusing on the learning systems used by governance actors to inform what they know and understand about CCA.

During the workshop and interview engagements I invited participants to share information about the sources of information they use to learn (*learn from whom*). Participants indicated that they acquire climate change and CCA information from media, secondary materials and peers in different sectors, and collectively these sources form

their learning system. In the following section, I provide a detailed analysis of the sources of learning identified by the participants.

6.3.1 Materials and media that provide CCA information

A review of policies and programmes presented in Chapter 4 (e.g. National Climate Change Adaptation Strategy (DEA, 2019), LGCCSP (DEA, 2015), SARVA (SAEON, 2019), interviews and workshops provided insights into the materials, media and actors that provide CCA information for decision makers in CDM. These include policy documents developed by national and subnational actors, scientific outputs such as journals and information portals, internet and traditional authorities. Figure 6.2 indicates the sources of information that participants from workshop 2 identified as avenues they use to gather information on climate change and CCA. Feedback from workshop 2 highlighted that the most common source of information was forums and networks, which was mentioned by eleven actors., municipal reports, policy documents and the internet followed suit, as indicated by eight, seven and six participants, respectively.

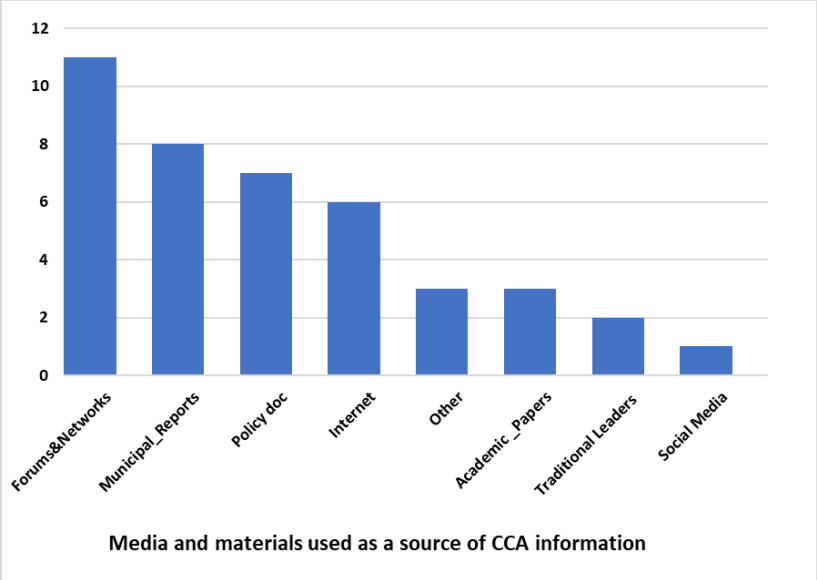


Figure 6. 2: Media and materials used by CDM officials as sources of climate change adaptation information as identified by participants in workshop 2.

Further to this, I requested the participants to identify the sources of information that they found to be the most effective in supporting CCA learning. Their responses are illustrated in Figure 6.3. The participants pointed to forums and networks, municipal reports, the internet, policy documents and short courses as the most useful sources of information.

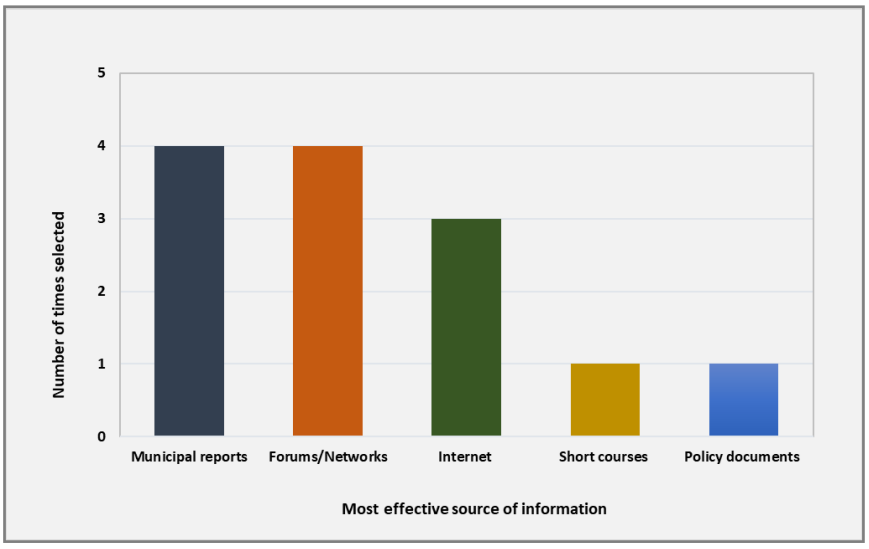


Figure 6. 3: CDM Officials perceptions of the most effective sources of information that support learning as identified by participants in workshop 2.

A detailed discussion of the identified sources of information and their usefulness in learning is provided below. Furthermore, I unpack the learning typologies that emerge from the use of the identified sources of information providing insight on their benefits and shortcomings, drawing on perceptions of the research participants and secondary literature.

a) Forums and networks: Informal and self-directed learning

Eleven officials selected forums and networks as a source of information used to learn about CCA. In addition, four officials considered these to be the most useful sources of information for learning because they are internal and self-driven social learning processes. Information shared in workshops includes experiences of weather-related events, the impacts on the sectors and climate research and policy related information received from external stakeholders. Examples of forums cited by participants include the Capricorn District Environmental Forum, Provincial Climate Change Forum, Disaster Management Forum, Air Quality Forum and the Limpopo Agriculture Steering Committee. These forums are non-political but recognised official structures within the municipality that are coordinated at the provincial and district level to allow for informal discussions, collective learning and knowledge sharing.

In-house coordination of these forums by governance actors enables them to set the agenda and have greater control as well as ownership of the learning process and information is considered credible as it shared by peers with whom officials have established relationships with. By driving their learning process, governance actors also manage to identify areas in which they require additional support to enhance learning. In these instances, external experts are consulted or invited to provide support in addressing complex topics identified. The use of external experts in forums was highlighted by Participant 22 (2018), who shared that:

'The municipality also coordinates with external stakeholders to share knowledge in their forums…'

External stakeholders who are invited include NGOs such as AWARD, academics of University of Limpopo and researchers from the CSIR and SAEON. The role of the epistemic community in these forums is, however, limited because they are only engaged to address areas of specific need without any further assessment of the impact of information shared. Assessment of learning is integral to knowledge production in that it helps both the learner and facilitator to gather evidence to demonstrate achievement of the intended learning goals. The facilitation provided by external experts tends to provide piecemeal information which is offered without a full understanding of the context and application thereof.

Literature shows that forums have been used in other contexts to support situated and collective learning about CC and disaster risk management (Vincent *et al.,* 2018; Kong *et al.,* 2020). Gaps, however, exist in the ability of forums to influence systemic changes within municipalities as forums have no authority over the municipal structures and processes that should be changed to promote double-loop learning and/or transformative adaptation. Moreover, the success of forums is also dependent upon the presence of skilled facilitators and political champions to ensure buy-in from actors who attend these learning events as well as the municipal executives who often do not participate in these initiatives (Kong *et al.,* 2020). Owing to this, the forums seemingly promote incremental adaptation as participants continuously receive more information with little impact on municipal operations as well as the factors that increase vulnerability.

Three climate change networks, namely the Adaptation Network[4], Ethical Leadership[5] and Future Earth[6] were mentioned as other sources of information utilised by the research respondents. Participant 3 (2017) pointed out that:

> *'As a member of the Adaptation Network and Future Earth I have been able to access general information on climate change as well as information on climate change initiatives that are being done elsewhere where we can get best practices to also implement in Limpopo'.*

Participant 8 (2017) added that:

> *'Awareness-raising and exchange of knowledge are done through forums such as the Ethical Leadership on climate change. This is a faith-based organisation led by Reverend Pataki and they are championing climate change in the province'.*

Participation in networks illustrates the ability of officials to develop personal social learning networks that are outside the formal forum boundaries. Full participation of government actors in networks, however, requires institutional and management support since networks are entities outside of municipal structures (Oettle *et al.,* 2014; Kong *et al.,* 2020). Networks have a less formal structure, and officials in CDM join them as an unofficial

[4] The Adaptation Network is a national initiative created to enable stakeholders from government, business, parastatals, civil society, research and academia to share experiences and find 'out of the box solutions' that support CCA. See https://www.adaptationnetwork.org.za/

[5] The Ethical Leadership on Climate Change is a Limpopo based initiative whose work focuses on environmental ethics through awareness-raising and training of local environmental actors in the province. See https://ethicalleadership.org.za/

[6] Future earth is an international network of scientists, researchers and innovators who share knowledge and collaborate on projects that support transformations towards sustainability. See https://futureearth.org/

activity that provides social capital to support individual and collective learning. As members of the network, they share ideas and experiences with other members through in-person meetings or online platforms where learning is provided by peers. Thus, the networks create opportunities for members to get support from a wide-reaching pool of actors with similar interests, creating a CoP, a feature that has also been noted by Pelling and High (2005).

Further to peer learning in informal workshops, the Adaptation Network provides members with a help desk where they get learning support on adaptation-related queries. Importantly, these learning platforms have played an advisory role to governance actors but have limited ability to influence decisions or transformative actions in CDM, a trend that has also been noted by Downsborough (2009) and Kong *et al*. (2020). The success of these learning systems is influenced by their ability to integrate language diversity, values and cultural systems that are used. However, in the case of CDM, Sepedi is the main language spoken, yet most interactions in forums and networks are done in English, which is a minority language, as shown in the previous chapter.

Networks have also been noted to play a key role in advancing knowledge in wealthier cities, particularly on efforts to reduce GHG emissions (Fünfgeld, 2015; Busch *et al.,* 2018), and it is assumed they can also do the same for adaptation, especially in developing countries which are more vulnerable to the impacts of climate change (Heikkinen *et al.,* 2020). In this respect, my study contributes to this knowledge gap and has identified some of the networks used by officials to support CCA learning in CDM through self-directed and informal learning. However, measuring the impact of the information that is shared through these social learning systems is not easy as the information is not necessarily implemented. Some of the reasons for non-implementation are that:

> *'The wrong people are attending the capacity building workshops, hence no implementation takes place thereafter',* (Participant 17, 2018).
>
> *'We do not always know how best to engage and share knowledge, hence some of the products we have and anticipate would help do not seem to be utilised*', (Participant 24, 2018).

The comments made by interview participants 17 and 24 above highlight gaps in the design and implementation of learning initiatives as they fail to include all the decision-makers to enlighten the intended users and make consensus-building easier within the municipality. In interacting with research participants, I found that forums and networks, although they are a useful platform for collective learning and information sharing, however, if not well coordinated and sustained they offer piecemeal information that promotes short-term adaptation responses. Furthermore, they can also be made redundant, especially when they are not well coordinated and can cause participation fatigue when they fail to address the real-life institutional issues that municipalities are faced with. Moreso, networks contribute to lifelong learning for individuals and collective knowledge production but they also face institutional barriers that impede uptake of lessons learnt. Literature suggests that networks need to be strengthened to allow for knowledge sharing on local best practices that are closer to home that illustrate how municipalities can integrate CCA into existing municipal operations and structures (Geist and Howlett, 2013; Busch *et al.,* 2018; Heikkinen *et al.,* 2020).

b) Municipal policy documents and reports: self-directed learning

Municipal reports and policy documents were selected by eight and seven officials respectively in workshop 2, as key sources of local-level information that supports learning on CCA. Four officials considered municipal reports as the most effective source of CCA information. However, only one official identified policy documents as the most effective source of information. The reports and documents identified by officials include the IDP, Bioregional Plan, Land degradation assessment report, Comprehensive Agriculture Support programme reports and the Disaster Management Act. Officials explained that municipal reports and policy documents captured the realities of the local populations, which they were familiar with and they often contributed to their development. Reasons offered by participants on why municipal policy documents and reports are not the most effective sources of information include:

i. Lack of comprehensive information to guide adaptation given the complexity of factors that enhance social vulnerability;
ii. The documents are, at times, not developed to be used as sources of information for learning but rather for compliance with national directives, hence they may not be directly relevant to immediate operational needs;
iii. Information contained in these documents may be outdated because of slow revisions, and this creates a lag in responsiveness to the changes in the science and/or the operational contexts. For example, the CDM Climate Change Adaptation Strategy has not yet been finalised although it was developed in 2016. This gap denotes a lack of coherence and traction towards the other phases of the adaptation action cycle (i.e. policy adoption, implementation and evaluation);
iv. Policy overload that makes it difficult for officials to know the policy (as well as directives) they should be using. It is, therefore, easier for them to avoid and use other sources.

c) Internet: self-directed learning

Six of the respondents in workshop 2 selected the internet as a source of information. Added to this, three of these officials considered the internet as the most effective source of information. Participants elaborated that the internet has enabled them to access information from websites, email as well as social media. When using websites and social media pages, officials are required to have internet access and be tech-savvy in order to employ appropriate information search skills to gather relevant and credible information from online sources.

The internet has been applauded for improving dissemination and access to information, allowing individuals and organisations to benefit from the digital economy and society (Twigg, 2004). The internet supports self-directed learning, and this gives governance actors greater independence of the learning goal/s and choice to select what is worth learning. Officials in the study shared that they search for and use information drawn from online sources for decision-making, learning and to inform local strategic documents as well as business plans. Specific examples of websites they use include SANBI, where they gather information on the management of alien invasive species, the World Agroforestry (to obtain information on sustainable land management initiatives that promote food security

and soil conservation) as well as Review Online for daily news updates. Two of the respondents expanded on the above by stating;

> *'We have a research unit where members in that department search for information on the internet and in journals which they use to write business plans and recommendations on which activities to focus on'* (Participant 3, 2017).
>
> *'We do internet searches on work done that also usually includes images to illustrate what has been implemented in other places'* (Participant 10, 2017).

The internet allows users to have a wide range of information which includes grey literature, peer-reviewed publications, current news and best practices shared through, for example, PowerPoint presentations and videos, most of which can be accessed for free. It also includes a lot of unreliable information that a naïve user must wade through to build their confidence in the topic (Najjar, 2011). Access to the internet has also enabled the use of email as a means of communication which allows for relationships to be established between individuals within and between organisations. Officials, however, indicated that although the email has improved communication within the district, some of their colleagues do not always read email attachments. For example, some of the email attachments may be advertisements on call for proposals, hence they miss out on information and opportunities to secure funds to support the implementation of CCA initiatives. Furthermore, officials highlighted that they do not always have internet access at work and they often access internet at their own cost limiting their ability to participate in online based learning activities which use a lot of data.

Advances in ICT technologies have facilitated new ways of knowledge acquisition, knowledge exchange and knowledge production for individuals and groups (Cress and Kimmerle, 2017). ICT has for example enabled local actors to acquire information from new and innovative electronic platforms such as social media which facilitate social interaction (Voinov *et al.,* 2015; Murambadoro and Mambo, 2017b). Twitter and Facebook were specified as the social media platforms used to access information on CCA by following tweets and pages for institutions such as DEFF, SAWS and the Department of Water and Sanitation (DWS), among others. The DWS has been using Twitter to raise awareness on water conservation in response to the recent drought (South African Government Twitter page: @Government ZA, 2019). The DEFF has also been using Twitter to, among other things, improve understanding of the public's level of awareness on climate change and data collection through a survey (DEFF Twitter page 2019). The SAWS use both Facebook and Twitter to disseminate weather forecasts.

Globally, social media has undeniably transformed the way people live, work, communicate and learn by facilitating the dissemination of information to many people in a short space of time, something which would not have been possible with hard copy publications such as books and reports (University of Arizona Global Campus, 2020). Users of platforms such as Twitter can retweet (re-post) the message, reply to posts as well as mention other users who share the same value systems on the post, creating a virtual learning platform that transcends the boundaries of the CDM (Samantray and Pin, 2019). The challenge of social media platforms such as Twitter and Facebook as

sources of information is that they also contain fake news that impacts the credibility of information obtained from them, something which may also be difficult to discern for a naïve learner and non-specialist.

d) Self-directed learning through academic and scientific literature

Academic and scientific publications were selected by only three officials as a source of information and they initiated the curiosity-led learning process. Examples of scientific literature used by officials include articles in the local Journal of Disaster Risk Studies, IPCC reports, Long Term Adaptation Scenarios Flagship Programme reports, research reports by institutions such as the CSIR and SANBI and students' theses from local universities, i.e. the University of Limpopo and the University of Venda. The universities were identified as a key source of information that provides officials with science in the context of its application which officials can relate to (see Bielak *et al.,* 2008). The use of these publications illustrates self-directed learning as officials are driven by their curiosity and take the initiative with or without the support of others to identify scientific journal papers, reports and books that would help meet their learning goals. These can be accessed electronically on the internet (paid and open access), shared via email or as hard copies. However, none of the officials selected academic and scientific publications as an effective source of information, highlighting a science-policy-practice disconnect. Possible reasons for this disconnect include the challenges with conceptualising the information in scientific publications as a suit for purpose as it is often too technical and difficult for some non-specialists to read through (Najjar, 2011). Equally important, scientific information is only one source of information that municipalities usually make use of, and both experiential and tacit knowledge are two examples of additional information that may be used to navigate complex change, including climate change. Scientific and academic journals are presented in English which presents challenges for learners who do not have English as their first language. There is limited effort to develop and disseminate clear terminology for climate change related terms in most of the South African languages, and individuals understanding of these terms varies depending on factors such as location and how they experienced it. The variations in understanding and interpretation from area to area makes providing standardised translations more difficult.

Consequently, though there is no one way of increasing uptake of information, there is increasing evidence that engaging the users in the knowledge production as a process can help interactions across the science-policy-practice interface (Roux *et al.,* 2006; Audouin, 2011; Cook *et al.,* 2013; Roux *et al.,* 2017). The Embrace Project, for example, by Pelling *et al*. (2015), aimed at building the resilience of European communities to disasters, also confirmed that leaflets and/or books are often impersonal and do not allow the reader to engage with the writer and share ideas and experiences to co-produce knowledge which often makes it difficult for the reader to apply this knowledge. Gibbons *et al*. (1994) has described this linear science production model (science transfer to the user) as Mode 1 knowledge production. Therefore, there is a need to connect across the science-policy and practice interfaces (Modes 2 and 3) by creating an enabling environment for actors to collectively experiment and learn how others enact CCA (Ensor and Harvey, 2015).

e) Other sources of climate change information identified by officials

Three of the officials also identified other sources of information they use to access information on CCA. These include the experiential and indigenous knowledge, Office of the Mayor, short courses and the municipal newsletter where they access different types of information (Table 6.1).

Table 6. 1: Summary of other sources of information identified by participants in CDM identified during workshop 2 and validated during individual interviews.

Source	Example of information accessed
Experiential and indigenous knowledge	• Officials also have personal experiences of climate change-related extreme weather events in the areas they work and live. Traditional leaders often use platforms such as the community engagement workshops and municipal forums to share traditional and indigenous knowledge on issues such as the impacts of droughts on agriculture productivity, early warning and seasonal forecasts
Office of the Mayor	• The Office of the Mayor often shares climate policy or project information received from internal and external stakeholders through staff meetings and memos distributed within the district.
Short courses	• Institutions of higher learning that can provide short courses on climate science and climate change response. These include local tertiary institutions such as the Limpopo University and the University of Venda who offer short courses on request
Municipal newsletter	• The municipal newsletter CDM Talk is published quarterly and highlights the completed public service delivery initiatives, community engagement and awareness-raising campaigns, communities in need of intervention, as well as special features on local champions (e.g. in business, sports etc.).

Table 6.1 highlights additional sources of information that can support informal, self-directed and formal learning. The participants elaborated that apart from codified knowledge in publications such as municipal reports and newsletters, they also tapped into indigenous and experiential knowledge to understand changes in climate variables. Participant 2 (2017) shared that:

> '*In our community, we know its spring when trees such as mangos start flowering and in winter we know that the days are short and the nights are long*'.

The comment above points to the symbolism that participants have developed through socialisation within their respective communities as part of social learning. Other indigenous weather indicators that they have identified through lived experiences are noting the colour of vegetation between season, the behaviour of insects and animals, which has become intuitive knowledge that helps them recognise transitions through seasons. Existing studies have highlighted the role that indigenous and traditional knowledge systems play in the management of natural resources and land management, which contributes to CCA (Gyampoh *et al.,* 2009). For example, Ecosystems Based Adaptation has been identified as one approach that can be harnessed to integrate local capacities and indigenous knowledge (Makondo and Thomas, 2018; UNESCO, 2018b).

The integration of indigenous, tacit and local knowledge in CCA allows for active intergenerational learning on climate change response which is an important part of lifelong learning as it builds on social learning through

knowledge, value and skills sharing. It also facilitates improved shared understanding of the complex interactions between natural and social systems that may enable or constrain adaptation efforts (UNESCO, 2018a). Anticipatory learning theories also suggest that to advance adaptation, social actors need to reflect on the strengths and limits of their existing knowledge (e.g. experiential and indigenous knowledge) to create new memory (Walker *et al*. 2006, Marx *et al*. 2007, Bohensky, 2008; Tschakert and Dietrich, 2010). Social learning systems such as networks and forums can also facilitate constructive dialogue to address conflicts that may arise between different knowledge types (and experiences) and enable compatibility of plural world views (Pelling and High, 2005; Roux *et al.,* 2006; UNESCO, 2018a; EMIL, 2020). Furthermore, there is need for climate change terminology and experiences to be documented in African languages so that this is not confined to English to allow learning and knowledge sharing in a language of choice.

In this section, I have highlighted the materials and media sources that are used by officials in learning through individual and collective learning initiatives. These media demonstrated that governance actors rely on four lifelong learning typologies to acquire knowledge about climate change and CCA. My interactions with the officials further pointed out their preferences around learning systems available to them. They are inclined towards forums and networks as opposed to scientific and academic publications. Each of these learning systems, however, has its strengths and weaknesses, as discussed above. Following on from identifying the materials and media that officials use to learn about CCA, the next section explores the actors who support learning as part of the learning systems, and I further analyse their interactions using the social network analysis.

6.3.2 Actors who support CCA and the type of support provided

Section 10.3 of the National Climate Change Response Strategy recognises and propagates for the collaborated efforts for climate change response in South Africa, drawing on the input of stakeholders such as the private sector, civil society, academia and scientists (DEA, 2011). During Workshop 2, I requested participants to identify actors who support learning in CDM. They pointed out 11 key actors, namely CSIR, DEFF, University of Limpopo, LEDET, NGOs, Development Bank of Southern Africa (DBSA), SAWS, GIZ, DALRRD, Department of Public Works (DPW) and SANBI. I used interviews to validate and explore further details about the actors identified, and more stakeholders were revealed, resulting in a total of 22actors (Table 6.2). The actors identified below are not an exhaustive list as the study relied on respondent experiences and perceptions, which may not capture the full database of players involved with the district.

The forms of support provided to local governance actors by external stakeholders include capacity building, funding and technical support which benefited both individuals and their organisations. Actors that provide capacity building support are DEFF, LEDET, SALGA, University of Venda, CSIR, NGOs (i.e. AWARD and Choice Trust) and SAWS through workshops that result in self-directed, non-formal and informal learning. Funding for the initiatives they conduct is often provided by organisations such as GIZ, DALRRD, DPW, DBSA, SANBI and International Council for Research in Agroforestry (ICRAF).

Table 6. 2: Workshop 2 and interview participants' perceptions of actors that support learning in CDM and how the information filters through to local actors to support learning.

Actor	Type of support or role in CCA learning	How does this support filter through the different levels of government
Department of Forestry, Fisheries and the Environment (DFFE)	Support local governments with capacity building through workshops and attachment of officials at district level; coordinate the development of climate change response plans at the local government level; manage funds that comes through national programme and international organisations such as GIZ; provide environmental information and toolkits	Provide DFFE Local Government Support Officials who promote peer to peer learning; capacity building workshops & policy documents; information portals e.g. http://environmental-impact.org.za/site/home/dea-local-government-support-program/
Department of Agriculture land reform & rural development	Funding for projects and programmes e.g. Fetsa Tlala and LandCare projects; technical support	National Assessment Panel (NAP), Guideline documents, (e.g. LandCare); policies; conservation agriculture forums
LEDET	Capacity building workshops; central in the development of the district and local municipalities climate change response plans; technical support	District and provincial forums, Provincial Climate Change working group
Capricorn District Municipality Council	Municipal managers play a role in the approval of projects; community engagement when implementing projects and awareness-raising	Forums e.g. District Development Planning Forum, Premier's Intergovernmental Forum; Workshops
COGSTHA/Disaster Management	Collaborate with CDM when implementing national programmes at the local level	Forums, workshops
SALGA	Information and technical support; capacity building	Workshops; technical documents and tools also available online http://www.letsrespondtoolkit.org/
Department of Public Works	Funding for EPWP projects	EPWP Forum
LDARD	Implementation of national programmes e.g. LandCare; conservation agriculture projects; monitoring of projects; capacity building, funding e.g. Land Care grant	Provincial Assessment Panel; Limpopo Department of Agriculture Steering Committee; Workshops; research publications
IGCCC	Information	National and provincial officials attend IGCCC meetings and share information with lower levels of government through forums and municipal meetings and memos
University of Limpopo	Information; technical support and implementation of projects especially agriculture projects	Information is shared through workshops and students research thesis available at the university library or online; collaborate with sector departments to implement projects
University of Venda	Technical support; capacity building and implementation of projects	Workshops with local officials and students research thesis available at the university library or online, conferences
Development Bank of Southern Africa	Funding for infrastructure projects and technical support	Technical support officials assigned to work at the local government level
GIZ	Funding for Local Government Support Programme and community-based natural resource management project, technical support and training	Capacity building workshops coordinated by DFFE, SALGA etc
Council for Scientific and Industrial and Research	Technical support; capacity building and information on climate change and CCA	Workshops and scientific publications, tools e.g. Green Book
NGO's- AWARD, Choice Trust	Implementation of projects in communities; community engagement and awareness-raising; training	Provide training and capacity building workshops; Cross learning tours and tools such as guidelines, manuals, etc
SANBI	Funding and technical support	Workshops; Scientific publications/reports, website
Local municipalities	Implementation of projects and provision of local-level information	Workshops, Forums e.g. Disaster management
South African Weather Service	Provide weather and climate information including early warning information. Participate in provincial and district information sharing/ capacity building workshops when requested	Workshops, radio, television, newspaper, social media (e.g. Twitter) and Smart Weather Application, NDMC
Media	Dissemination of climate change information including awareness-raising	Online, print media and radio e.g. Capricorn FM
ICRAF	Funding and technical support	Information shared through websites and networks
Communities	Share information on current and past climate risks and adaptation/coping measures based on IKS; help with identification and prioritisation of CCA projects	Community workshops and Community Development Workers
Traditional authorities	Share information on current and past climate risks as well as adaptation/coping measures based on IKS; implementation of projects; dissemination of information	community workshops, Municipal council meetings and Traditional leaders' forums

Institutions that provide technical support, such as designing development projects, include the University of Limpopo, University of Venda, DBSA and SANBI. Other than the above support, actors such as DEFF, traditional leaders and NGOs attend, and support initiatives implemented by the CDM officials. The presence of these actors enables knowledge sharing and buy-in of a wider network of actors within the local community.

The support provided by the different actors indicated in Table 6.2 filters through for example technical documents, workshops, policy and guideline documents that are designed to support learning at local level. Technical, policy and guideline documents are shared to local government officials as hard copy documents or internet links that that be accessed through for example the municipal or an external website. Accessing information through the internet as has already been discussed is difficult for the CDM officials who have limited ICT resources and requires them to be tech-savvy to navigate through the websites. Furthermore, technical, policy and guideline documents have been criticised by some participants for being the least effective sources of CCA information to support learning as these do not address their immediate operational needs and fail to integrate indigenous knowledge. The actors supporting learning also share information through workshops whereby they make use of presentations and other methods to support learning and often use English as the l*ingua franca.* Most officials in CDM and the general population do not have English as their first language hence this presents a challenge for learning as some information loses its meaning during translation. The provincial forums, climate change working group and municipal council meetings facilitate non-formal and informal learning because they provide social learning platforms where local learners interact and generate knowledge through peer learning.

Actors such as DEFF and DBSA promote peer-to-peer learning by deploying officials to leverage skills and capabilities to enhance service delivery in sectors such as health, housing, education and municipal infrastructure programmes. For example, the DEFF has an assigned district-based environmental officer who supports environmental-related initiatives in CDM. Participants pointed out that peer learning relieves pressure on municipal officials who are overstretched and enables skills transfer from the experts deployed. It also provides technical experts with an improved understanding of the context of the application and has been identified as one of the fastest ways to facilitate deeper learning (Pelling *et al.,* 2015). Actors who share similar goals with CDM may be easily mobilised to support municipal development challenges that can also reduce the impacts of climate change as they share similar mandates, creating communities of practice that facilitate resilience building (Pelling, 2008; Pelling *et al.,* 2015).

The flow of policy information from actors at the national level, such as DEFF, SALGA, DPW, to sub-national level departments and municipalities in CDM, provides insights into processes that support the diffusion of national policies facilitated by the polycentric governance system (Tosun, 2018). However, policy formation and diffusion do not necessarily result in the uptake of policy innovations at a sub-national level due to issues such as limited human and financial capacity and competing developmental priorities, which have been discussed in Chapters 4 and 5. In the following section, the focus is on how the actors discussed in this section interact to promote the flow

of information to governance actors in CDM. I employed social network analysis to illustrate how actors influence learning by using measures such as degree of centrality, prestige, betweenness centrality and nearest neighbour.

6.4. Interrogating the flow of support based on the interaction of actors in the social network

In this section, the social network analysis is used as a tool to help make sense of all the interactions discussed thus far and to analyse the interactions between the actors who support learning as well as the flow of information in CDM. Four measures are used: the degree of centrality, prestige, betweenness and nearest neighbour, which have been described in Chapter 3. These four measures were selected for analysis in this study because they illustrate key actors who supply information to CDM as well as connect the municipality to other actors who are sources of information. They also illustrate actors who are within reach of the CDM and can support learning as well as CCA initiatives in the area. The social network analysis is thus well suited for examining the flow of information in CDM and providing an improved understanding of how governance actors learn and the channels through which information flows to the municipality. The centrality measures were mapped using data collected from Workshop 2 which included the hand drawn map that showed the interactions of actors and their level of influence. This was validated through the twenty-nine interviews which highlighted the actors and their linkages in a network matrix. The data was then analysed through VisuaLyzer software to illustrate the different network maps and centrality measures. The information generated from this analysis is useful in identifying major actors in the climate change knowledge enterprise and informing how they can be best positioned to meet the learning needs of governance actors in CDM.

6.4.1 Degree of centrality and prestige of actors supporting learning in CDM

As discussed in Chapter 3, the degree of centrality denotes the number of ties, connections or links between actors within a network. Actors with the highest number of ties are said to have a high degree of centrality, which means they have a higher number of connections within the network. Having a higher number of connections influences the contributions that the actor makes in a network regarding the ability to receive and disseminate information as well as influence individual as well as collective learning. In Table 6.3, results show that there are 161 links between the actors/nodes in the CDM network based on the responses provided by the participants. The network's average degree of centrality is 14,636, which indicates that actors within the network are highly connected.

The actor with the highest number of connections, CSIR, has 24 links, whilst the actor with the least number of connections is ICRAF with one link (Table 6.3). Scholars such as Schiffer and Waale (2007) point out that actors with the highest number of connections assume the role of being both a supplier and recipient of information within the network. In this study, research participants indicated that the CSIR was a key actor in providing CCA information, which corroborates existing literature (Schiffer, 2007; Mishra, 2017; Hanneman and Riddle, 2019) that highlights the connection between actors with a high degree of centrality and their role as major players in the network.

Table 6. 3: Degree of centrality for the actors supporting learning in CDM based on interviews with participants.

Degree centrality			
Node number, actor	**Degree**	**In-Degree**	**Out-Degree**
14.CSIR	24	11	13
15.NGOs	23	10	13
1.DEFF	22	12	10
3.LEDET	22	13	9
17.Local Municipalities	22	13	9
4.Capricorn District Municipality DPEMS	21	15	6
8. LDARD	20	12	8
5.CoGSTHA/Disaster Management	19	12	7
7. Department of Public Works	17	10	7
10.University of Limpopo	15	9	6
18.South African Weather Service	14	5	9
11.University of Venda	14	8	6
22.Traditional authorities	14	1	13
6.SALGA	12	8	4
19.Media	12	10	2
21.Communities	12	1	11
12.DBSA	9	2	7
2.Department of Agriculture Land Reform and Rural Development	8	2	6
9.IGCCC	7	4	3
16.SANBI	7	3	4
13.GIZ	7	0	7
20.ICRAF	1	0	1
AVG:	14,636	7,318	7,318
STD:	6,300	4,799	3,322
MIN:	1	0	1
MAX:	24	15	13

The CSIR could have attained a high degree of centrality because of the recent activities it organised within the network during the study that allowed for information sharing through projects such as SARVA and the Green Book, as discussed in Chapter 4. During the fieldwork, officials shared that the workshops coordinated by the CSIR provided scientific information and capacity building. Hence the CSIR in this network is a key source of information

within the network, and this is also illustrated in Figure 6.4 by the inbound and outbound arrows indicating the connection it has with other actors in the network.

A visual depiction of the connections between social actors based on the degree of centrality and prestige illustrated in Figure 6.4 provides insights into the interactions between major and minor actors who support learning in CDM. There is evidence from Figure 6.4 that learning within the network is a very messy and complex process because of the varying channels of interactions that information goes through to get to governance actors in CDM. Actors who are more connected and receive more information from several actors in the network can provide CDM with more information because of their ability to connect with other actors in the social network. These connections allow them to share the information and exploit the network to meet their resource needs, a feature that was also noted by Mishra (2017) and Smith (2019).

Apart from the CSIR, NGOs have the second-highest degree of centrality with a score of 23. They provide information/support to 13 actors and receive information/ support from 10 actors. The DEFF has the third-highest degree of centrality with a total of 22 links. It receives information/support from 12 actors (in-degree) and sends out information to 10 actors (out-degree). On the contrary, ICRAF, GIZ, SANBI, IGCCC, the DALRRD and universities have the lowest scores on the degree of centrality and prestige, i.e. 1,7,7,7 and 8 respectively. These scores indicate that they are not major actors in receiving and disseminating information. For example, ICRAF is a major actor on the global scale, but its position in the network concerning CDM is much farther out (which is what you would expect), and rather, their influence is linked through other actors (betweenness centrality). Their work focuses on agriculture and forestry, hence their links are with actors that pursue the same interests, and, in this case, it is LDARD. As indicated in Table 6.2, the scope of work covered by each actor further influences the type of support it provides to CDM. Through these initiatives, the actors provide varying forms of information, which were discussed in section 6.3.1.

GIZ is a unique actor within the network because it provides funding for national programmes such as the DEFF LGCCSP. The mandate of GIZ is to support CCA programmes through the national department due to bi-lateral agreements between the German and South African governments. However, officials in the study criticised how GIZ programmes are designed and implemented at the local level because they are perceived to only serve the interest of the funder and technical partners such as DEFF. The shortcoming of the externally driven initiative brought by GIZ is the lack of local input and ownership, hence local actors participate for compliance, and there is no meaningful engagement. There is limited meaningful participation and uptake of learning tools thereafter.

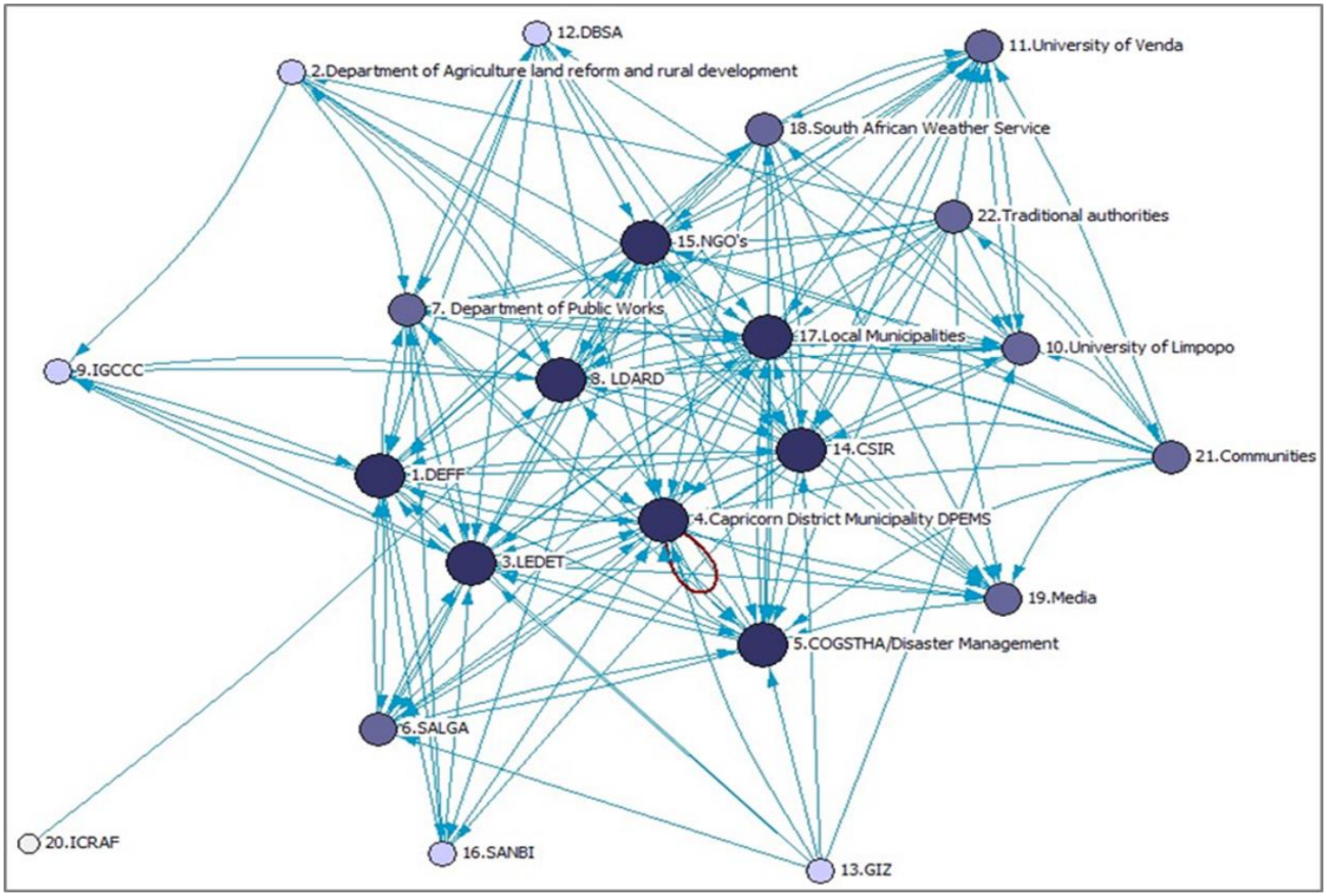


Figure 6. 4: Degree of centrality between actors that support CCA learning in CDM represented by node colour and size. The actors' scores on the degree of centrality were clustered into 4 groups 19-24; 12-18; 7-11; and 1-6. The darker and larger nodes indicate actors with a degree centrality of 19-24, i.e. higher number of links with other actors in the network. Outbound arrows represent centrality; inbound arrows represent prestige.

Some actors can have both high prestige and high centrality, e.g. CSIR, NGOs, DEFF, LEDET and local municipalities, indicating key recipient and key disseminator of information. Figure 6.4 also points out that the CDM has a total of 21 links within the network. Its inbound connections are 15 and the outbound 6, suggesting that it receives more information than it shares with others in the network. Medical Decision Logic (2014) highlights that actors with higher in-degree than out-degree, such as CDM, can become overloaded with information from different sources, creating challenges for decision-making when contradictory information is received. Furthermore, it may be difficult for the local actors to use the information, especially when the information provided is not tailor-made for their contexts.

Implications of centrality and prestige of actors in supporting learning

The results presented above on the degree of centrality and prestige provide an interesting understanding of how connections between actors influence the information shared amongst them. Research institutions such as the CSIR, for example, have a great deal of information as shown by the high degree of centrality. The CSIR is recognised as one of the leading scientific institutions who have contributed to national climate change programmes including South Africa's second and third national communication on climate change to the UNFCCC (CSIR, 2020; UN Spider, 2020). Furthermore, the CSIR has supported the development of several projects that support CCA, for example, the Global Environmental Facility Program 5 on Sustainable Land Management (GEF 5), SARVA (now managed by SAEON) and the Green Book described in Chapter 4. The main contribution revealed by these data is that although there are multiple actors in the network, only a few actors play a significant role in influencing the flow of information in the network. This has implications for how and what local governance actors learn, thereby shaping the CCA discourse and methodological approaches adopted at the local level. In addition, this may also present challenges should such major actors withdraw their support or shift the focus of their research due to, for example, a decline in dedicated funding for climate research and capacity building.

Moreover, although many actors disseminate information in the network, not all this information is communicated well and trusted by users. One attendant in Workshop 2 made the remark that:

> *'The media disturbs the work by provincial, district and local municipality as they tend to exaggerate issues at times and it creates tensions between the municipality and communities'* (Workshop 2, 2017).

The participants elaborated that some information shared by the media does not present a true reflection of the issues on the ground and initiatives in place to address them. This creates anxiety and mistrust between actors in the network, affecting the reliability of the information gathered through media sources. Existing literature suggests that building trust with users of information is crucial to organisational and social learning because it influences perceptions of what is considered valuable or useable at the local level (Virapongse *et al.,* 2020). Furthermore, local government actors have the agency to promote adaptation for their municipalities and may not always implement information passed through from actors within their network.

6.4.2 Betweenness centrality of actors supporting learning in CDM

Betweenness centrality measures how actors are strategically positioned to connect the information to other actors within a network (Bavelas, 1948; Shaw, 1954 in Freeman, 1979). The role of these actors is akin to intermediaries or brokers, making them a central Figure in the flow of information. Intermediaries can connect actors who, at times, are not within reach of each other. They perform their work by connecting with like-minded actors to steer CCA activities by offering support and other incentives. In polycentric governance literature, this process is referred to as orchestration (Abbot, 2018). Brokers thus have an indirect influence on the flow of information and can use their position to strategically influence the learning process of governance actors. However, actors in this position run the risk of over steering the nature and agenda of information that is disseminated to users.

A visual illustration of betweenness centrality for this social network is shown in Figure 6.5. In this Figure, actors with the highest betweenness centrality as identified by research participants are LDARD, CSIR and NGOs. As indicated in Chapter 5 of this study, agriculture is one of the key economic activities in CDM, which makes LDARD an influential player in providing links between the municipality and other external actors such as ICRAF. The CSIR and NGOs such as AWARD are involved in research projects in Limpopo that link actors from diverse institutions and levels of government, and this supposedly contributed to their higher betweenness centrality. AWARD for example has projects such as the Dialogues for Climate Change Literacy and Adaptation (DICLAD) and RESILiM-Olifants Programme that have been implemented in collaboration with local government actors to promote climate change learning and improved transboundary water management in the Olifants River Catchment. Similarly, the CSIR through projects such as SARVA and the Green Book have provided local governments in CDM with climate change information to support learning. Actors with a low degree of betweenness score (see Table 6.3) such as IGCCC, University of Venda, GIZ, DBSA, SALGA, SANBI and ICRAF seemingly do not play a major role in connecting actors within the network.

Although Figure 6.5 shows that actors such as SALGA and the University of Venda have a low betweenness centrality, participants expressed that their role needed to be strengthened to support learning in the municipality. SALGA is considered a leading authority for local governments mandated in the NCCRP to support municipalities in lobbying for resources. Hence participants emphasised the need for it to play a key role in linking governance actors to sources of information and support its integration in municipal operations. Similarly, the University of Venda and the Risk and Vulnerability Science Centre at the University of Limpopo are public institutions that have technical and scientific expertise as well as a local understanding of the province. However, governance actors in CDM shared that the role of these institutions needed to be enhanced to support individual and social learning. The two academic institutions are best suited to deconstruct and contextualise (including translating) the varying sources of information to support the learning process of governance actors.

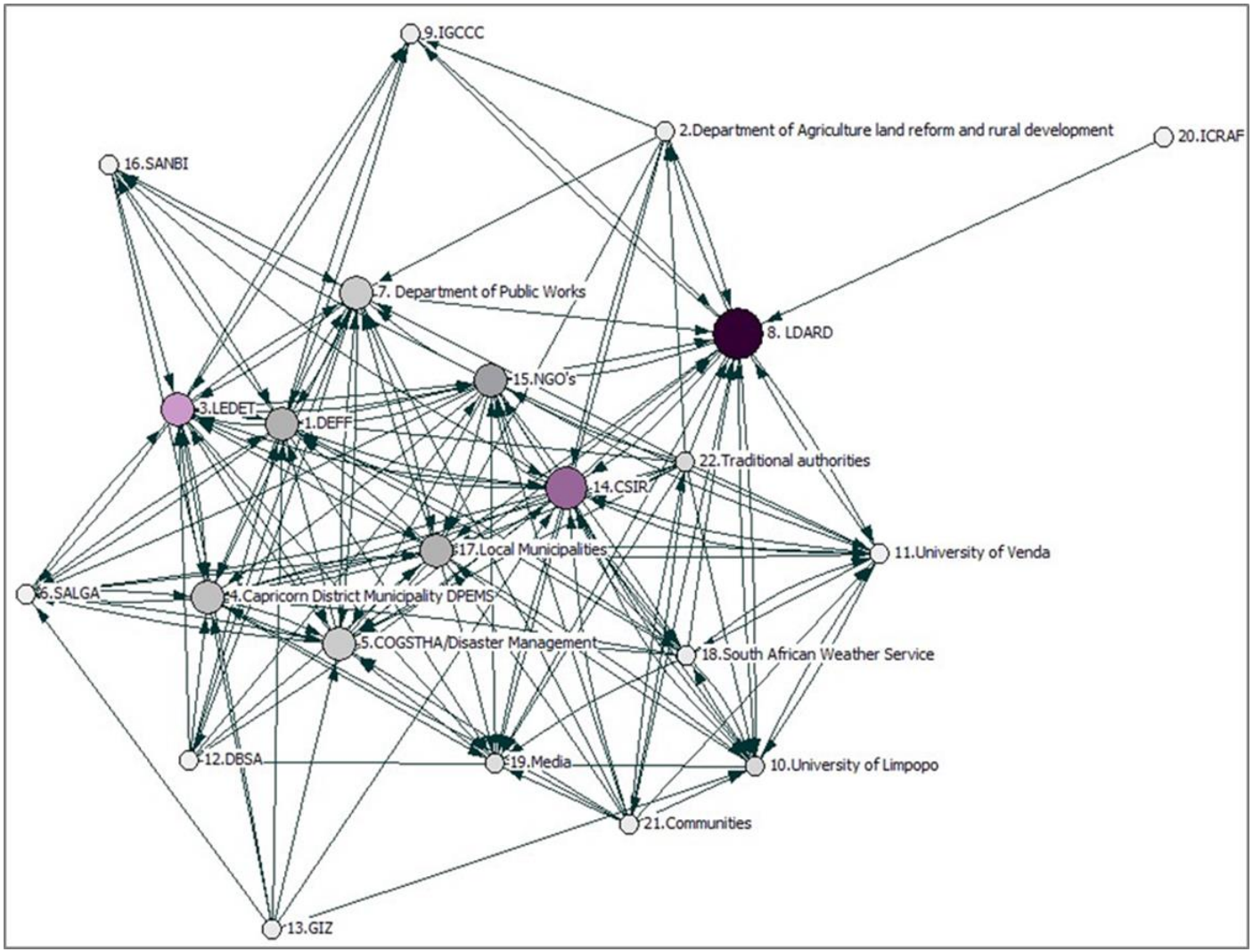


Figure 6. 5: Betweenness centrality of actors that support CCA learning in CDM represented by node colour and size, i.e. the darker and larger the node, the higher the score for the actor .

Implications of betweenness in supporting learning in CDM

The results from Figure 6.5 illustrate that some actors within the network act as conduits of information. This position gives them more power to decide the format and amount of information that they share, often through non-formal and informal learning typologies. Hence the learner, i.e. governance actor, has little control over the content that is provided to support learning on CCA. Studies in ecosystems sustainability have also noted that actors who are in between may not have planned to be intermediaries but can, at times, exploit their position to define the focus of interventions and funding thereof (Schultz *et al.,* 2018). Within the field of CCA, several stakeholders support learning, but scholarship (Tschakert and Dietrich, 2010; Boström *et al.,* 2018) has not been able to provide a visual display of how these actors interact to influence the flow and uptake of climate change at local government level. The contribution of this study is providing a depiction of the actors involved in CDM and the extent of their connections, level of influence and position within the network. Usually, there is so many programmes and actors who, at times, duplicate efforts and tend to overburden learners, an issue that was pointed out by Participant 7 (2017) who said:

> *'Research institutions tend to cause information fatigue for government departments and communities as most of the work just ends up in reports and yet they would have left people (research participants) with high hopes which are never fulfilled.'*

Through an analysis of brokers within the network, the study shows how brokers bridge the gap on what is known on the role of actors orchestrating learning in CDM. The study also highlights the actors from whom officials in CDM learn about CCA, information that is useful in informing the process of learning by understanding actors who can channel information to governance actors at the local level. Understanding which actors are involved in channeling information and improving coordination of their efforts can help to address participation fatigue and duplication.

Notwithstanding the benefits of stakeholders who act as connectors, if there is a high number of actors through whom information must pass that can delay or distort the learning process, an issue pointed out by Hanneman and Riddle (2019). These actors need to have effective communication skills and channels so that information reaches users in a timely and transparent manner. Transparency in information sharing can be enhanced by documenting the knowledge generation process and making users aware of the gaps in the information provided.

6.4.3 Analysis of actors with a close distance to CDMs who can support learning: Nearest neighbours

The nearest neighbour is an actor with the shortest travel (i.e. geodesic) distance to get to a selected node, in this case, the CDM. It is used to illustrate the ease of access that varying actors within the network have in reaching CDM. In this study, the actors were clustered into three groups of neighbours (Figure 6.6) based on their geodesic distance to CDM, with group one being the closest and group three the furthest.

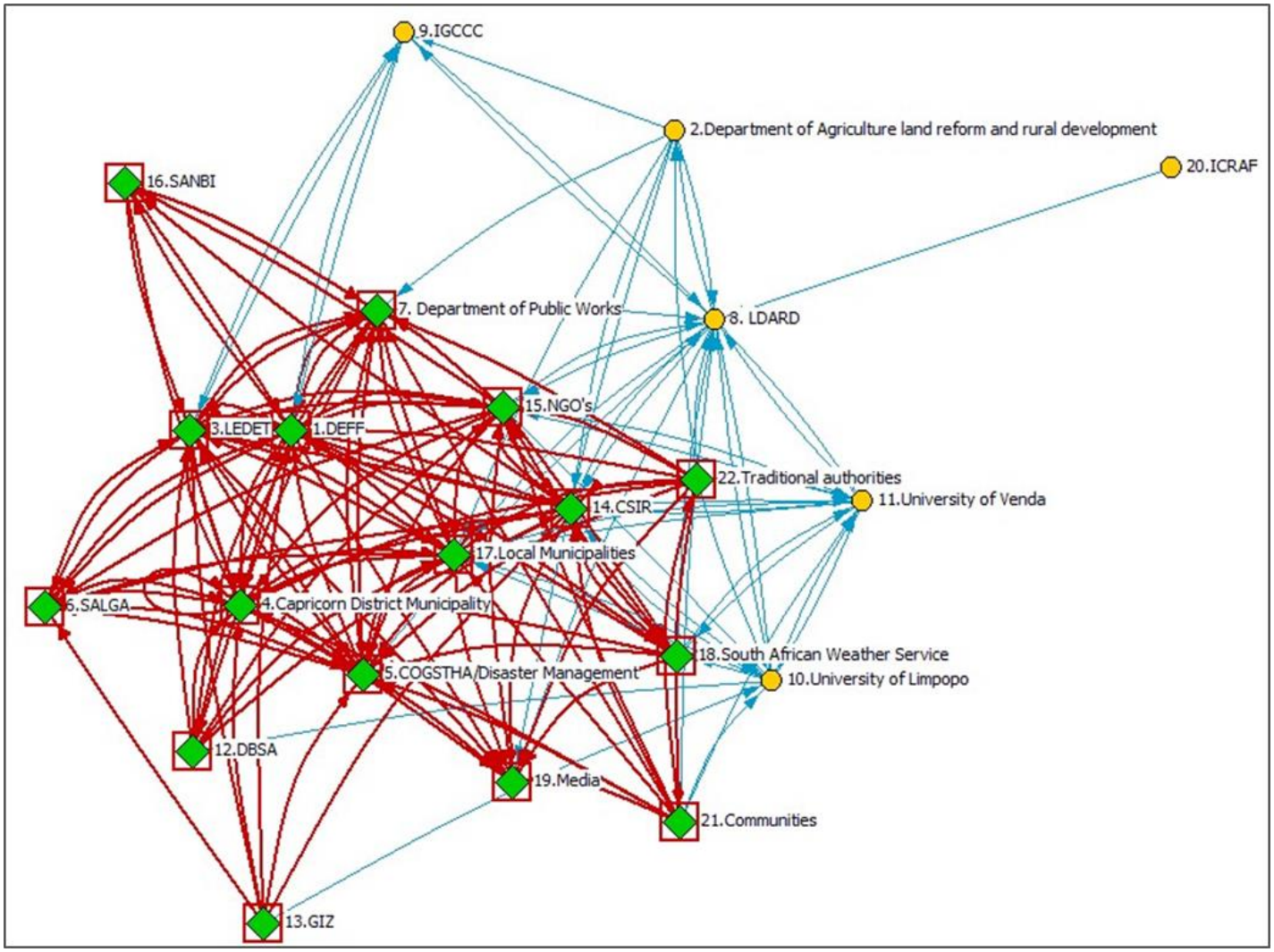


Figure 6. 6: Nearest neighbours of CDM with a geodesic distance of 1 are shown in red links and green nodes. The actors with yellow nodes and blue links illustrate actors who have a geodesic distance greater than one.

Fifteen actors are within group 1 and can be considered the nearest neighbours to CDM. These include DEFF, DBSA, GIZ, CSIR, NGOs, SANBI, local municipalities, the SAWS, Media, Communities and LEDET. The IGCCC, DALRRD, LDARD, University of Limpopo and the University of Venda had a geodesic distance of 2 from CDM. Meanwhile, ICRAF was the furthest with a geodesic distance of three, suggesting that this depends on several other actors for its information to reach CDM. Actors in group 1 are important to this study as they highlight the potential channels through which information can be channelled to reach the intended user or for experimenting with CCA initiatives and support social learning. They are, therefore, a focal point for this study because they currently play a key role in supporting learning within CDM through capacity building, funding, technical support, and providing scientific and indigenous knowledge on weather and climate as well as awareness-raising. The above actors identified through network analysis were also pointed out by research participants during the second workshop for their role in supporting learning initiatives in the municipality.

However, when officials were asked to rank the level of influence of these actors using the influence towers, they identified CDM, LEDET and DEFF as the major actors. These stakeholders also share similar goals on environmental management, which could be the basis for the network ties, referred to as homophily in a network and social organisational studies (MacPherson *et al.,* 2001). Lazarsfield and Merton (1954) explained homophily with the expression" birds of the same feather flock together", suggesting that actors who share similar values tend to develop close bonds that influence their activities, norms and values within a network. Close network ties also provide opportunities for actors to collaborate and share the costs of CCA activities that contribute to their shared vision. Homophily has implications on the sources of information that are considered trustworthy, the behaviour of actors (individuals and organisations) and interactions they take part in (Mc Pherson *et al.,* 2001). Participatory learning platforms are one such avenue that foster closeness of reach among actors. Herein, governance actors at the local level can collaborate in understanding climate change and explore a range of response actions as a collective.

Implications of the nearest neighbour on the learning process of governance actors within CDM.

In the results, Figure 6.6, actors were clustered into three geodesic groups based on the distance from CDM. Actors identified in group 1 have the shortest distance compared to those in groups 2 and 3. The implication of these variations in distance point out actors who are better placed to influence learning in CDM based on their proximity. Relations of neighbours in a network can both be positive and negative. Neighbourly actors are prone to develop shared interests, norms and values that foster a CoP with similar traits. This feature is characterised as homophily. The benefit of having like-minded neighbours in a network is that they are encouraged to engage in mutually beneficial collaborative work.

Despite the above benefits, nearest neighbours can have negative relations that result from opposition, distrust, resentment and avoidance. Several participants in Workshop 2 aired their dissatisfaction with some of their nearest neighbours, for example, Participant 4 (2017) stated:

'DEA [now DEFF] does not always consult the municipalities or provincial department, hence people have lost interest in taking part in they just attend to tick the register'.

The above issue was reiterated by Participant 9 (2017) who added:

'The Department of Environmental Affairs now disturbs local initiatives as they push their national initiatives which are at times at the expense of the local ones. In the GIZ funded programmes, DEA was focussing on making a success or achieving their own goals without supporting district and local municipalities to achieve their own goals'.

Both participants 4 and 9 demonstrated huge disapproval of the perceived domineering approach in which the national department as the nearest neighbour engages CDM in CCA initiatives. This issue of domineering extended to other actors such as LEDET and NGOs as expressed by participants 1 and 5 who said*:*

'LEDET is providing more budget for air quality projects (mitigation) and very little or none for climate change adaptation, therefore, it becomes an unfunded mandate that no one is too keen to work on or implement' (Participant 1, 2017).

'NGOs run workshops without informing the relevant municipal departments/ structures so that they can also take part. NGOs have their mandate and funding which does not always benefit the municipality and can cause problems with communities' (Participant 5, 2017).

Research participants pointed out that external actors although crucial for supporting their learning process, tend to interfere in their work. External actors are accused of failing to engage local governance actors to co-design, co-create and co-produce knowledge, issues that make the uptake of information provided by these sources difficult to contextualise and integrate into municipal operations. Consequently, these distrusted relationships between these nearest actors illuminate the underlying tensions and power struggles between the different levels of government and actors involved in supporting learning in CDM. In addition, study participants shared the view that they considered the national (and provincial) environmental department to be politically weaker when it comes to enforcement as compared, for example, to departments dealing with energy, treasury and planning, an observation also noted by Averchenkova *et al*. (2019). This conception of the national department weakens its ability to influence behaviour and implementation at the local level, despite the several initiatives where it provides information as the nearest neighbour. As such, officials attend the learning events that are organised by the national (and provincial) department or facilitated by consultants/ researchers out of obligation rather than a willingness to be an active learner in the process. Provision of information and technical support to understand local climate change risks even by nearest neighbours such as these, therefore, does not on its own support municipalities to go through all the segments of the adaptation action cycle (Ziervogel and Parnell 2010; Park *et al.,* 2012; McNamara, 2013; Averchenkova *et al.,* 2019).

Henceforth, the analysis of the social network measures above helps to improve understanding of the knowledge gaps identified by Dunlop (2009), indicating the variety of ways in which scientific knowledge is exchanged between

knowledge experts such as climate scientists and users, i.e. local government officials. It also highlights the bottlenecks in the flow of information which need to be addressed to ensure social learning within a social network.

6.5. Conclusion

In this chapter, the focus was on highlighting the learning process for governance actors who are involved in managing CCA in CDM. The chapter drew on the social constructivist theory of learning, lifelong learning and social network analysis to illustrate the sources of CCA information and how it flows to governance actors. Participants in the study identified the CDM DPEMS, LDARD, LEDET, CoGHSTA and local municipalities in the district, i.e. Polokwane, Blouberg, Molemole and Lepelle-Nkumpi, as the governance actors who make decisions about CCA in CDM. The study highlighted that governance actors have specific mandates and operate in a hierarchical system that is shaped and influenced by complex social-political structures and processes. These factors have an impact on how actors respond to and integrate climate change information. More so, it affects their ability to make systemic changes that result in transformative adaptation.

The study also established that governance actors obtain information about CCA from different learning systems, which include media, materials, the public sector and non-government social actors. The specific materials and media identified were academic and scientific publications, municipal reports, experiential and indigenous knowledge, policy documents, the internet, forums and networks. Participants perceived forums and networks to be the most effective for their learning, hence these were frequently used. A key benefit of forums and networks is that they encourage collaborative knowledge generation and facilitate the transfer of information among governance actors within the network.

Using the social network analysis, I was able to examine the links between actors who support learning in CDM and their relative positions and degrees of power and influence within the network whilst also illustrating the flow of information that influences how learning takes place. The measuring unit degree of centrality revealed that, although there are multiple actors in the network, only a few play a critical role in influencing the flow of information in the network. These findings contribute to knowledge on how power and politics influence group processes, i.e. learning, the flow of information and barriers to uptake (Armitage *et al.,* 2011; Schultz *et al.,* 2018). This has implications on the nature of learning and information that governance actors draw from the network as well as the methodological approaches adopted at the local level. From the measuring unit betweenness centrality, the study established that some actors within the network are conduits of information and play a critical role in orchestrating learning in CDM. As such, these orchestrators need to develop effective communication and coordination skills to ensure governance actors obtain useful information timeously.

Lastly, an analysis of the actors who are closest to CDM, i.e. nearest neighbour, revealed that there are 15 actors with the shortest geodesic distance to the municipality. Actors within reach of each other are likely to develop common interests, norms and values, resulting in a CoP. These close-knit networks are crucial in learning as they can support the needs of laggard municipalities that have financial, technical and human resource constraints by collaborating with them to implement CCA initiatives. More so, their proximity presents opportunities for the quick

flow of information. However, social network studies have noted that like-minded neighbours tend to get locked into certain ways of thinking, i.e. thinking inertia (Smith, 2019), which may restrict different ways of thinking. Hence it is important to foster different knowledge types by partnering with other actors who bring a critical voice to the network.

In the next chapter, the focus is on assessing what has been learnt by governance actors on CCA and what effect this has had on enhancing their understanding and implementation of CCA in CDM.

7. Making Sense of Climate Change Adaptation in Capricorn District Municipality

7.1 Introduction

Global concepts such as climate change are conceptualised and interpreted by individuals and organisations in different ways (Fünfgeld and McEvoy, 2011). This process of sense-making is described as framing, i.e. "a process by which actors construct and represent meaning to understand a particular event, process or occurrence" (Fünfgeld and McEvoy 2011:15). Framing of CCA occurs at three levels, i.e. at a metalevel, conceptual level and operational level. Framing CCA at meta-level includes the various public discourses often found in media and political discussions that draw on culturally distinct values and beliefs that argue for reducing climate risks and managing climate change for the benefit of everyone, regardless of their social group or geographical location (Fünfgeld and McEvoy, 2013). Adaptation is also framed at a conceptual level whereby theories, concepts (such as hazard, risk and vulnerability) and outcomes are given meaning by drawing on some of the values that influence meta-level framing. At the operational level, both meta-level and conceptual framings influence policy development, decision-making and implementation of adaptation actions. Adaptation policy and practice can be constrained when the various governance actors at multiple levels have divergent understandings of adaptation (Fünfgeld and McEvoy, 2013). One of the ways to bridge the gaps is to evaluate *how* the learners make sense of the CCA content to generate coherent meanings that allow for context-based adaptation (Fünfgeld and McEvoy, 2011; Keenan *et al.,* 2016).

Assessing how governance actors conceptualise and enact CCA is crucial to establishing the strengths and gaps in the learning process. Ostrom (2009) has criticised the framing of climate change at the global level as it has blinded local actors from appreciating their role in shaping the discourse and required implementation efforts. As highlighted in Chapter 2 of this study, assessment is critical in CCA learning because it helps to gather evidence on what the local governance actors know about climate change and the competencies they have in attaining the learning goals related to CCA. Thus, the purpose of learning in the context of CCA is to build the adaptive capacity of local governance actors to understand, interpret and relate to the local context in generating suitable actions where needed. Assessment is crucial in the CCA learning process for reflecting on the methods and context in which learning is occurring and establishing the efficacy of the process in attaining the desired learning outcomes. In Chapters 4,5 and 6 of this study, I attended to questions on context, sources of information and methods of learning available to the governance actors in CDM. However, the effectiveness of these is best understood by assessing the ability of governance actors to demonstrate comprehension and application of what they have learnt or are learning about CCA.

Hence, in this chapter, I drew on the adaptation action cycle (discussed in Chapter 2) as a theoretical lens to illustrate how officials conceptualise climate change and CCA as well as risks and enact CCA within a complex local government system. Furthermore, I adopt Argyris and Schön's (1974; 1996) loop learning model to explore

barriers in the flow and uptake of information by illustrating how governing variables and action strategies influence how climate change is being mainstreamed for action. Lastly, the chapter will examine opportunities for improved flow of information to support governance actors to close the gaps in the adaption action cycle.

7.2 Conceptualising climate change and CCA: A governance actor's perspective

Climate change, as shown throughout this thesis, is one of the current and future global, complex and wicked problems that individuals and organisations have to learn about and take actions to respond, even though there is uncertainty surrounding the phenomena, drivers and consequences (Taylor *et al.,* 2014; Ziervogel *et al.,* 2014; Clark *et al.,* 2015; Baudoin and Ziervogel, 2017). With increasing calls for actors such as local governments to play a role in climate change response, determining what constitutes adaptation is often based on subjective interpretation and understanding of the concept. The methodology that is used to understand how people make sense of their reality and attach meaning is referred to as interpretive research (Thomas, 2010). The interpretive scientific approach has, for example, been used by Tavares *et al*. (2017) to illustrate urban residents' nature and social meanings of comfort in the context of seasonal climate variability in Christchurch, New Zealand. Similarly, Schultze *et al*. (2018) used the interpretive approach to understand how actors in UNESCO's biosphere reserves learn to navigate through complexity by highlighting the diverse interpretations and areas of conflict.

Adopting a similar approach as used by Tavares *et al*. (2017) and Schultze *et al*. (2018), I engaged with officials in CDM, who are responsible for planning and making decisions on climate change, to reflect and share their diverse interpretations of global concepts related to climate change and CCA as well as their lived experiences. In so doing, the research was able to attend to study objective 1, which sought to establish the understandings of governance actors around the concepts of climate change and CCA as well as their lived experiences and perceptions of risk. Officials in CDM defined climate change as follows:

> *'Climate change refers to changes in temperature, that is, increasing temperature and increasing period of drought'* (Participant 1, 2017).
>
> *'Climate change is change of weather patterns over an area over time'* (Participant 3, 2017).
>
> *'Climate change is a phenomenon that arises due to accumulation of greenhouse gas emissions from anthropogenic activities as well as natural causes that has adverse impacts on humans'* (Participant 8, 2017).
>
> *'Climate change are the changes in weather patterns that we are undergoing at various levels which cause further stress on the environment'* (Participant 12, 2017).

The responses by participants, although they are varied as shown above, provide an overview of the officials' conceptualisation of the climate change concept. The key indicators of climate change identified by officials were changes in weather variables such as rainfall and temperature over time. A key finding here, however, is that officials also made comparisons between their past experiences of weather patterns in the past fifteen years or

less. Climate scientists, however, refer to climate change as the average change in these weather variables (e.g. temperature, rainfall, humidity etc.) that would have occurred over at least thirty years (WMO, 2019b; NOAA, 2020). The changes that officials have observed thus really point to climate variability, which refers to "variations in the mean state and other statistics (such as standard deviations, the occurrences of extremes, etc.) of the climate on all temporal and spatial scales, beyond individual weather events" (IPCC, 2014a:1761).

Climate variability includes notable deviations of climatic statistics over a given period, such as a month, season or year, which can include an abnormally cold winter or dry summer that cannot be attributed to anthropogenic activities (NOAA, 2018). Studies also show that the difference between climate change and climate variability is often misunderstood, resulting in these concepts being misinterpreted and inaccurate attributions given to observed changes in variables such as rainfall, temperature and extreme weather events (Meze-Hausken, 2004; Stone, 2014). Officials attribute their current experiences of extreme weather events such as floods and changes in seasons to climate change, yet these are indicators of climate variability. This points to a gap in understanding how climate change is being perceived. If CDM officials better understood the weather and climate change timescales, they would be able to have both incremental and transformative actions. However, their current conceptualisation limits them to the short term and often reactionary responses to extreme weather events.

I made a follow-up question to the officials in which I asked them to relate their understanding of the concept of CCA. Some officials shared that:

> *'Climate change adaptation refers to how people adapt to the changes in the weather patterns to survive with less rain and higher temperatures'* (Participant 1, 2017).
>
> *'Climate change adaptation is when you make changes to fit in with the changing climatic conditions'* (Participant 3, 2017).
>
> *'Climate change adaptation are the efforts we undertake to cope with the changes and take advantage of some opportunities that can create jobs and help some sectors such as agriculture to stay productive'* (Participant 8, 2017).
>
> *'Climate change adaptation are the changes we make to adapt better to the changes in climate'* (Participant 12, 2017).

The above descriptions of CCA indicate that officials relate the concept of CCA to adjustments taken to cope with climate stimuli. From the above descriptions, only one out of the twelve participants managed to provide a broader understanding of CCA by including CCA aspects that may take advantage of the opportunities presented by climate change. Most of the officials (92%) perceived CCA as coping with short-term changes, which shows a narrow understanding of the concept that should integrate both short term and long-term adaptation actions. Pereira *et al*. (2020), for example, highlight that a limited understanding of CCA has implications on the ability of actors to creatively experiment and explore the opportunities presented by climate change that shift their way of thinking and doing. Given that collapse due to environmental catastrophe seems inevitable (IPBES, 2019), adaptation

needs governance actors to engage in long-term collaborative efforts with actors within and outside their jurisdiction to address some of the root causes of vulnerability (Lotz-Sisitka *et al.,* 2015). More so, transformative adaptation interventions require multiple actors to collaboratively co-design policies and programmes that empower governance actors with the knowledge that can be used to negotiate power relations that underpin vulnerability (Cork *et al.,* 2007; Tanner and Bahadur, 2012; Pereira *et al.,* 2020). Transformative adaptation, however, can include taking advantage of policy windows resulting from cabinet reshuffles, budget speeches, economic circumstances and disasters (such as drought and the recent COVID-19 pandemic), for example, to influence the policy direction so that decision-makers make the systemic changes needed, e.g. changing the municipal structure to ensure effective mainstreaming of CCA into municipal operations (Tanner and Bahadur, 2012).

7.3 Governance actors' perceptions of climate change risk

To contextualise the governance actors' understanding of climate change and how they respond, I probed them further to share their perceptions of climate change risk. The term risk perception was used in this study to assess the ability of governance actors to form a judgement about the seriousness and probability of the threat posed by climate change (Di Giulio *et al.,* 2015). Existing literature shows that disaster risk management, including CCA, is influenced by perceptions of climate risk, and this shapes the response that actors take (i.e. action or inaction) as well as the urgency with which the risks are addressed (Ropeik, 2010; Bubeck *et al.,* 2012; Mañez, *et al.,* 2016). In the interviews, I asked officials from CDM whether they considered climate change a current or future risk for their municipality. Twelve of the district officials interviewed acknowledged that climate change was an *immediate* risk facing the municipality as well as the Limpopo Province. One official shared that:

> *'Climate change is a current risk with a possibility of huge future impacts'* (Participant 5, 2017).

Another participant said:

> *'Climate change is a current risk, which many parts of the province are battling with as it affects different sectors of our society'* (Participant 11, 2017).

The officials substantiated their perceptions of climate risks by indicating that they had encountered extreme weather events such as droughts and floods, which affected the livelihoods of people in their constituency. Between 2016 and 2018, the CDM and Limpopo Province witnessed adverse impacts of the drought that exacerbated water shortages and adversely impacted their agricultural productivity, as also noted in many parts of the country (Baudoin *et al.,* 2017; Swemmer *et al.,* 2018). The recurring effect of these extreme weather events made the officials concur that climate change poses an imminent threat to their society.

Apart from their personal experiences of extreme weather events, the governance actors shared that their views of risk were informed by the information they had obtained through engagements with different learning systems, which also shows they are actively engaged in lifelong learning. The learning systems, as highlighted in Chapters 4 and 6, include the SARVA and Let's Respond Toolkit workshops as well as forums. These workshops included learning activities that encouraged peer learning and sharing of information on varying risks and vulnerabilities

present in their respective sectors (DEA *et al.,* 2016; Murambadoro and Mambo, 2016). The ability of participants to recall information they had gathered in workshops, forums, among other sources of information used, suggests that assimilation of information has occurred. More so, these learning systems are providing the governance actors with information that advances their understanding of climate change and its effects.

Though excerpts from Participants 5 and 11 indicate their understanding of current extreme weather events in relation to climate change, it should be noted that their interpretation of the phenomenon (i.e. climate change) misrepresents what it entails. The information they receive from different learning systems is, however, not explicit on the timescales on which climate change occurs, and this clouds the distinction that governance actors should be able to make between climate change and climate variability. For example, the videos and presentations on the Let's Respond Toolkit website disseminated to governance actors do not indicate the timescale of changes, which is a key component that distinguishes between climate change and climate variability (DEA *et al.,* 2020). Hence CDM officials have a knowledge gap in this area that contributes to their reactionary approach as they cannot tell the time when permanent climate change occurs (i.e. 30+ year period) and the need for long term planning to adapt to the transitions.

The misinterpretation and misuse of terms such as climate change to describe seasonal or yearly changes in weather have also been noted in other studies. Meze-Hausken's (2004) study in northern Ethiopia, for example, found a divergence between climate data and people's perceptions of changes in weather from wetter to drier, which impacted water availability. The findings of my study relating to the knowledge gap on how officials in CDM perceive climate change and climate risks affirm the observations made by Adger *et al.* (2009) and pose the argument that such gaps can influence the response taken by actors in addressing the problem.) A critical finding of the study is that attending a workshop or access to online CCA resources without a holistic understanding of climate change will not necessarily result in the uptake of risk reduction actions. Rather it can generate helplessness and psychological distancing, especially where actors are overwhelmed with fear-provoking future projections that do not have a clear and sufficient indication of timescales that can be harnessed to develop adaptive capacity (Lotz-Sisitka, 2009; Taylor *et al.,* 2014).

7.4 Lived experiences and impacts of climate change as perceived by local governance actors

The engagements with participants also brought to the fore information on *lived experiences* of climate change-related events and how they affected their work. A key finding was that officials perceived variations in weather by making use of parameters such as rainfall and temperature as well as incidents of climatic hazards that were linked to extreme weather. Their understanding of these weather variations was informed in part by a cultural and individual understanding of the annual calendar, i.e. they related seasons to months of the calendar. Research participants related socio-cultural activities they perform throughout the year that coincide with changes in seasons, for example, the Pedi and Venda have rain calling rituals held at the beginning of summer. Since some of their

traditional ceremonies are seasonal, they can note the seasonal variations because the seasons serve as markers that inform them on when to perform certain activities. Research participants pointed out that they used other social-cultural indicators such as the behaviour of certain animals and the appearance of certain plants to denote seasonal weather forecasts and variations. These socio-cultural indicators of seasonal patterns illustrate the relevance of indigenous knowledge in shaping the understanding of governance actors.

In Figure 7.1, I highlight some of the events that participants from CDM were able to recall based on their lived experiences between the period 2002-2017.

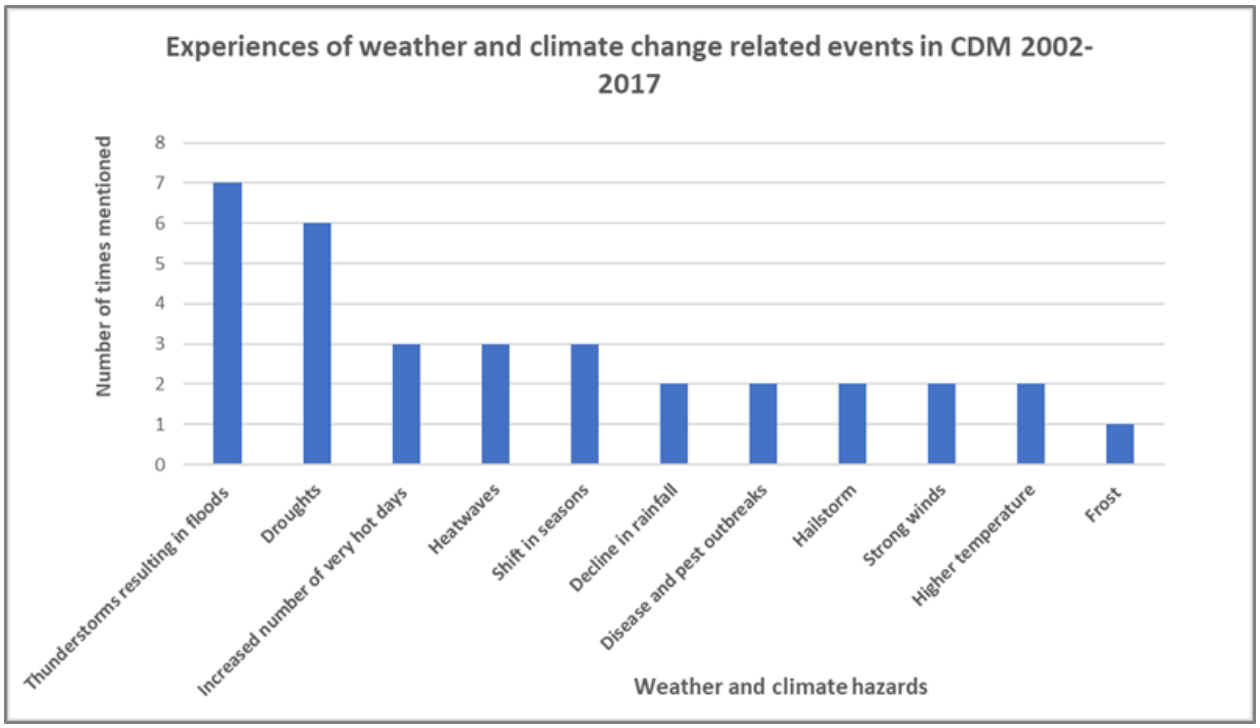


Figure 7. 1: Experiences of weather and climate change-related events in CDM based on feedback in interviews with officials working in CDM.

A summary of the impacts of climate change-related extreme events on officials' work also a key finding influencing perceptions of climate change risk is presented in Table 7.1.

Table 7. 1: Shared experiences of climate change-related hazards and their impacts on the work of CDM officials.

Hazard	Impacts
Thunderstorms/Intense storms	• Floods affecting many communities, including the central business district in Polokwane • Damage to roads and other infrastructure • Disruption of electricity supply • Increased soil erosion
Droughts and decline in rainfall	• Loss of livestock and decline in agricultural productivity which, at times, requires external intervention from national government departments • Water shortages affecting households and schools • Loss of biodiversity
Heatwaves, an increase in the number of very hot days and an increase in temperature	• Human discomfort, especially for workers who work outside, e.g. EPWP workers, construction and farmers • Increase in the extent of areas affected by alien plant invasion and officials struggle to keep them under control
Shifts in seasons	• Prolonged winter months resulted in increased exposure to the cold with health impacts on the elderly and school children • Increased uncertainty on planting seasons as the onset of rainfall shifts making it difficult to advise farmers
Frost	• Damage to crops
Strong winds	• Damage to homes, air quality monitoring equipment

The most mentioned extreme weather-related events experienced by participants in workshop 2 were thunderstorms that resulted in flooding (n=7) and droughts (n=6). Frost was the least mentioned hazard (n=1). More details on the lived experiences and impact of these extreme weather events are provided below.

7.4.1 Experiences of thunderstorms and strong winds by CDM officials

Thunderstorms, also referred to by some officials as intense storms, were indicated by 7 of the CDM officials in workshop 2 to be a key hazard affecting them and are frequently coupled with strong winds (n=2), causing damage to homes, infrastructure and air quality monitoring equipment. One official stated that:

> *'I have seen people who are affected by intense storms, strong winds and…air quality monitoring equipment gets damaged by strong winds and thunderstorms'* (Participant 4, 2017).

The damage to air quality monitoring equipment by strong winds and thunderstorms as highlighted above presents challenges to the work of officials because the equipment helps them to monitor and reduce pollution from industrial and commercial activities in the district, e.g. the Polokwane Smelters and Silicon Smelters. The presence of high volumes of air pollution has multiple effects on their community, including damage to human health, reduced visibility and imbalance on climate and ecosystems (DEA, 2013c; Campbell-Lendrum and Prüss-Ustün, 2018). In Chapter 5 of this study, I related some of the health challenges being faced by CDM that include the prevalence of respiratory diseases. As such, air quality monitoring equipment always needs to be fully operational to ensure that air quality officials maintain as well as improve the air quality in CDM.

Officials in CDM also stated that windstorms experienced in 2012 had damaged homes in areas such as Sekonye Village and Ga-Mashashane Village. Addressing the damaged properties required support from the provincial disaster management centre as the district had limited adaptive capacity to support the affected communities.

Disaster management officials in the district shared that their department is increasingly facing challenges that require intervention from the national government, which poses further challenges and delays in providing the required support timeously. This was specified by an official who said that:

> *'Polokwane is growing fast and struggles to meet the increasing demands. Stormwater systems in Polokwane are not well maintained, they are insufficient and often blocked, resulting in flooding in the city. We often have to request support from the provincial disaster management centre and this usually prolongs the time we can get the required resources to the people'* (Participant 6, 2017).

Municipal reports, media coverage and SAWS records have documented the effects of heavy rains, severe thunderstorms and hail in CDM, with many of these incidents occurring in spring and summer seasons (Joubert, 2015; Sebego, 2018; CDM 2019a). Factors that contribute to Polokwane's increasing vulnerability to flooding are inadequate and poorly maintained stormwater systems; hence there is a need to have coordinated efforts by all sectors in the area. Currently, learning initiatives are targeted at officials in Environment and Disaster Management departments, which tends to side-line other key actors who need to be drawn in, for disaster preparedness and eventually reinforcing a siloed approach to municipal operations. There is a need, therefore, for CCA learning initiatives to include actors from sectors such as Department of Infrastructure Services so that they can also support efforts to mitigate the impacts of intense storms highlighted above.

7.4.2 Experiences of droughts and decline in rainfall as related by officials in CDM

Governance actors in CDM also identified droughts and decline in rainfall as other extreme weather and climate change related events they had experienced in the past fifteen years. These hydroclimatic extremes have reportedly contributed to reductions in water availability from surface water resources in the district and have consequently increased the community's dependence on groundwater resources. As noted in Chapter 5, the municipality is currently not able to meet the residents' water demand, and this is also evidenced by continuous protest actions by local communities demanding that the government provide water. Local government officials have had to provide water tanks at some schools so that they do not run out of water, even more so during the COVID-19 pandemic (CDM, 2020).

Apart from the droughts and decline in rainfall, challenges with water availability in CDM are also a result of increased water demand by economic activities such as agriculture, mining and industry. Owing to this, surface water resources in CDM are part of the water management areas in Limpopo that have been over-allocated since the year 2000, creating an imbalance in terms of water demand versus supply. Furthermore, the projected increases in extreme weather events such as droughts, population growth, expansion of urban areas as well as economic growth may, if not managed well, exacerbate CDM's water challenges in the future (Petrie *et al.,* 2015; CDM, 2016; Mwenge Kahinda *et al.,* 2016; Botai *et al.,* 2020). There is an urgent need to manage water resources more efficiently to curb the imminent risks and conflicts posed by water scarcity. Research shows that resources such as water are one of the key drivers of conflict in water-scarce areas. These tensions are already being noted

in North Africa and the Middle East regions (Ashton, 2007; Adeel, 2017), hence it is prudent for governance actors to implement the necessary CCA initiatives to support the water sector.

Officials also expressed the view that the frequent droughts in CDM had contributed to overgrazing and land degradation in communal areas. One of the officials shared that:

> *'Some of the farming areas have dongas which are so deep they may be lost forever if nothing is done to rehabilitate them so that vegetation can grow on it again. There is also a lot of thorny bushes which cows cannot eat'* (Participant 1, 2017).

On my site visit to Limpopo, I also observed examples of the dongas referred to by the participants (Figure 7.2). These features are common in the rural landscapes of the Limpopo and have also been reported by other authors for example Stronkhorst *et al*., (2009) and Morokong and Blignaut, (2019) as a major feature in this landscape. Elsewhere in South Africa dongas are similarly viewed as major degradation concern (Boardman, 2014; Falayi *et al*., 2020).

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Figure 7. 2: An illustration of the degraded land in Limpopo.

The impact of land degradation includes a loss of arable farming land, decline in groundwater and vegetation cover, which affects economic productivity in the municipality (CoGTA, 2020a). Implementation of CCA initiatives that promote sustainable management and use of agricultural natural resources is required to support vulnerable agrarian landscapes in CDM and Limpopo. The thorny bushes identified by Participant 1 above could be indicative of bush encroachment in the district, which weakens the grass and herbaceous vegetation as well as reduce grazing feedstock and this has also been noted in provincial and national reports (LEDET, 2016; DEA, 2019d). Mpati (2015) notes that bush encroachment alters the ecosystem function and structure with additional impacts on rural livelihoods. The DEA (2019) report has highlighted bush infestation as a challenge facing the district and province at large due to a surge in woody plant densities (e.g. *Vachellia karoo/*Sweet thorn and *Dichrostachys*

cinereal/Sickle bush) that are changing the agrarian landscapes. Climate change scenarios also indicate that grasslands will be more vulnerable and therefore requires urgent conservation meanwhile the woody plants are projected to thicken (DEA, 2013b). There is an urgent need to implement measures for sustainable management and rehabilitation of landscapes through, for example, removal of alien invasive species, planting indigenous trees and construction of gabions.

7.4.3 Perspectives on temperature extremes and increase in temperature as related by CDM officials

Heat waves, frost, increased number of very hot days and rise in temperature were indicated as other weather variables witnessed by governance actors in the past 15 years. In workshop 2 frost was mentioned by one official who shared that it had caused damage to crops especially in Blouberg and Molemole local municipalities. Other officials in the workshop shared that they had experienced increasing temperatures (n=2), heatwaves (n=3) and an increase in the number of very hot days (n=3). These extreme weather events affected crops, livestock, human health and worsened water insecurity in some communities. A key impact of the high temperatures and heatwaves is that it made it difficult for governance actors to engage in outdoor activities. Several participants were concerned about working outdoors because of the potential health effects associated with high temperatures, such as heatstroke. Three participants shared that:

> *'Limpopo gets so hot it's difficult to be outdoors, so during a heatwave we don't do any field visits'* (Participant 12, 2017).
>
> *'Temperatures in Capricorn at times get to 36°C for several days and this is very uncomfortable'* (Participant 2, 2017).
>
> *'During summer we have heatwaves and we have to raise awareness among workers in construction and agriculture to take more water to avoid heatstroke'* (Participant 11, 2017).

The high temperatures described above were also recorded by Swemmer *et al*. (2018), who reported that the recent drought had presented record-breaking average monthly temperatures. Taking note of the above extreme weather events, governance actors pointed out that their response actions at present revolve around awareness-raising and putting out-door activities on hold until the weather is favourable. Apart from this, they could not share any information on the long term and systemic changes that could be made by their respective sectors to increase adaptive capacity. The response actions followed by the officials are largely informed by the recommendations offered by external actors such as SAWS and NDMC (see the advisory in Figure 7.3).



Figure 7. 3: Heatwave alert in January 2018 which also affected parts of Limpopo Province (Source SAWS, 2018b).

The study established, therefore, that these recommendations, well-meaning in intent promote short- term interventions to immediate weather extremes, and there is limited guidance on long-term planning for climate change. Thus, the information that governance actors access influences their response to risks posed by climate-related weather events. These short-term actions promote incremental adaptation with no long-term adaptive capacity building, yet the climate change projections show that the risk of heatwaves in Limpopo is projected to increase in the future (Davoudi *et al.,* 2012; Mbokodo *et al.,* 2020), hence the need for transformative adaptation.

7.4.4 Perceptions of governance actors on shifts in seasons

Three officials (25%) in the study highlighted that shifts in seasons, particularly prolonged winter months and changes in the onset of the rainfall season, were affecting their work. They reported that cold periods witnessed in the past five to ten years had extended the number of winter months from the end of April up to October. An example was shared that this prolonged winter period has seen pupils in the district keeping their winter clothing on until October, at the onset of summer. As such, the local government has had to consider providing resources to keep the learning environment warm enough for the learners to endure the harsh weather. Effects of the prolonged winter season include increased incidences of officials missing work because of colds and cases of flu which also increases the burden for health officials at local clinics as people seek treatment.

Other shifts in the seasons relate to changes in the onset of the rainfall season, which is becoming more unpredictable. CDM rainfall season is normally between October and March, but officials highlighted that there had been recent shifts in the onset of the rainfall season in the past five to ten years with rains, at times, starting in mid

to late November or early December until, at times, April or May. The shift in the rainfall season was narrated by an official who said that:

> *'Growing up we knew that the rain season ends around March and we get wind from mid-July and August but now we only getting wind in October, yet this is the time that we expect the onset of the rainfall season'* (Participant 10, 2017).

The remark made by Participant 10 above indicates that the official derived an understanding of climate variability from experiential knowledge. This affirms the point raised earlier on the role of non-scientific knowledge in shaping the information that governance actors have about weather and climate. The experiences noted by Participant 10 can be corroborated by writings of scholars such as Mpandeli *et al*. (2019), who observed that there had been shifts in rainfall seasons within CDM. Over the last two decades (2000-2019), variations in rainfall seasons have affected sectors such as agriculture, which is a key source of livelihood for many communities in the area.

The shift in the onset and duration of the rainfall season has also impacted the work of agricultural advisories. Agricultural officials shared that shifts in seasons associated with climate variability make it difficult for them to make recommendations or provide information to farmers on, for example, the actual onset of the planting season. This concern was expressed by an official who said that:

> *'Right now (in October) we do not know if we should advise farmers to put seeds in the ground as we are not sure if this will be a normal planting season. We do not want farmers to blame us if the rains are late as they would have planted seeds too early*' (Participant 8, 2017).

Research by Mabhaudi *et al*. (2019) and Mpandeli *et al*. (2019) suggests that governance actors in municipalities such as CDM need to revise their cropping calendar as well as consider planting traditional and indigenous crops such as sorghum and millet, which cope better with the current climate and projected decline in rainfall.

A key finding regarding the concern raised by Participant 8 above is that there is a fundamental gap in knowledge on how to communicate the uncertainty in weather and climate information to farmers/communities to ensure they retain confidence and trust in agricultural advisers. Weather and seasonal forecasting are, however, beset with huge uncertainties due to the dynamic atmospheric conditions that affect accuracy in predicting the weather. Forecasting weather with greater certainty requires the use of advanced technology that can process complex atmospheric and oceanic models. Seasonal forecasts are developed by institutions such as the SAWS to provide users, i.e. agricultural advisers and farmers, with timely information to inform planning for each upcoming season. However, officials expressed concerns with accessing the seasonal forecasts from SAWS as these are not disseminated to them directly but go through intermediaries such as the DALRRD's National Agro-meteorological Committee (NAC). A key concern regarding these intermediaries is that they disseminate information using English as a medium of instruction and delegate actors at sub-national level who are mostly non-native English speakers to make sense of it first and then translate this into other languages used in CDM such as Sepedi, Xitsonga and Afrikaans. Translating scientific information is not easy but necessary as it could influence the way people plan and make decisions to mitigate climate risks (Naustdalslid, 2011; Clear Word Translations, 2019). Furthermore,

understanding and improving how climate information is translated and integrated into society will help augment climate action so that climate change is not considered as just another environmental problem.

The varying narratives shared by CDM officials account for the lived experiences witnessed in the past 15 years or less (i.e. 2002 and 2017). As a result, these experiences illustrate that the officials are aware of climate variability and extreme weather events rather than climate change, which refers to changes that occur for 30 years or longer (WMO, 2019b; NOAA, 2020). This indicates that there is a gap in learning as participants have a limited conceptualisation of climate change and climate change risk. A key challenge posed by the above learning gap is that it affects the actions that officials take and the urgency with which key strategic documents on CCA are adopted and implemented.

More so, experiences and impacts of extreme weather events shared by officials in CDM highlight the physical, socio-cultural and economic effects of weather variability on their work and the well-being of the greater community. Weather events are often understood through physical manifestations, but the officials expanded on the social manifestations as evidenced by the impacts of extreme weather events on their everyday activities that include observance of religious-cultural activities. A deeper understanding of the indigenous knowledge system and practices is required to develop grounded information that reflects both the scientific and experiential knowledge about climate change and climate risks.

7.5 To what effect has CCA information been assimilated in the operations of CDM officials?

One of the objectives of learning is to build the capacity of the learner to transition from merely acquiring information to developing agency to make sense of that knowledge and use it to inform actions or change (Queens University, 2021). To understand how governance actors have assimilated CCA information into actions, I asked the participants to share details of initiatives that they were implementing that would contribute to CCA. The term initiative is used in the study to refer to activities such as conducting a risk and vulnerability assessment as well as developing, adopting and implementing a climate change response strategy/plan. Findings on these matters are discussed below.

7.5.1 Developing climate response plans

Governance actors in CDM shared that in 2016, they had participated in the development of the CDM Climate Change Vulnerability Assessment and Response Plan and CDM DRDP. The development of the CDM Climate Change Vulnerability Assessment and Response Plan was driven by DEFF, GIZ and SALGA with technical support from Urban Earth Consulting. The CDM DRDP is an initiative by the national DRDLR with technical support from Ditau Geo-Informatics Solutions, a technical consultancy. The challenge with such externally driven initiatives is that they tend to promote non-formal learning with local governance actors lacking ownership of the outputs. The lack of ownership and commitment to implement these outputs was expressed by an official who said:

'*There is currently poor commitment by officials- you can take a horse to the river but you can't force the horse to drink the water*' (Participant 8, 2017).

The above remark suggests that although officials develop strategic documents that are initiated by national actors, uptake of the information into day-to-day municipal decision-making cannot be forced. Such externally driven processes constrain the governance actors' ability to learn, unlearn and relearn, which, when coupled with other factors such as limited financial resources and complex decision-making processes, has impacts on the implementation of policies and plans (Menelisi *et al.,* 2020; Pereira *et al.,* 2020). It is critical, therefore, for external actors to involve all local-level stakeholders and structures from the inception of the initiative and have a holistic understanding of what is needed to enhance implementation and sustainability.

7.5.2 Integration of CCA into other municipal documents

The officials also shared that CCA had been included in the Bioregional Plan and IDP. The development of the Bioregional Plan was a provincially led initiative done in compliance with the Biodiversity Act (Act No. 10 of 2004). CDM officials provided inputs into the Bioregional plan to ensure that it aligns with the other planning instruments, programmes and policies in CDM. The plan was, however, only gazetted in November 2019; hence it is still too early to comprehend the impact of the Bioregional plan in influencing uptake of CCA priorities identified therein to support land use planning, environmental management and development in CDM.

The IDP, as presented in Chapter 4, is also a CDM driven initiative that highlights the municipal development priorities, directs municipal operations and budget expenditure. Climate change has been integrated into the IDP to highlight key findings of the risk and vulnerability assessment, and it emphasises awareness-raising as the only activity they are currently undertaking. However, when I reviewed the document, I identified other prioritised development activities that contribute to CCA, such as the greening of public spaces and removal of alien invasive species. There is a need, therefore, to recognise and take advantage of the adaptation co-benefits that can be derived from the implementation of such development-oriented activities.

7.5.3 Government actors' engagement in climate response projects

During my engagements with officials in CDM, I also inquired from them to provide details on CCA initiatives they had enacted in their municipality. The responses provided by officials, however, mostly referred to mitigation initiatives in the transport and energy sector which indicated that they were likely unaware of the distinction between adaptation and mitigation actions. For example, one official stated:

'Polokwane is trying to implement a rapid transport system Leeto la Polokwane similar to what is in other big cities such as Cape Town, Johannesburg and Tshwane' (Participant 9, 2017).

The rapid transport system has been adopted in many metropolitan cities in South Africa and other countries across the globe to facilitate the efficient movement of large groups of people while also contributing towards reducing greenhouse gas emissions by reducing the volume of vehicles on the road. Considering that the rapid transport system is a mechanism seeking to reduce greenhouse gas emissions, it is classified as a mitigation action and not

an adaptation. The identification of such interventions as CCA actions highlights a learning gap that could be addressed through the provision of a better understanding of the distinction as well as the linkages between these two concepts.

These projects identified by participants in CDM together with other examples of climate change initiatives that have been implemented in CDM are summarised in Table 7.2. I reviewed some municipal reports and the IDP to identify other climate change response initiatives in the municipality. This is however, not intended to be a comprehensive list of all climate change actions in CDM. I am using these to highlight how some of the service delivery projects are contributing towards climate change response in CDM, even though this is not explicitly expressed in the respective documents. This finding confirms an earlier finding by Smit and Wandel (2006), who indicated that adaptation is usually never implemented in response to climate stimuli alone but is rather integrated into other initiatives such as service delivery. In this case, the EPWP project and Greenbelt project, for example, have focused on alien plant removal and planting of indigenous plants to save water due to current water shortages, but this consequently also contributes to CCA as the municipality is also faced with drying in the future (Hoegh-Guldberg *et al.,* 2018; Maúre *et al.,* 2018).

The urgency of climate change response is also often submerged by other immediate challenges, which also require the governance actors' attention. The officials identified basic service delivery backlogs, unemployment, land degradation and poor waste management as some of the immediate challenges in the district. Under these circumstances, there is often competing agendas because of the mandates that governance actors have from their respective departments, some of which may derail the collaborative agenda required to tackle climate change at the local government level. In so doing, communities and governance actors set an agenda of what is important to them, which cannot be easily swayed by discourses of climate change, although they need to build resilience in the long term (Kaika, 2017). Therefore, CCA needs to consider issues of social and environmental injustice to ensure that no one is left behind and that response actions also support sustainable social-ecological systems. Another consideration is how learning could be enhanced to ensure that all development initiatives become adaptive to the projected changes in climate whilst also giving the local actors the platforms to lead in climate change activities.

In the next section, I present findings on some of the reflections shared by participants on the factors that encourage or discourage officials from playing their role in adaptation and opportunities to support the flow and uptake of CCA information in CDM.

Table 7. 2: Highlight of climate change response projects implemented in CDM which contribute to CCA and climate change mitigation.

Sector	Climate change projects implemented (CCA/Mitigation)
Agriculture	• In 2018/19 LDARD held 120 LandCare awareness campaigns to encourage sustainable management of resources such as water and land within communities (adaptation) • LDARD constructed 1km of fire belt to minimise veld fires and 17 gabion structures to reduce soil erosion while the EPWP created 6256 jobs across the province; Agricultural extension support services in the district help disseminate weather and climate information (adaptation) • Supports the implementation of the draft national Conservation Agriculture Policy at the local government level to promote food security (adaptation) • 2018/19 financial year LDARD supported two hundred households in CDM with a water-saving technology to promote home gardens that produce vegetables with little water through the Vegetable Tower Garden Technology (adaptation) (LDARD, 2018; LDARD, 2019)
Environmental management	• Participate in the Greenest Municipality Competitions run by the DEFF to encourage municipalities to implement the National Waste Management Strategy and the Climate Change Response Policy (mitigation/adaptation) • The Green belt project to upgrade certain areas, eradicate alien invasive species. through the EPWP grant from the DPW and Infrastructure, the CDM has been able to create more than 2000 jobs to enable the removal of alien plants and waste collection projects in Blouberg, Molemole and Lepelle-Nkumpi (adaptation) • Collaborated with the SAWS to undertake awareness-raising campaigns through disaster risk reduction competition in schools (adaptation) • Partnered with the DEFF to run the cleanest school competition which sought to engage learners in developing interventions to support waste management (mitigation)and water conservation. Support rainwater harvesting at schools(adaptation) • Sponsored the Eco-Schools programme in partnership with the WESSA for the past seven years to provide environmental education amongst learners and raise awareness education on themes such as climate change, water and eco-tourism. In 2018/19 about twenty-seven schools in the district participated with plans to expand this to more schools.(adaptation) Awareness-raising campaigns specifically for traditional councils and ward committees to build their capacity in land use planning (adaptation) (DEA, 2011a; DEA, 2011b; CDM, 2019a)
Water	• Investments in water regional supply projects to alleviate water shortages in Sephala, Mokopu, Thoka and Makwentja (adaptation) • Collaborating with the Waterberg JV Resources Pty Ltd mine to fund water infrastructure to benefit both the mine and communities in Blouberg local municipality (adaptation) (CDM, 2019a)
Transport	• Construction of the Rapid transport system, Leeto la Polokwane, which started in 2016 to provide a safe, reliable and integrated public system. Phase 1A links Seshego high-density township on the east with the central business district and settlements on the west i.e. Westernburg and Flora Park (mitigation) • Use of synchronising the timing of main traffic lights in the central business district to ease traffic flow e.g. the traffic lights along Thabo Mbeki Street and Biccard Street have been synchronised and most of the traffic lights are using LED lights (mitigation) • Parts of the district the municipality have transformed traffic lights to traffic circles to regulate traffic flow and reduce vehicle delay time at intersections as well as air pollution (mitigation) (Workshop 2 Participants, 2017; CDM, 2019a)
Energy	• Private sector funded solar farm projects supported by LEDET and local government municipalities to provide households with safe and clean energy. Examples include the Soutpan Solar power that is co-owned by the Kurisani Community Trust in Blouberg local municipality and produces about 61 000 megawatt hours per year (mitigation) (Workshop 2 Participants, 2017; Globeleq, 2019).
Disaster management	• Construction of a fire station at Rampuru, Polokwane West to improve emergency response to fire incidents (adaptation) • Support community awareness campaigns by Community Development Workers climate change (adaptation) • Collaborates with the SAWS, traditional authorities and schools to implement advocacy, training and public awareness programmes to build capacity for effective prevention and mitigation of both climatic and non-climatic risks (CDM, 2019a)

7.6 Barriers to and challenges for effective flow and uptake of CCA knowledge in local contexts: What is not working, why is this so and what needs to change?

In this section, I highlight some barriers and challenges that were identified by officials that discourage their uptake of CCA information in CDM. Action or inaction by governance actors is not only influenced by lack of information but can also emanate from restrictions within the environment they operate in, i.e. institutional arrangements (Bourdieu, 1990; Argyris and Schon, 1974; Mukheibir *et al.,* 2013; Pasquini *et al.,* 2013; Eisenack *et al.,* 2014; Bisaro and Hinkel, 2016). The concepts of institutional arrangement and structural arrangement are interchangeably used to refer to "the relationship between policies, practices and systems in place that ensures the effective functioning of an organisation or group*"* (UNDP, 2009:13). Institutions such as local government are anthropogenically constructed structures with political, economic and social muscle. They consist of both informal (e.g. sanctions, traditions, customs and code of conduct) and formal rules (i.e. polices, acts and laws) that govern activities, interactions of actors and use of resources within the interface (Saebo, 2017). The role of institutions within society is to effect and affect social behaviour by interchangeably enabling and constraining the agency of beings within. Thus, institutions have the potential to be transformative, reformative, as well as conservative (Bourdieu, 1990; Saebo, 2017). Drawing on the experiences of CDM officials and the actors supporting learning in CDM, the study was able to identify key challenges or barriers within the municipality that impacted learning, flow and uptake of information among governance actors. These challenges are discussed below by examining the effect of institutional arrangements and CCA learning interactions within the network on the day-to-day operations of municipal officials.

7.6.1 The absence of tailor-made information for local contexts

Despite the wide range of policies and learning systems that support learning in CDM (Chapter 4 and 6), officials stated that they currently have limited local level information tailored for planning and decision-making in the district. The information provided thus far is often externally driven, abstract and has not been tested in CDM. Hence, officials shared that even though they understand some key climate change-related concepts, they struggle to conceptualise this information to innovatively fit their local context and implement adaptation projects. For example, one of the adaptation recommendations for human settlements is "to manage potential increased migration to urban and peri-urban settlements" (CDM, 2016:7). The migration of people to urban areas is driven, however, by a wide range of factors, some of which are beyond the control and knowledge of local government officials. As such, the products are developed, and information is provided with limited understanding of the practical implications in the context of the application.

7.6.2 Limited agency and lack of administrative and political champions

Participants also highlighted that there is a lack of agency amongst officials and political leaders to be proactive in responding to climate change. CDM does not have local governance actors who are champions in driving the climate change agenda and make things happen at the local level (Leck and Roberts, 2015; Roberts, 2015). One governance actor stated that:

> '*Currently the success of climate change initiatives depends mainly on who is leading the department or research directorate and there are very few leaders who support adaptation initiatives in the district*' (Participant 2, 2017).

The comment by Participant 2 above shows that the lack of administrative and political champions in CDM has had implications in sustaining the morale of governance actors to apply information that they acquire from different learnings systems. Literature has highlighted that champions play a critical role in promoting learning and uptake of CCA at local government level (Westley *et al.,* 2013; Pasquini *et al.,* 2014; Taylor *et al.,* 2014; Leck and Roberts, 2015; Leck and Simon, 2018; Wolfram *et al.,* 2019). However, participants attributed the lack of champions in CDM to several factors, including the prevailing perception that Limpopo, as a largely rural province, is backward. Consequently, this has had implications on governance actors' morale and confidence to lead CCA initiatives in the province.

Other factors affecting governance actors were administrative barriers that constrain the ability of governance actors to experiment with new ideas and an overbearing presence of external actors in adaptation learning spaces. The officials shared that external actors tend to design climate change learning activities and outputs with little or no inputs from local actors (i.e. non-formal learning). One official expressed that:

> '*Those guys (DEFF, GIZ, DAFF) just come and present their programmes/projects with no inputs from our side and then they go*' (Participant 5, 2017).

The comment by Participant 5 highlights that the current learning process fails to facilitate essential co-designing of the learning agenda (Shackleton *et al* ., 2015; van Breda and Swilling, 2018) with the learners so they can decide what they want to learn, how and for what purpose. Owing to this, the externally driven initiatives although they are developed with well intent to support collective learning in CDM, governance actors shared that the learning is imposed. Hence, their participation is out of compliance to directives given by provincial and/or national departments and this has impacted on the uptake of this information into municipal operations. This challenge is not unique to CDM but has also been noted in other municipalities in South Africa that have received external assistance to support CCA learning, but implementation has been limited (Anguelovski *et al.,* 2014; Pasquini *et al.,* 2014). The existing learning systems have thus promoted incremental learning that consequently propels the status quo, i.e. reactive, instead of proactive adaptation. There is, therefore, a need to create learning platforms that enhance the agency of local actors to take ownership of the learning process and the outputs.

7.6.3 Competing priorities that dampen municipal capacity

Governance actors also highlighted that CDM, like other municipalities in South Africa, is faced with competing municipal service delivery demands, which also need to be prioritised to achieve national and sub-national development goals**.** The mandate of governance actors is derived from the constitution (Chapter 7) and other national legislation that seeks to meet the needs of the citizens(RSA, 1996), especially in a country that has inherited historic challenges of poverty, inequality and underdevelopment in disadvantaged communities such as those in CDM. That critical legal context cannot be ignored in the new democracy whereby climate change may aggravate the vulnerability of the poor and marginalised. One official stated that:

> '*Most people want to deal with immediate problems that have immediate benefits and recognition. Climate change seems distant to many political leaders and communities because projections talk of changes that will happen in rainfall and temperatures for timescales beyond our current lifetime like in 2050 some people just want to know about the short term-5-10 years*' (Participant 14, 2018).

Governance and political actors are overwhelmed by competing basic service priorities and the need to remain relevant to their constituency. Providing immediate relief to socio-economic disparities through basic services such as water, housing and electricity, ranks higher on their list of duties because failure to do so puts the government in tension with the citizenry (e.g. water service delivery protests highlighted in Chapter 5). The process of meeting developmental needs is often subject to political interference to ensure political interests take precedence (Hague *et al.,* 2019). Implementing CCA is, therefore, a complex task, but it needs to support officials to address existing developmental needs as well as respond to current and projected changes in climate (Satterthwaite *et al.,* 2007; Anguelovski *et al.,* 2014).

7.6.4 High staff turnover and lack of continuity

The CDM faces challenges with high staff turnover resulting in vacant positions, especially for key senior and mid-management level officials. Participants highlighted that high staff turnover had reduced the skilled human resources available to implement key mandates such as service delivery as well as CCA activities. Thus, officials are overstretched and have limited capacity to effectively integrate CCA into current decision-making and planning. In addition to this, changes in senior management have affected the continuity of initiatives as priorities are changed when new leaders join the administrative teams.

7.6.5 Limited financial resources and capacity to fundraise for CCA initiatives

Another key challenge raised by officials is the limited funding and technical support for adaptation. The officials perceived that key sector departments such as DEFF and its sub-national departments had prioritised budget allocation towards mitigation initiatives such as air quality monitoring and waste management. Therefore, officials working in other directorates where adaptation interventions are a key activity perceived that their work is not important, and this has affected their morale. One official expressed that:

'*Adaptation is usually not prioritised so even if you look at the name of the directorate, the focus is on air quality and waste*' (Participant 7, 2017).

In as much as climate change and CCA are cross-cutting issues, at sub-national level these have been clustered with and diluted by other environmental aspects such as waste, planning and air quality. Consequently, this diminishes the responsibility within the collective of who is responsible for it. This dilution is illustrated by the differences between the national and sub-national level. For example, at the national level CCA is led by a Deputy Director-General for Climate Change, Air Quality and Sustainable Development in DEFF with clear programmes and budget to support CCA. At provincial level and specifically in Limpopo, climate change falls under the Integrated Pollution and Waste Management Directorate, a sub-directorate within the Limpopo Economic Development Environment and Tourism provincial department where the focus of activities is on waste management and air quality. Finally, at the district level in CDM, CCA falls under the DPEMS where areas of priority are environmental management, economic development, strategy and planning, spatial planning and integrated transport planning. As such, at the sub-national level, there are no specific programmes or structures to mainstream CCA. The local level is where most of the impacts of climate change are felt, and it is also the level where most implementation will be done. However, the structures at the local level do not seem to highlight this responsibility.

The officials in CDM also highlighted that they have limited capacity to respond to calls for funding proposals that would support the implementation of projects. This is compounded by the fact that, at times, they do not understand some of the adaptation recommendations from science which also makes it difficult for them to compile a concept document to be considered for funding. The climate change financing space is very scientifically competitive as such municipal officials often lack the confidence to submit applications for funds to support their initiatives. The officials indicated that they have difficulties with conceptualising the problem and its solution (CCA) to meet the requirements of funding institutions such as the Green Fund. Even more, the application process can be cumbersome as there are high-level questions that require a certain level of competency in packaging the proposal. This was expressed by an official who shared that:

'*To access funding, we need technical assistance from other stakeholders so we can write sound business plans and implement projects together*' (Participant 5, 2017).

The comment by Participant 5 highlights the need for capacity building and/or technical support to access climate finance. Without these skills and/or support, governance actors fail to access climate finance to implement CCA, even though their municipality is at risk. CCA learning and support, therefore, needs to go beyond the provision of information but also include continued support to access funding, co-design and co-implement appropriate projects, as well as monitor and track progress (Menelisi *et al.,* 2020).

7.6.6 Bureaucratic red tape

Research participants expressed concern with the government legislation and supply chain process, which they described as being cumbersome and causing further delays in the implementation of CCA initiatives. Specific legislation mentioned by governance actors were the Municipal Finance Management Act No. 56 of 2003 (MFMA) and Municipal Systems Act No. 32 of 2000 (MSA). These acts were established to promote sound and sustainable management of the municipal finances in all organs of the state. However, some sections of this legislation that constrain governance actors in engaging in CCA activities include section 19 of the MFMA on Capital Projects. It stipulates that municipalities can only spend money on capital projects that have a budget allocated to them, and it should be approved by the council. Then again, council approvals for CCA can be a challenge given that the impact of the projects often takes time to be realised and this may be longer than the administration cycles, and many politicians prioritise meeting the short-term needs of the community (Oelofse *et al.,* 2014). Additionally, Chapter 4 of MSA requires that municipalities should engage communities for projects that affect them, and this adds additional costs and delays to project implementation.

Apart from this, the supply chain process can take up to nine months and has an estimated cost of about R2 million, however, such an investment (time and money) does not always result in a short-term contract and may require an additional 2-3 years to establish (Oelofse *et al.,* 2014). Officials expressed that such processes are costly for CDM as they are already struggling with financial constraints for service delivery. Therefore, there is some reluctance to take on adaptation projects which may be difficult to quantify and, as noted earlier, are difficult to monitor and evaluate their impact. These cumbersome and hobbling organisational processes discourage officials from engaging in climate change projects. Participants indicated that they are often over-committed and worried about investing time in efforts that will not be considered for the deliverables that their performance assessment is based on. These concerns on the impact of bureaucratic processes on climate change response have also been raised in other cities across the globe (Biesbroek *et al.,* 2018; Klein and Juhola, 2018) including South Africa for example in the City of Cape Town (Colenbrander and Bavinck, 2017).

7.6.7 Absence of overall policy framework

Engagements with actors supporting learning in CDM also revealed that the delays in the implementation of the CDM climate change strategy and impromptu CCA initiatives in CDM (and other local governments in South Africa) can also be attributed to the lack of implementation of national policy to guide CCA at the sub-national level (Chapter 4). The current policy gaps have constrained the uptake of actions required to advance CCA, as some municipal officials are reluctant to act when there is no formal structure or regulation that enforces action. Consequently, climate change structures have also not been mandated by the NCCRP, hence there are no performance indicators or incentives for officials, which also makes it difficult to monitor progress (Petrie *et al.,* 2018). It is anticipated that the proposed Climate Change Bill, as summarised in Chapter 3, will address some of these challenges and enforce climate change action at the local government level, but at the time of submission of this thesis, it is still a draft and is under consideration by the National Economic Development and Labour Council

(The Presidency RSA, 2020). When the Bill becomes an Act, it sets the binding rules of engagement. Accordingly, governance actors must have resources and structures to comply (Hague *et al.,* 2019).

7.6.8 Traditional leadership contestations in communal areas

Another factor that is making CCA implementation difficult in CDM (and Limpopo in general), as highlighted by governance actors, is the presence of contested traditional leadership resulting in leadership conflicts (Chapter 5 section 5.2). Municipal actors have to negotiate access to and cooperation of traditional leaders who are custodians of the land with oversight of all activities that take place in communal areas (Traditional Authorities Research Group, 1999). Thus, traditional leaders influence how community actors engage with municipal actors, participate in initiatives driven my municipal and other external actors. They are gatekeepers of the local community who can determine the potential of CCA initiatives to achieve the intended outcomes. When there are contestations among traditional authorities, particularly in relation to succession, land boundaries and allocation of resources, it presents a challenge to get buy-in from all parties within the community. In Chapter 5, examples of tensions amongst traditional authorities were illustrated, adding to the complexity of the environment in which governance actors operate, the power dimensions that impact their work and what is prioritised. It is, therefore, crucial for traditional authorities to be considered in the learning process to ensure that there is a full understanding of the contribution that their communities can make to achieve better outcomes for CCA. For instance, in some communities, traditional leadership is contested, and some leaders are not officially recognised by the government but are supported by communities, resulting in conflicts (Traditional Authorities Research Group, 1999; Hungwe, 2017). In the context of CCA, traditional leaders are key stakeholders at community level who can facilitate and champion community engagement processes in risk and vulnerability studies, adaptation scenario planning and implementation of CCA projects.

The above barriers have helped to map some of the areas where governance actors are stuck within the adaptation action cycle. There is some evidence from the narratives shared by the participants and the review of the municipal documents that show that the municipality has gone through the first two phases in the adaptation action cycle, i.e. detect, define and frame the problem and policy formation. The CDM has conducted a risk and vulnerability assessment for the municipality (i.e. first step in the adaptation action cycle) and developed a Climate Change Response Plan to support CCA (i.e. the second step in the adaptation action cycle). However, the response plan is yet to be approved for adoption and implementation. The lag in adoption and implementation of the adaptation strategy presents a lag in the subsequent steps of the adaptation action cycle, i.e. implementation of prioritised adaptation actions and MEL. Thus, the adaptation actions taken to date are *ad hoc* and are tinkering at the edges and lean towards incremental adaptation as there is no evidence of transformation taking place. It is essential that learning initiatives also focus on supporting governance actors to go through all the components of the adaptation action cycle. MEL would particularly enable officials to assess what is working, what is not working, why is this so, what needs to change and develop appropriate interventions. Suggestions on how to unplug some of the barriers

and opportunities that can be explored to enhance the flow and uptake of information at the local government level are presented in the following section.

7.7 Opportunities for improved learning and flow of information in CDM.

During the engagements with governance actors and the external actors involved in learning within CDM, they also provided insights into avenues that could enhance the flow and uptake of information at local government level. The research has established that whilst there are many sources of information available to governance actors, the dissemination of this information has not resulted in uptake. Similar findings were noted in the work of Tanner and Bahadur (2012) and Kong *et al*. (2020), who argue that the epistemic community or knowledge brokers/intermediaries can provide information, but that information alone has limited power to institute change in the recipients or contexts in which they operate. To bridge the gap between science-policy-practice dissemination and uptake, the epistemic community needs to work with other political actors that have power or who can influence decision-making by using their power constructively (e.g. municipal manager) (Drimie and Quinlan, 2011; Kong *et al.,* 2020). In Table 7.3, I highlight some of the avenues for strengthening the flow and uptake of information that were indicated by the research participants.

The actors listed in the table above were identified as key actors whose role could be strengthened to enhance the flow of CCA information and effective implementation at the local government level. Some of the actors identified above (e.g. CSIR, Disaster Management and NGO's) were also highlighted as having high degree centrality and betweenness because of their level of influence and position in the social network (see section 6.4) The role of actors such as research and academic institutions who provide information also needs to be enhanced to ensure that that they provide tailor-made products and information that is useable (consider the format and local languages). Besides, these stakeholders need to also explore different platforms and shadow architectures that can be used to support learning and integrate other forms of knowledge that can complement science produced by these institutions. The gaps in adoption, implementation and enforcement of policy can be enhanced by actors such as SALGA, National Treasury and CoGTA. These actors can play a key role in ensuring that policy and programmes support the long-term planning of CCA initiatives and provide a clear direction on the roles and responsibilities of governance actors.

Governance actors also identified a lack of technical expertise and funding as some of the key barriers to the implementation of CCA initiatives. However, the role of actors such as private and financial institutions, NGOs and DBSA could be reinforced, so they partner with governance actors in accessing funding and provide technical support to experiment as well as implement CCA in CDM. The implementation also requires buy-in from actors such as local municipalities, traditional authorities and community-based organisations who can also co-design CCA actions that could be implemented at the community level.

Table 7. 3: Examples of opportunities highlighted by the participants that could be explored to strengthen the role of actors in the polycentric governance network to enhance the flow and uptake of CCA in CDM.

Actor	The current or new role that needs to be strengthened to support learning and implementation of CCA in CDM
Local municipalities	• Local municipalities need to take on more responsibility for climate change response, but they are currently playing a minor role except for Polokwane LM. They could do more to help identify stakeholders in communities to collaborate with and lead community projects. More so, they can identify areas that could be prioritised for experimentation of adaptation projects, including targeted community awareness-raising and education
Disaster management	• The department should improve and collaborate with local actors to support the dissemination of early warning information to mitigate the impact of climate-related disasters.
Research and Scientific Institutions SANBI, CSIR ARC	• The institutions should provide technical advice based on local level information and illustrate how this compliments the different municipal operations • Package and disseminate information to meet user needs • Support the district and local municipality sector departments to get political support and budget for environmental-related projects, which are often marginalised
DBSA	• The funding institution could provide more funding for municipal infrastructure and technical expertise, particularly around CCA
SALGA	• SALGA should work more closely with municipal departments responsible for climate change and the environment to advise and support adaptation initiatives • Present the needs of local governments (e.g. financial and human resources) and lobby for support from higher levels of government • Consider reviewing the organogram of municipalities as a lot of work is amassed upon a few individuals who feel overwhelmed when they must be innovative in integrating CCA into municipal operation
Traditional authorities	• As custodians of communal areas, they should promote the use of indigenous knowledge systems to respond to climate change and support awareness-raising initiatives by the municipality • Integrate municipal planning instruments such as SPLUMA into land-use planning and decision-making in communal areas to avoid allocating land in environmentally sensitive and disaster-prone areas or worsen the loss of grasslands due to land-use change
Political leaders, Members of the Municipal Council and executive management	• There is a need for CDM to have political champions within the district municipal executive structures and administrative staff to drive the CCA agenda • Take part in CCA learning initiatives rather than assigning junior and mid-level administrative staff who cannot enforce transformative change in the municipality • Political buy-in and provision of budget to support CCA initiatives • Support learning platforms that are outside the formal municipal structures that build the capacity of officials, e.g. networks
Private sector and financial institutions	• Provide funding, information and technical support for local climate change response initiatives • Insurance companies support the dissemination of early warning information to communities at risk
University of Venda and University of Limpopo (especially the RVSC)	• Academic institutions in the province need to be more accessible to local governments and share local research conducted by students that are often missing in national and international learning systems such as scientific publications, the internet etc. • Collaborate with local governments in experimenting with CCA initiatives • Provide short courses to meet the needs of local government officials and political leaders
CoGTA	• Performance indicators by CoGTA (list of actions) need to incorporate the implementation of CCA so that officials can also report on and monitor performance
NGOs and Community based Organisations	• Collaborate with municipalities to apply for climate finance, implementation and monitoring of projects at community level, including the integration of indigenous knowledge systems • They should be encouraged to establish climate change learning forums that bring together public and private sector actors, academic institutions etc
Dept of Water and Sanitation	• Support efficient water management initiatives given that the municipality already has challenges with water security
Dept of Agriculture – national and provincial	• Improve coordination of climate change efforts with environmental departments at provincial and district level to build on synergies that enable sharing of human and financial resources as well as information
National Treasury	• The department should change the performance indicators of municipalities so that they start to report back on the implementation of CCA and include financial implications

The findings of this study highlight that many external actors in the polycentric governance system support CCA learning in CDM, the current modes of support, however, should be leveraged and enhanced to move CCA into the more transformative space.

7.8 Conclusion

In this chapter, the study established that the understanding that governance actors have of climate change, CCA and experiences of climate change demonstrates some key gaps in knowledge on the differences between incremental and transformative CCA. Factors hinting at the lack of transformative adaptation are the lack of long term CCA actions as well as the limited understanding of the distinction between terms such as climate change and climate variability. As shown, research participants treated the terms climate change and weather variability synonymously and this limited their ability to see the former as a phenomenon that occurs over a long time (i.e. 30 years plus). This lack of distinction between the two concepts limits their ability to action appropriate responses to address both the short-term and long-term actions needed for CCA. Hence the priority of actions employed by governance actors continues to revolve around the short term and *ad hoc* projects, and these are not sufficient for transformative adaptation.

Given the lived experiences of governance actors with impacts of climate-related extreme weather events and their acknowledgement of these encounters as an immediate risk, it is astonishing that their responses do not correspond to the actions required. For example, from 2016, when the CDM Climate Change Response Plan was developed, it has not yet been adopted and implemented, a shortcoming that indicates the lack of political will to champion the priority actions. Drawing on the adaptation action cycle, CDM is stuck on the second phase of the cycle due to barriers such as lack of agency and political champions to drive CCA in the municipality. At the same time, actors supporting the learning processes need to critically reflect on how they can facilitate transformative adaptation because the current initiatives promote incremental adaptation with an emphasis on returning to normal without understanding what normality entails (Davoudi *et al.,* 2012). Maintaining social learning and achieving transformative adaptation in the Global South is a long term and cumbersome process with no one way of achieving this (Kronlid, 2009).

The study was able to identify opportunities within the polycentric governance network that could be harnessed to enhance the flow and uptake of information into municipal operations. These include strengthening the role of actors such as universities within Limpopo to provide contextual information to support understanding of the local context and the design of appropriate CCA responses. Private institutions such as insurance companies, for example, can play a bridging role and support institutions such as SAWS to disseminate early warning information to reach stakeholders within their customer databases to support disaster preparedness. In addition, actors such as political leaders and executive management could also play a key role in championing the integration of CCA within the municipal

structures as well as support the continuous learning for individuals and groups working within municipalities.

Chapters 4, 5, 6 and 7 have presented the findings of the five explorative questions on *who learns*, *what is learnt*, *learnt from whom and how the learning takes place*, *the effect of learning* and *what else can be done* to enhance learning. In the next chapter, I drew on the governance, learning and adaptation action theoretical lenses to present conclusions of the findings of my study as they respond to the study objectives and central aim of the study, i.e. to enhance CCA learning in local government contexts.

8. Conclusion and Recommendations

8.1. Introduction

In this study, I explored the question: How do local actors learn to adapt to climate change, and how may these learnings be scaled up to impact national learning systems? The CDM was used as a case study to understand how local government officials in this municipality learn about CCA. There is still very limited knowledge on the range and scope of actors involved in climate change governance (Wolfram *et al.,* 2019), how they learn ((Dunlop, 2009; Hopkins, 2013) and the different sources of information used in learning (Hopkins, 2013: Angeulovski *et al.,* 2014). Global and local research and policy have shown the need for local government actors in the governance of climate change, however there is still a need to improve the flow of information from different learning systems to enhance the adaptive capacity of governance actors to mainstream this into municipal operations. South African local governance systems are complex, and priorities for governance actors have been shaped by the historical, cultural, political and economic factors that influence the decision-making landscape (Scott, 2017). In addition to the state actors, other non-state actors such as civil society, communities and the private sector also influence the governance of CCA, resulting in a complex polycentric governance system. These social actors can also play a role in fostering the adaptive capacity of local actors and transformative change at local government through, for example, social learning (Davoudi *et al.,* 2012). In this research the focus was on government actors, because these actors have been identified as one of the key stakeholders in implementing CCA and there is need to understand the challenges and opportunities for climate change uptake at local the government level (DEA, 2011; Reddy *et al*., 2021).

In this final chapter, I recap the key arguments of this study captured in preceding chapters and provide a synthesis of the main findings using the four main objectives for the study set out in Chapter 1. Beyond this, I also provide a reflection of the research journey, highlighting some of the key steps followed, lessons learnt, and challenges faced along the way. Lastly, the chapter concludes by offering recommendations for actors supporting learning, actors in local governments and future research in the field of climate change governance and learning at local government level.

8.2. Overview of preceding chapters

This thesis comprises of eight chapters. In the introductory chapter, i.e. Chapter 1, I outlined the research overview, contextualised the research question and relevance of the study, aim and objectives. More so, the chapter provided the scope and focus of the research as well as definitions of key concepts, a preamble of the research design and structure of the thesis.

Chapter 2 discussed the governance, CCA and learning theory lens deployed by the study to improve understanding of and explore five key questions on i) *who learns* ii) *what is learnt; iii) to what effect*; iv) *learning from whom and how this learning takes place*; v) *what else can be done*. The governance theory

(Ostrom, 2010) was used to address the gap identified by Wolfram *et al*. (2019) on who the governance actors are who learn and their learning process. This lens provided insights into the complexity of governance systems as they are polycentric, thus influenced by varying norms, rules, practices and institutional cultures that create competing demands on the learners (i.e. governance actors). Following this, the adaptation action cycle was used as a conceptual framework to illustrate the learning that occurs through either the incremental or transformative adaptation cycle. Drawing on the lifelong learning typologies by Moser and Spear (1982) the study was able to assess the type of learning that learners use and its impact on the flow and uptake of information.

Chapter 3 described the research journey that facilitated the collection of data relevant to my study and the rationale for selecting CDM as a study site. My research was situated in the interpretive paradigm and used a PAR approach to enable deep conservations with key informants so they could share personal, interpersonal and impersonal knowledge about climate change and CCA. The chapter discusses the qualitative research techniques used to collect data, namely workshops, semi-structured in-depth interviews, focus group discussions, participant observation and an integrative literature review. A combination of stratified purposive sampling and snowballing was used to identify the research participants. There were twenty-nine participants in total, and their demographics are provided in this chapter. A limitation of this qualitative research design is that the results cannot be generalised, given the small sample size. However, the approach was adopted because of its potential to provide rich narratives on the subject from a few but resourceful people, which would have been more difficult with a bigger sample size. The chapter also described the data analysis used, i.e. thematic analysis and social network analysis using the VisuaLyzer tool to illustrate the flow of information as well as the position and influence of social actors in that process. The positionality, ethics and limitations of the study are also provided in this chapter.

Chapter 4 sets the global and national scene for climate change and CCA by highlighting some of the global climate change agreements, national and sub-national policies, programmes and projects that have been developed to support climate change response. Implementation of the global commitments, national policies and programmes depends on the actors at the sub-national level. Strategic documents developed to guide CCA at provincial and district level as well as efforts to mainstream climate change into the municipal planning documents are also presented in this chapter. The chapter provides insights into what and how actors at sub-national level learn from these sources of information. A key finding is that most of this information is accessible through the internet and, in some instances, disseminated through social platforms that are facilitated by national government departments as well as research and academic institutions.

Chapter 5 presented the local scene-setting in the CDM. The chapter presents the governance context, which highlights a complex decision-making system linked to other vertical and horizontal structures that are part of a cooperative governance system. In addition to the three-spheres of government, rural

municipalities such as CDM also have traditional authorities who play a key role in management and decision-making in communal areas. Literature shows that, at times, there are tensions within and between the municipal administration and traditional authorities, which affects CCA implementation at the community level. The chapter also presents the climatic, social and economic context in which learning and climate governance take place. These social-economic and biophysical factors highlight some of the key issues that make climate change governance difficult as decision-makers must balance between managing climate risks that involve uncertainty and societal considerations. The climate change projections for Limpopo indicate a drier and warmer future which, without effective adaptation actions could exacerbate current challenges such as water shortages.

Chapter 6 examined three key questions on who learns, learning from whom and how does this learning take place. Firstly, the chapter used the governance lens to identify governance actors who make decisions and learn about CCA in CDM. The narratives shared by officials revealed the polycentric nature of climate change governance with hierarchical decision-making structures. Secondly, the chapter described the different learning systems used by officials to learn about climate change which includes forums, municipal reports and actors from national and academic institutions. Officials indicated the learning systems that are most effective for them, followed by an analysis of the strengths and weaknesses of each learning system. The effectiveness of the different learning systems is an aspect that needs to be considered when designing initiatives to support learning at local government level. Lastly, the data derived from the Net-Map exercise and interviews were used in this chapter to analyse the interactions and flow of information between social actors, i.e. social network analysis. The VisuaLyzer tool demonstrated how information flows between actors and the position or influence of actors using centrality measures of the degree of centrality, betweenness and nearest neighbours.

Chapter 7 interpretively analysed how local government officials make sense of climate change, CCA, perceptions of risk and lived experiences. By so doing, the governance actors provided insights on *what they have learnt* and *to what effect*. The chapter also presents some of the climate response initiatives in the municipality that could contribute towards CCA and the challenges with the uptake of climate information. The chapter concludes by illustrating some of the actors and actions within the polycentric governance system that should be strengthened to enhance the flow and uptake into municipal operations.

8.3. Key findings

The main key findings on CCA learning process for governance actors in CDM are as follows:

- In Chapters 4 and 6, the research established that the process of learning for governance actors in CDM is complex. There are varying sources of information (e.g. policies, scientific outputs and indigenous knowledge systems) and external actors through which the officials are learning about climate change and CCA. As shown in Figure 8.1, governance actors in CDM have varying

levels of control over both the learning process and content. Self-directed learning enables governance actors to have high control over the learning content and objectives while, learners have less control of both aspects when using the formal learning typology.

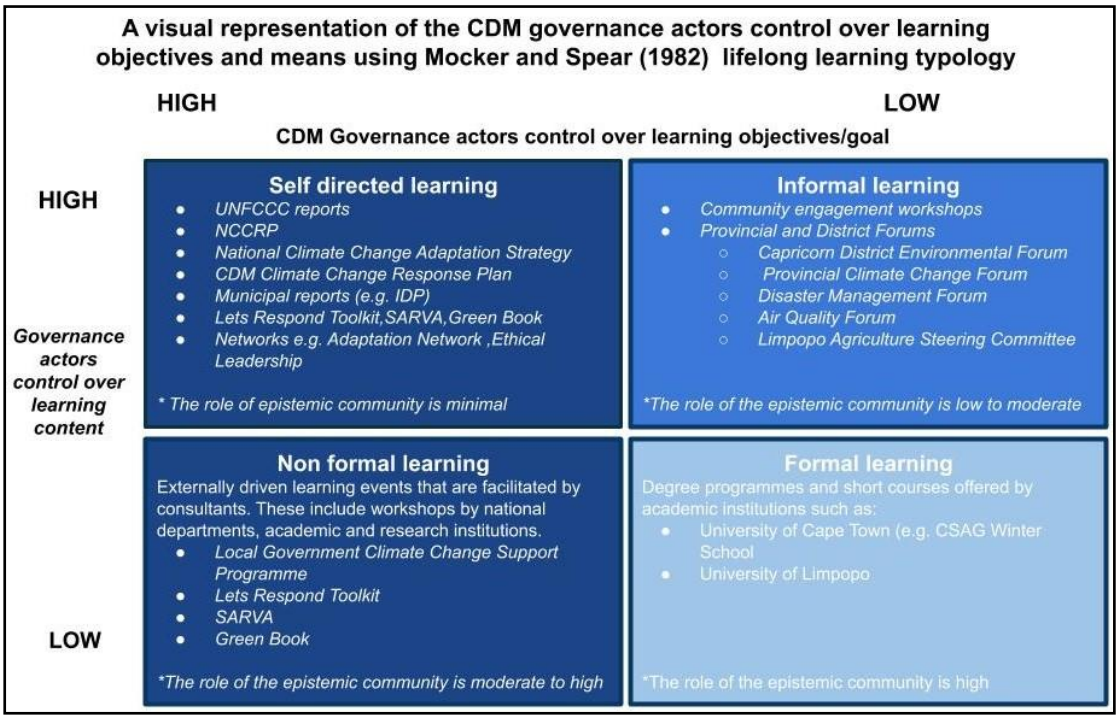


Figure 8. 1: The learning typologies and sources of information available for CDM governance actors to learn about CCA. In each learning typology governance actors have different levels of control over learning content and objective. Darker shades of blue indicate the most selected types of learning and sources of information, used in their learning i.e. self-directed and non-formal learning.

- The multiple sources of the information shown in Figure 8.1 illustrate that CDM governance actors use all four learning typologies, i.e. self-directed, non-formal, formal and informal learning. These avenues of learning, however, often provide contradictory, complex and incomplete information that requires additional support for it to be useable at the local level. Governance actors are therefore required to make sense of CCA information and apply it in complex socio-political contexts where there are other competing development priorities. Furthermore, engaging in different learning typologies does not necessarily result in uptake of CCA and disaster risk reduction actions as actors do not have the resources to develop the required adaptive capacity.
- Chapter 7 brought to the fore a finding that the CCA initiatives implemented to date in CDM, on the one hand, foster incremental adaptation and single-loop learning, as illustrated in Figure 8.2. This is evidenced by reactive interventions to disasters and *ad hoc* projects (e.g. community awareness campaigns by Community Development Workers). On the other hand, the learning process requires governance actors to be self-driven learners in a context where there are

inadequate ICT and human resources. Consequently, the externally driven learning initiatives offer piece-meal information that is unsuitable to the context of use, hence perpetuates incremental CCA actions. The existing approaches to learning are thus providing fragmented information and support that fails to empower governance actors to complete all phases of the adaptation cycle. More so, the information is mostly provided in English, yet most of the governance actors are non-native English speakers who struggle with making sense of and translating scientific information with colleagues and communities who are native speakers of other languages such as Sepedi and Xitsonga.

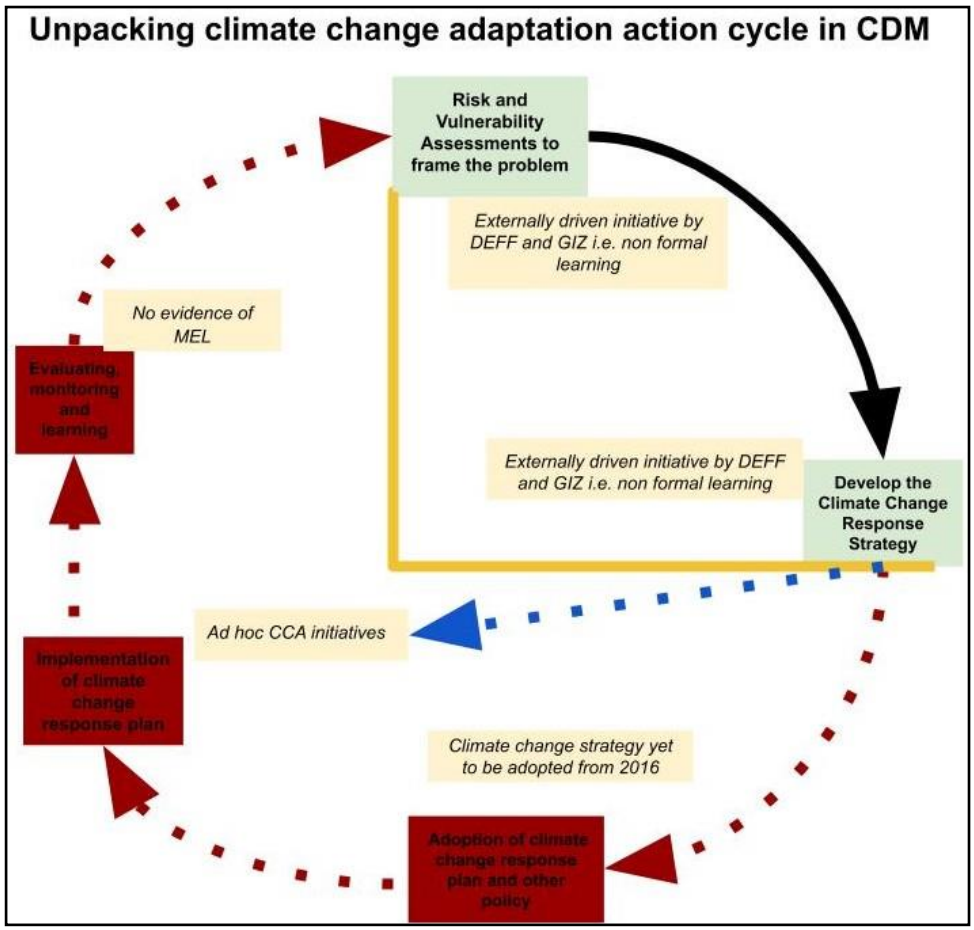


Figure 8. 2: Illustration of how the process of CCA is undertaken in CDM. The green blocks indicate the phases of the action cycle currently completed in CDM with the transition from phase 1 to 2 illustrated by the bold solid arrow. The red-dashed arrows and red blocks illustrate the action phases that CDM has not yet been completed; hence current initiatives are ad hoc (blue arrow).

- Using the social network analysis, Chapter 6 of the study indicated that external actors such as DEFF, GIZ, CSIR and NGOs play a key role in the CCA learning system. National departments also make use of consultancy companies and research institutions to design and undertake policy related programmes and projects at the sub-national level. The learning initiatives brought forth by these actors are externally engineered with little to no inputs from the local actors in

CDM. As such, there is often a mismatch between the information provided and the needs of learners. Owing to this, governance actors frequently participate in many of these learning events for compliance and not as active learners who own the learning process and outcomes though these activities are vital. This impacts their ability to implement the recommendations or outcomes brought by the learning activities because they are created outside their scope of influence (i.e. absence of co-production). Furthermore, the social network analysis also highlighted the role of actors who connect, actors who would not otherwise connect a role that can be likened to brokers or intermediaries. These actors influence the flow of information and the learning process and, in this case, include LDARD, CSIR and NGOs such as AWARD.

- Lastly, the study established that there are actors within the CDM social network whose role should be strengthened to support the flow and uptake of CCA in the municipality. The actors, as shown in Chapter 7, include actors who are well connected within the network, intermediaries and CDM's nearest neighbours such as DEFF, LEDET, local municipalities and the University of Limpopo, among others. Strengthening the relations and collaborative activities between these actors and CDM would enhance access to local-level information, which can be harnessed to implement tailor-made CCA initiatives at the local level.

8.4. Main conclusions

The subsections below present the conclusions based on the four main objectives of the study and key questions addressed under each objective that guided this study, as identified in Chapter 1 (section 1.2). I have used the answers to these questions to reach the conclusions of my study, and these are also summarised in Figure 8.3.

Objective 1: Establish the governance actors current understanding of climate change, climate change adaptation, lived experiences as well as perceptions of risk

Before establishing the current levels of understanding of CCA and related concepts, the study drew on the governance lens (Ostrom, 2010; Jordaan *et al.,* 2018) to establish who are the governance actors involved in CCA learning and decision-making in CDM. The participants indicated that local government contexts such as CDM have a complex governance system comprising multiple governance actors, i.e. municipal council, an executive mayor, municipal manager, executive managers and municipal administration management and staff (Chapter 5 section 5.2.1). In addition to the district municipal structure, there are traditional authorities, provincial sector departments and local municipalities within the district who in their respective constituencies, as guided by their mandate, also learn and make decisions around CCA. These governance actors include CoGHSTA LEDET, LDARD, Polokwane and Lepelle-Nkumpi local municipalities. The governance actors each have their unique bureaucratic structures and processes, varying mandates and levels of power, as well as human and financial capacity challenges (Beyers, 2015; Hungwe, 2017).

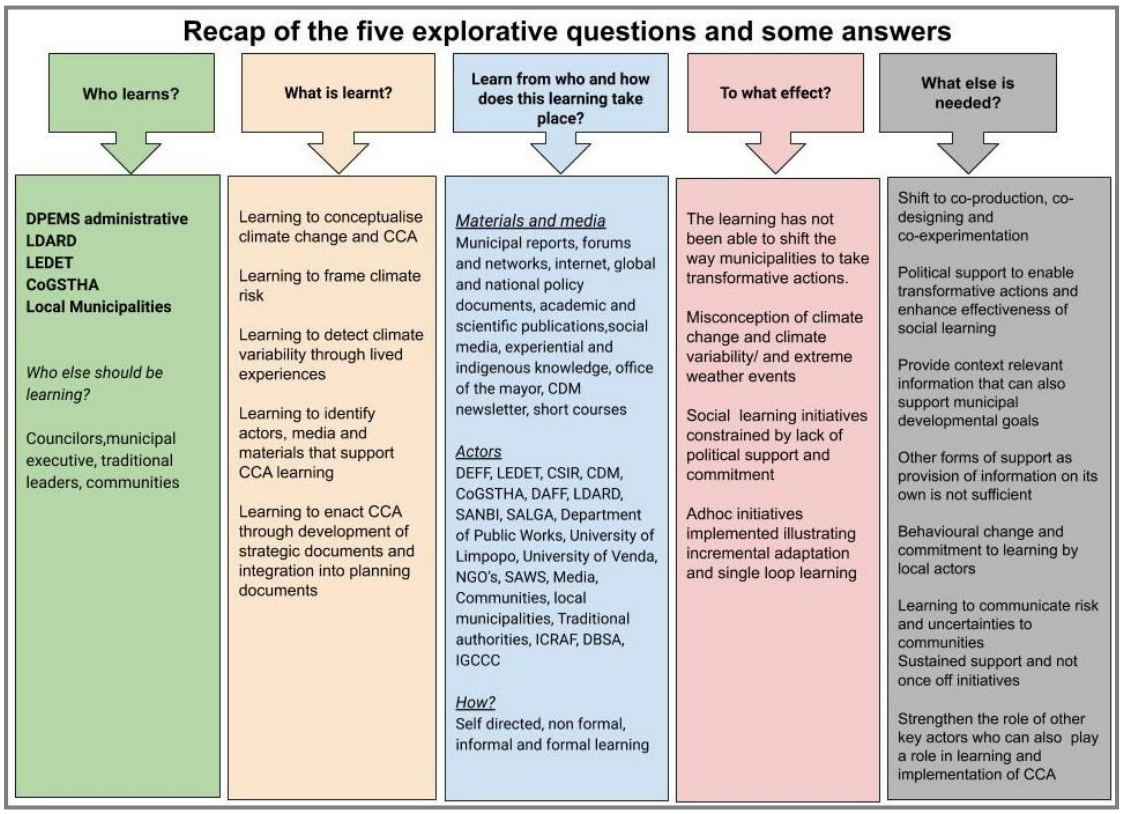


Figure 8. 3: An overview of the key findings relating to the five explorative questions on who learns; what is learnt; learn from whom and how this learning takes place; to what effect; and what else is needed.

These factors increase the complexity of governing climate change in CDM, particularly because of poor coordination within and between the actors. The administrative staff have been the key focus of externally driven climate change learning initiatives given their role as implementers at the local level, but their work requires approval from the municipal executive and council and also integrates the needs of sectors, traditional authorities and communities that are captured during public participation events, e.g. IDP workshops. Undoubtedly, overlooking the principals who approve municipal activities in the learning space can make getting the necessary approval required difficult to attain.

Following on from identifying the governance actors and mapping the governance landscape, the adaptation action cycle (Park *et al.,* 2012) was used to interrogate how the identified governance actors conceptualise key climate-related concepts such as climate change, CCA, risk, lived experiences. The adaptation action cycle was used as a conceptual framework as it is anticipated that, as actors go through the sequential phases of the cycle, there is learning that takes place that informs the subsequent phases. The cycle starts with identifying and defining the problem (climate change risk and vulnerability) and ends with the monitoring, evaluating and learning phase, where the performance of actions is measured against the objectives and informs incremental or transformative changes in the next phase. Sense-making plays a key role in informing the value that is given to the outcomes derived from each of the steps (O'Brien *et*

al., 2007; Fünfgeld and McEvoy, 2013), for example, defining climate change and influences what is followed and/or disregarded.

Definitions of climate change and CCA provided by the governance actors indicate some significant learning gaps that could be addressed in future learning initiatives to support the development and implementation of long term and sustainable interventions. Firstly, officials' framing of climate change was based on observed extreme weather events and seasonal variations from one year to another for less than 15 years. The officials' local experiences in extreme weather events, variations of weather and social and cultural indicators of seasonal patterns have been used to interpret the global and national discourses of climate change. The officials had conceptualised these short-term variations, i.e. climate variability, as climate change, and they perceived this to be an urgent risk based on their experiences and the impact on their work. Secondly, a significant proportion of the governance actors were not able to provide a holistic definition of CCA as the definitions they provided did not integrate the aspect of taking advantage of the opportunities presented by CCA. The incomplete framing of the concept by the participants has implications on initiatives undertaken at the municipal level. Lastly, although all governance actors perceived climate change to be an immediate risk for the CDM, there is no congruence between their perceptions of risk and CCA strategies in the IDP. The governance actors shared that the actions taken by sector departments have been mostly developed to respond to other development issues, react to disasters or comply with directives. These actions, therefore, tend to lean towards incremental adaptation and are evident in single-loop learning (Argyris and Schön, 1996).

Climate change projections for Limpopo, however, show that the province is likely to become drier and warmer and at the same time experience increases in extreme weather events such as heatwaves (Engelbrecht *et al.,* 2015; Hoegh-Guldberg *et al.,* 2018; Mbokodo *et al.,* 2020). For this reason, the focus of governance actors needs to shift from incremental actions that target the low hanging fruits, i.e. coping and survival but also making deep, systemic changes to social and political processes and structures (double and triple-loop learning) that contribute to vulnerability (transformative adaptation) (Bourdieu, 1990; Pelling, 2011; Tanner and Bahadur, 2012; Lonsdale *et al.,* 2015; Bendell, 2018).

Objective 2: Identify the sources of climate change adaptation information, its flows and uptake at the local government level

Governance actors indicated the sources of information (that form part of their learning systems) that they use to learn about CCA and how the information flows to officials in CDM. The sources of information identified in this learning system include materials and media such as municipal reports, policy documents, scientific publications, forums, workshops, networks, internet, experiential and indigenous knowledge, short courses and the Office of the Mayor. CCA learning in CDM was also supported by actors from national and provincial departments, civil society, research and academic institutions. Forums and networks were selected most used sources of information, followed by municipal reports and policy

documents, while social media was the least used. The most effective source of information for officials were forums (e.g. Capricorn District Environmental Forum and Disaster Management Forum), networks (e.g. Adaptation Network and Ethical Leadership on Climate) and municipal reports. Governance actors highlighted that forums and networks promote collective learning, while municipal reports enabled self-directed learning on realities that they were familiar with. Forums and networks, if sustained, are an entry point for social learning within local governments that can be used to co-produce, codesign and experiment with CCA.

Literature shows that networks have also played a key role in supporting mitigation, and more recently adaptation, in developed countries, and the assumption is that they can also do the same in developing countries such as South Africa (Fünfgeld, 2015; Busch *et al.,* 2018; Heikkinen *et al.,* 2020). Forums have also been identified by the Climate Change Agriculture and Food Security Research Programme (CCAFS) of the Consortium of International Agricultural Research Centers' (CGIAR) work on climate change communication as one of the most effective in supporting learning and dissemination of information (Harvey *et al.,* 2012). My study established that networks and forums can play a key role in supporting social learning. However, they have limited ability to influence systemic changes and implementation of CCA. This finding also confirmed what has been noted in earlier studies on their ability to support learning in policy issues such as HIV/AIDS, food security and nutrition (Drimie and Quinlan, 2011), CCA (Leck and Roberts, 2015) and disaster risk reduction at local government level (Kong *et al.,* 2020). Additional challenges identified include little or no political support, high staff turnover, poor attendance and limited capacity to influence decisions or systemic change within municipalities, which need to be addressed for the learning systems to be effective.

Despite all the scientific and policy documents and products available to support learning at local government level, the participants indicated that these were the least effective sources of information. The reasons for this were the lack of local-level information that governance actors can relate to, limited internet access, use of technical language that non-specialists struggle to interpret into action and information overload, which makes it difficult to cull through. More so, accessing CCA information on the internet requires a learner who is tech-savvy to navigate through the websites and includes unreliable sources of information that a naïve user must muddle through (Najjar, 2011). Apart from scientific information governance, actors also have other sources of information such as indigenous knowledge and experiential knowledge that also needs to be integrated to design user-inspired adaptation interventions (Walker *et al.,* 2006; Marx *et al.,* 2007; Bohensky, 2008; Tschakert and Dietrich, 2010; Makondo and Thomas, 2018). Integrating indigenous knowledge systems and practices can enhance the work by intermediaries supporting CCA learning to develop grounded information on climate change risks and appropriate responses that suit the context of the application.

In parallel to the sources above, governance actors also highlighted that they learn from actors from national and provincial departments, research institutions and NGOs. National departments such as

DEFF, LEDET, LDARD, CoGTA and SALGA also provide technical support, funding and capacity building. The DEFF has, in partnership with GIZ, for example, employed the expertise of consultants, i.e. Urban Earth, to support CDM to develop its climate change response strategy. Additionally, DEFF, GIZ, CoGTA and SALGA have collaborated in developing the Let's Respond Toolkit and governance actors participated in workshops facilitated by Sustainable Energy Africa and Palmer Development Group to help them integrate climate change into the IDP. Furthermore, participants pointed out research and academic institutions such as CSIR, SANBI and the University of Limpopo to be key actors who support CCA learning in CDM. Civil society organisations such as AWARD and Choice Trust support the municipality with implementing projects, training, community engagement and awareness-raising and are a key component of their learning system.

The interactions, flow of climate information and support between these actors promote knowledge sharing, the achievement of national climate change objectives and diffusion of ways of doing things that could inform behavioural change (Oberthür and Gehring, 2006; Pattberg *et al.,* 2018). Inversely it has also brought to fore challenges and tensions between actors that affect the uptake of climate change information which have also been highlighted in the literature (Averchekova *et al.,* 2019). In my research, the social network analysis was used in Chapter 6 to understand how these actors interact and the level of influence of each actor in learning. The maps indicated that actors such as the CSIR, NGOs and DEFF are more connected within the network as they receive and share information with a significant number of actors illustrating a high degree of centrality and prestige. These external actors can provide CDM with more information because of their ability to connect with other actors in the social network. They can also direct governance actors at local government level to reliable sources of information, given that sources such as the internet have a mix of reliable, unvalidated and contrasting information that can constrain learning. The challenge with actors with high centrality, however, is that they have more power to influence the national climate change discourse in pursuit of their own interests or the interests of the funder and may fail to appreciate the realities and needs at the local level (Rusinowska *et al.,* 2011; Mishra, 2017). There is a need, therefore, to ensure that actors with high centrality develop user-inspired information and products to enhance their uptake by governance actors at the local government level.

The social network analysis also revealed that actors can also be intermediaries between actors as they influence/control the flow of information to CDM and other actors. Major actors who play the intermediary role as shown by high scores of betweenness are LDARD, CSIR and NGOs, while IGCCC, the University of Venda, GIZ, DBSA, SALGA, SANBI and ICRAF were minor actors in that role. Actors who act as information conduits in a network have more power to choose the format used to share information and can also distort the information (Freeman, 1979; Hanneman and Riddle, 2019). The greater the number of actors that information has to go through, the further the delay in transfer to its intended users and the greater the opportunity for dilution (Hanneman and Riddle, 2019). For example, governance actors miss out on calls for funding as they get these too late with little time to engage other external actors to

collaborate. Governance actors indicated that the municipality needs to establish political and administrative champions who could also be the key contact persons and help address the challenges associated with delays and dilution of information accessed through intermediaries.

Lastly, the social network analysis illustrated actors such as DEFF, LEDET, NGOs and the SAWS to be the closest to CDM, i.e. nearest neighbours. The presence of nearest neighbours highlights an opportunity that could be explored to co-create and co-implement in CCA communities of practice through social learning that could benefit a wide range of state and non-state actors. Social networks need to manage negative relations between nearest neighbours that also emerge as a result of mistrust, resentment and opposition, which affect the uptake of information from these actors (McPherson *et al.,* 2001; Yan and Gay, 2006; Barbieri, 2016). Governance actors also added that the role of actors such as NGOs needed to be strengthened to support the co-production of knowledge and collaborative implementation of CCA. The wide range of actors supporting CCA learning mapped through the social network analysis illustrate the polycentric nature of climate change governance in CDM.

Objective 3: To identify some of the challenges for effective flow and uptake of climate change adaptation information in local contexts

Participants identified several challenges that affect the flow and uptake of CCA information from actors at various scales to CDM. These included the lack of political support, limited human capacity, attitudes, low staff morale and perceived limited political influence by the environmental departments. Theoretically, central authorities in hierarchical structures such as DEFF should be able to coerce implementation of CCA as proposed by Winsvold *et al*. (2009). However, CDM officials shared that CCA is not prioritised by either the municipal executive or traditional leaders as they have other pressing interests (e.g. political). Studies in other local governments in South Africa have also shown similar findings, highlighting the need to integrate CCA into development priorities and capacitate local champions to support the implementation of CCA (Pasquini *et al.,* 2014; Leck and Roberts, 2015; Dyssel, 2018; Leck and Simon, 2018). There is a need to ensure the buy-in of actors such as council members and traditional leaders so that the political, cultural and developmental interests do not override and derail uptake of CCA initiatives.

Governance actors also pointed out that externally driven research and programmes to support CCA have failed to provide platforms for local authorities and communities to co-create adaptation scenarios for their community that integrate priority socio-economic goals. The scenarios-based approach is emerging as one of the governance approaches that can be used to promote social learning. The approach builds the capacity of stakeholders such as communities and local government officials to design adaptation actions that address immediate risks as well as tackle systemic barriers to achieve their desired development outcomes (Rickards *et al.,* 2014; Butler *et al.,* 2016).

Furthermore, officials shared that CDM, like other municipalities in South Africa, is also faced with limited funding for service delivery and climate response. Some of the current climate finance utilised for learning

in CDM comes from multilateral agencies and is often channeled through top-down processes by organisations such as DEFF who are not able to learn from past experiences. Funding from multilateral agencies has the potential to address some of the challenges in municipalities, but the capital needs to be designed with an understanding of the dynamics in the context of the application and the possible trade-offs (Leach and Scoones, 2006). Besides, there is a need to establish the appropriate governance arrangements that promote ownership at the local level so that local government actors do not participate in the externally driven learning initiatives just to comply with directives as this is affecting uptake.

State actors such as local governments play a key role in framing and enacting CCA in South Africa, but they currently have limited human capacity to integrate climate change response into municipal planning and actions due to lack of an institutional structure and policy to coordinate climate change at the municipal level (AWARD, 2020a). Programmes and projects supporting poor communities such as CDM to address climate change, therefore, need to run the race slow and ensure that the human resources and financial gaps are also catered for.

Uptake of information is also constrained by the current mode of knowledge production often used, which is not participatory, hence it creates and perpetuates monopolies of knowledge within societies. It often results in once-off piecemeal offerings that do not consider the dynamics of complex problems such as climate change which require continuous social learning and transformative actions, including the decoloniality of knowledge production and the learning process (Lotz-Sisitka *et al.,* 2015). As a result, there are a lot of policies, scientific publications, portals and toolkits that have not been able to shift understanding and actions taken at the local government level. At the same time, coordination between national departments is poor, hence officials receive several requests for similar initiatives, which causes participation fatigue. The epistemic community and intermediaries supporting CCA learning, therefore, need to assess the impact of the different programmes in achieving their intended goals and address factors that constrain the effective flow and uptake of information into municipal operations.

Objective 4: To improve the effectiveness with which learning systems can be supported to enhance the integration of climate change adaptation into local government operations

From the engagements with officials who make decisions in CDM and external actors supporting learning in CDM, some opportunities to improve the flow and uptake of CCA were identified. These opportunities contribute to the last research objective and the chapter concludes by offering recommendations for actors supporting CCA learning and governance actors who learn and make decisions in local government settings.

Recommendations for actors supporting learning in general

Firstly, the study established that national and international actors (e.g. multilateral agencies) supporting CCA learning need to understand the local landscape, including the development priorities and resources required to sustain CCA initiatives in the long term. Chapter 7 of this study highlighted some barriers to

learning within the local government context that make it difficult for governance actors at the administrative level to collaborate effectively in externally driven CCA initiatives. External actors, therefore, need to get buy-in from and extend learning initiatives to political actors, traditional leaders and other stakeholders making decisions at local government level. Including these stakeholders will ensure that administration staff do not bear the burden of attending CCA learning initiatives out of compliance with directives, yet CCA is not well understood and prioritised by other key stakeholders. Given the pressing development challenges at the local government level, engaging political actors will also ensure that the systemic changes required for transformative adaptation are implemented as it is currently difficult to implement without the support of these stakeholders.

Secondly, in Chapter 6, the findings of this study highlighted that governance actors use different learning systems and there is a preference for learning environments that facilitate co-generation of knowledge. It is critical, therefore, for external actors to understand the learning types that impact on learning in different contexts and unlock access to public-funded research. Additionally, there is a need to engage users when designing platforms for knowledge sharing as internet-based information is not easily accessible due to limited internet access and technical skills to paddle through such websites.

Thirdly, there is a need to provide local based CCA best practice cases and platforms for practical discussions on what is feasible based on reality and not theory. CCA is multifaceted with many possible goals and outcomes that need to be tailored into different developmental contexts hence, lifelong social learning is proposed in this study to enable collaborative sense-making, agency and collective efficacy to co-experiment CCA actions within municipal.

Fourthly, transformative and transgressive learning also needs to occur within the actors supporting learning such as academic, research and national departments so that they think reflexively on the way they produce knowledge so that it includes multiple actors and knowledge types to achieve sustainability.

Recommendations for national departments, universities and organisations supporting learning

National programmes and projects aimed at supporting CCA learning need to have a pedagogical underpinning that embraces the actors at sub-national level as a key player in knowledge production. Currently, national departments are over-dependent on external information and consultants to drive CCA, and this undermines the agency of local actors to co-design solutions for their problems. Grounding these initiatives in teaching and learning theory would assist external actors to avoid imposing initiatives on local actors as this affects ownership and sustainability at the local level. More so, there is a need to ensure the co-design of CCA initiatives with actors who are supposed to benefit from these efforts and also make use of the most effective actors, media and materials to disseminate information.

Further to this, national departments also need to coordinate efforts to ensure greater work is done with more resources instead of offering local officials' piecemeal solutions, which are often difficult to

implement. Improving coordination among national departments would also help reduce participation fatigue and sustain the ability of CCA initiatives to meet national climate change goals.

National actors need to provide funding and technical support that lasts through the duration of the implementation phase such that when challenges emerge, help is immediately available, and people address these before giving up.

Universities and research institutions produce a lot of scientific and non-scientific information which needs to be shared with governance actors at local government as well as other stakeholders using different platforms that meet the user needs. Additionally, there is the need for decoloniality of knowledge production and learning process to integrate knowledge and build the adaptive capacity of non-academic learners.

CoGTA and SALGA need to reconsider shifting the organisational structure of municipalities so that climate change is more centralised and coordinated from a central office, e.g. municipal managers office. This could be done by taking advantage of the policy windows to make transformative changes in municipal structures and procedures. Additionally, the performance indicators of municipalities by CoGTA and National Treasury should add CCA as one of the performance areas that municipalities should report back on, and this information can also feed into DEFF's climate change response monitoring and evaluation platform.

Finally, there is a need for strategies to retain staff and motivate local government officials to do their work well. Procurement processes are necessary to avoid fruitless and wasteful expenditure but there is a need to make this work better for the officials so that they can timeously procure resources needed to implement what they have learnt with regards to CCA.

Recommendations for governance actors in local contexts

The findings of this study highlight that governance actors need to develop a learning culture by creating an enabling environment for communities of practice. Some of the learning challenges identified by governance actors could be circumvented by creating an enabling organisational environment that allows individuals (as well as the organisation) to draw from the partnerships and links that are part of their social network.

Local government officials need to develop an agency. This can be done by identifying and supporting political and administrative champions to drive proactive climate change response and make use of existing platforms (e.g. forums) to support social learning.

Furthermore, there is a need to change the organisational and individual human factors that promote groupthink at the local government level. Groupthink is one of the factors that constrain the motivation and creativity that comes from social learning initiatives, for example, learning outside the normal

organisational settings or associations. Municipal executives and council need to uphold organisational values that condemn complacence and other organisational ills that impact learning and implementation.

Lastly, this study established that local government actors need to monitor and report on work being done within each sector department to reduce the risk of duplicating efforts and continuously funding projects that just wither after a few months.

8.5. A reflection of the research process

My interest in understanding what can be done to improve the uptake of CCA into municipal operations was personal and professional. I was part of the South African Risk and Vulnerability Atlas (SARVA) project team that was responsible for stakeholder engagement and had enthusiastically facilitated several workshops with stakeholders from the local and national government to raise awareness and build their capacity in using climate change information in SARVA (Chapter 3 section 3.7). The SARVA project, as described briefly in Chapter 4, is a multi-million Rand initiative by the South African National DSI under their GCGC Programme that seeks to transform South Africa into a knowledge-based economy (DST, 2009). The term knowledge-based economy can be described as an economy with greater dependence on knowledge, information and high skill levels, and the increasing need for ready access to all of these by the business and public sectors (OECD, 2005). Generation of knowledge to improve scientific understanding of global change was one of the key areas identified within the GCGC that would drive the country to be a knowledge-based economy (DST, 2009). The programme supported science and technology as well as key social, economic development, and environmental management objectives from different policy documents.

The SARVA was envisaged to be the one-stop-shop for global change findings, including climate change information. It was anticipated that at least 75% of municipalities and local government stakeholders who attended the workshops and received a copy of the Atlas or received a website address to link to the Atlas spatial portal would start using the information in the Atlas for planning and decision-making (DST, 2010). However, after three phases of the SARVA project, when I reviewed some of the municipal planning documents for municipalities in provinces such as Limpopo, it emerged that most IDPs barely referred to this information. More so, there was no indication that they had long-term projects explicitly targeted at climate change response. Climate change-related projects that were undertaken were mostly *ad hoc* and often in response to disasters such as the recent drought and this demonstrated incremental adaptation. Resultantly, my enthusiasm for the interventions made by the SARVA project faded as the evaluations were indicating that we had failed to achieve the desired outcome. Hence, I started reflecting on what could have gone wrong, what could be changed and what else is needed and consequently embarked on this research journey to explore from an intellectual point the gaps in the envisaged interventions of the SARVA project.

Undertaking the PhD research journey was one of the best decisions I made as I knew I would never be satisfied until I had a better understanding of what else could be done to support national programmes such as SARVA to support learning and uptake of both incremental and transformative adaptation at local government level. Once I was certain, I developed the research idea and shared it with my manager at the CSIR who supported the proposal, without which it would have been difficult to find the balance between work and the PhD studies. My research included several phases that I had to complete with the support of my two supervisors Professor Coleen Vogel and Dr Kaera Coetzer, some of which went smoother than others. I developed the proposal in 2016, and it was approved by the Science Faculty Committee in September of the same year. The ethics clearance took a bit longer as I was initially unaware that after completing the university ethics, I would also have to complete the provincial ethics as well, and this was only brought to my attention after I had requested interviews with key informants at the Limpopo Office of the Premier. I completed the ethics clearance with the Limpopo Provincial Research Ethics Committee, and it was granted after a long wait. My prior engagement with key informants at LEDET, LDARD, CDM, DEFF and the University of Limpopo helped me to easily get support with organising workshops and referrals to other key participants that could contribute to this study, and this was essential in undertaking PAR. I was often referred to as: Miriam from the SARVA team, an identity that was also used when I conducted the interviews and workshops as a Wits PhD student. Through this process, self-reflexivity enabled me to have an ongoing conversation with myself to analyse what I was doing and why. Self-reflexivity helped me to address power issues given my research positionality and made me aware of the subjectivity of participants as well as appreciate that their truth and values are different from mine. Finally, self-reflexivity was important because as participants shared their perceptions and experiences in this study, I could also do the same, especially taking note of any misgivings and actions that did not go according to plan.

When I had completed the data collection process, I started the mammoth task of data analysis to identify the recurrent themes from the data that comprised enormous narratives and re-engaging existing bodies of literature to sharpen my thoughts as I interpreted the research findings. Thus, data analysis turned out to be a long reiterative but worthwhile process as I oscillated between reading and re-reading interview scripts and workshop notes. I was able to notice how some data that may have seemed to be off-topic during the fieldwork became meaningful by allowing the narratives of participants to emerge, thereby offering new insights into the complexity of decision-making and learning in local government contexts. These narratives gave me a better understanding of how I had also already inadvertently contributed to the status quo as a CSIR and SAWS researcher whose focus has been mostly focused on disseminating information and hoping that the local government officials would just run with it.

Developing the chapters in my thesis was also an intellectually challenging process that helped me to sharpen my analytical skills. Despite having to juggle my full-time job and part-time studies, I also had a family life and personal setbacks, the worst being the passing of my mother. It was challenging, but I

persisted and have succeeded after all this. I have drawn on lessons from this PhD journey to inform my current work at the SAWS. My work now entails engaging with stakeholders from different sectors through Socio-Economic Benefit studies to understand weather and climate information needs of users. The feedback provided by users is used to enhance the value of products and services offered by the SAWS.

My research may not guide how to achieve transformative adaptation actions, but it provides a key starting point for this process which entails a paradigm shift in the knowledge production and learning processes to ensure that user-inspired efforts meet societal objectives. Pasteur's Quadrant (Stokes, 1997) points out that research should be able to address some of the current challenges' users have with scientific information by producing user-inspired products that are translated to fit different user contexts. Consequently, both basic and applied research and especially that which is public-funded, ought to create mechanisms to link rigor and relevance of scientific and technological innovations, especially when dealing with wicked problems such as climate change (Stokes, 1997; Smith *et al.,* 2013). Efforts to build the adaptive capacity of governance actors to respond to climate change, therefore, require an understanding of the diversity of users, their habitus and how best to facilitate learning and collaboratively generate new CCA actions that address their needs.

8.6. Recommendations for future research work

The research presented here established the role that different learning systems play in supporting learning, the current framing of the key concepts, experiences of climate variability and current efforts to respond to climate change in CDM. There is scope for further research to establish how other governance actors at various levels of government in South Africa learn about CCA, the challenges they face and how to strengthen the role of learning systems to support climate change response at their respective level of governance. Furthermore, there is a need for studies to establish the CCA response baseline in CDM to enable MEL to assess the progress being made at certain intervals. The findings of this research have highlighted areas for further research that could address the following questions:

- How can governance actors manage competing obligations and ethical dilemmas that arise from CCA demands?
- What can be done to improve the effectiveness of social learning in supporting systemic change and implementation of CCA at the local government level?
- How do key actors supporting learning interact at various levels of government and how do policy instruments guide or constrain their work?
- What skills and resources are required to enhance double-loop learning in CCA?
- What role and impact could shadow networks have in supporting local governments CCA efforts in predominantly rural settings?
- In what ways can researchers and academics rise to the challenge of promoting transformative adaptation in local contexts?

- What is the impact of both positive and negative transformative change in CCA among vulnerable communities?
- What are some of the benefits and limits of the sources of information used by local government officials in South Africa.

8.7. Conclusion

In almost all conceptualisations of CCA, learning plays an integral part directly or indirectly. CCA is not only a product of learning but a continuous learning process of building the adaptive capacity of social actors through knowledge sharing and skills development to enable governance actors to adjust their way of thinking and acting at an individual or organisational level. As established in this thesis, wicked problems such as climate change are complex social problems with diverse and far-reaching impacts that transcend administrative boundaries as well as disciplines and have no determinable endpoint. Efforts to support CCA, therefore, need to allow for participatory learning approaches to unmask and manage conflicts, integrate different knowledge types and co-produce new knowledge. The process of CCA needs to be grounded in the context of the application and mobilise the support of the different actors in the social network to experiment, reflect and reframe adaptation solutions.

In this research, learning is seen as a life-long process that should enhance agency in governance systems such as local governments to continuously and collaboratively create new CCA knowledge as the future unfolds as well as adjust norms, practices and structures to create sustainable socioecological systems. Learning, therefore, requires more than just global commitments, policies and provision of information to expand the adaptive capacity of governance actors to effectively integrate CCA into complex governance systems such as local governments.

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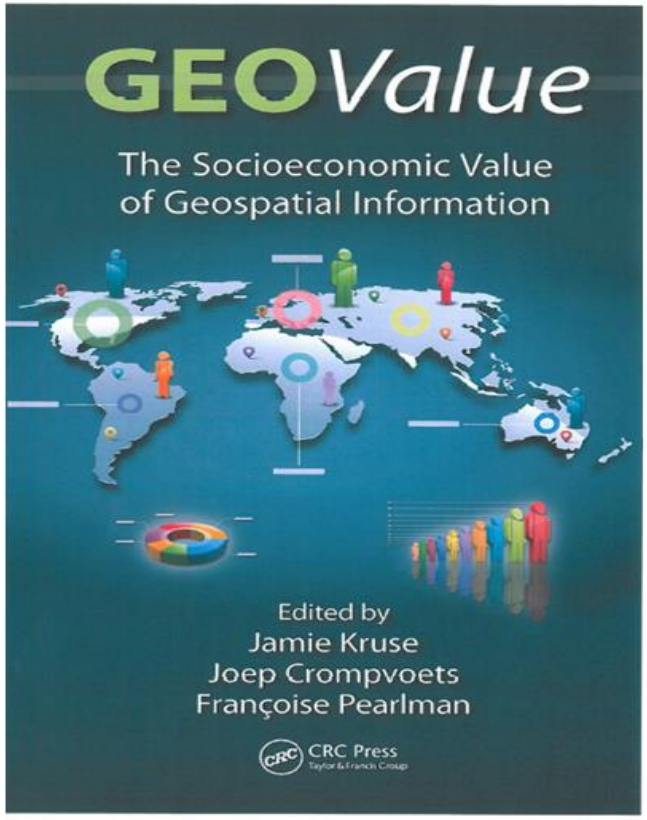
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10. Appendixes

Appendix 1: Qualitative and other social science-oriented methods to assess the importance of geospatial information book chapter





11

Qualitative and Other Social Science-Oriented Methods to Assess the Importance of Geospatial Information

Miriam Murambadoro and Julia Mambo

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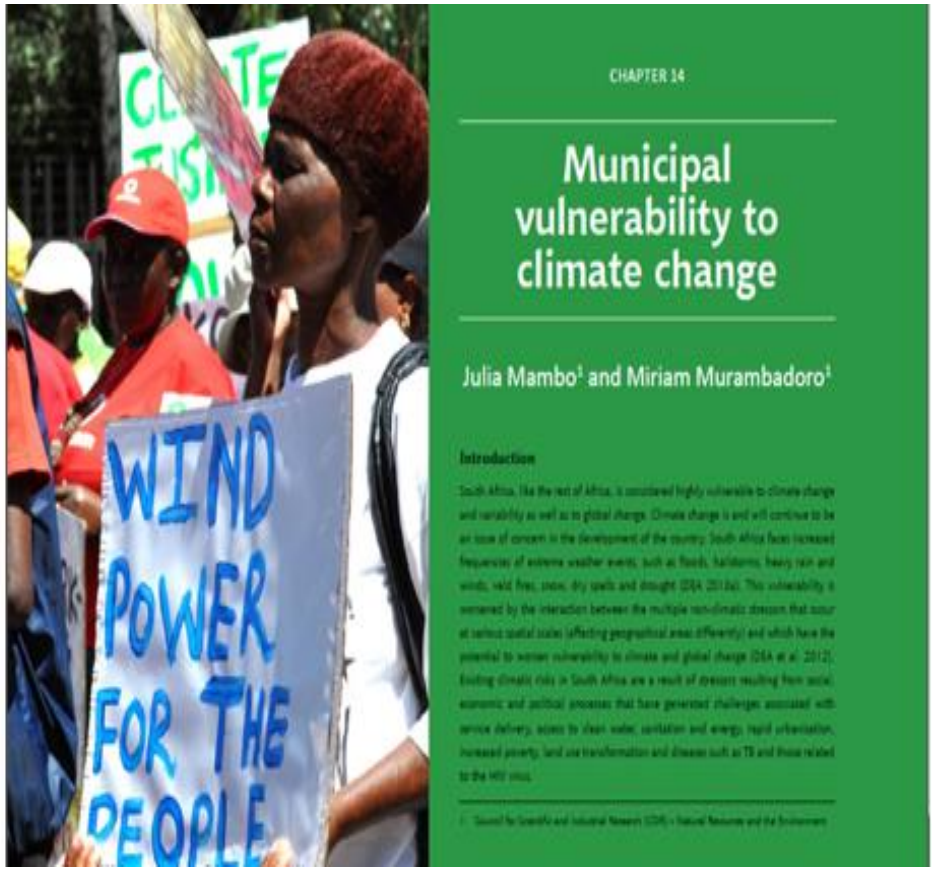
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(Lead Author Publication)Book available for purchase at https://www.routledge.com/GEOValue-The-Socioeconomic-Value-of-Geospatial-Information/Kruse-Crompvoets-Pearlman/p/book/9780367878894

Appendix 2: Book chapter on Municipal vulnerability to climate change.





(Co-author)Book available at https://www.csir.co.za/sites/default/files/Documents/CSIR%20Global%20Change%20eBOOK.pdf

Appendix 3: Journal Paper Ten Rules to Increase the Societal Value of Earth Observations.



Earth Science Informatics (2020) 13:233–247
https://doi.org/10.1007/s12145-020-00453-w

REVIEW ARTICLE

Check for updates

Ten rules to increase the societal value of earth observations

Arika Virapongse[1] · Francoise Pearlman[2] · Jay Pearlman[2] · Miriam D. Murambadoro[3] · Yusuke Kuwayama[4] · Margaret T. Glasscoe[5]

Received: 15 October 2019 / Accepted: 18 February 2020 / Published online: 3 March 2020
© The Author(s) 2020

Abstract
Earth Observation (EO) data play an important role in our society today, but there is still tremendous opportunity to improve how these data are used to affect change. In this paper, we provide guidance to help data providers and intermediaries within the EO value chain (from data to applications) increase the societal value of the EO data, information, and data products that they work with. We first describe the EO value chain as a conceptual framework for how data are translated and applied for societal benefit. We then introduce three approaches that are often used to assess and improve the EO value chain. Finally, we present "10 rules" that can be implemented to increase the societal benefits of Earth science information. The 10 rules emphasize meeting user needs, problem-solving within interdisciplinary teams, and long-term sustainable solutions. Some rules focus on a specific segment of the value chain or phase in the problem-solving process, while others are relevant to the value chain or process as a whole. Each rule includes at least one case study example to illustrate the key points. The rules are loosely organized according to project management principles with the initial rules focusing on defining problems, planning for data use, creating effective teams, and examining a diverse selection of solutions. The next set of rules are best applied throughout a project, and include such concepts as evaluation, interoperability, trust, adoption, and documentation. Finally, the last rule addresses the challenge of determining when to close a project.

Keywords Earth observation · Data · Information · Value · Societal benefit · Value chain

(Co-Author)Full paper available at https://link.springer.com/article/10.1007/s12145-020-00453-w

Appendix 4: University of the Witwatersrand Ethics Clearance Certificate

Research Office

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

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H16/09/17**
PROJECT TITLE	Assessing the role of learning systems in supporting local government climate change adaptation
INVESTIGATOR(S)	Miss M Murambadoro
SCHOOL/DEPARTMENT	Animal, Plant and Environmental Sciences/
DATE CONSIDERED	23 September 2016
DECISION OF THE COMMITTEE	Approved
EXPIRY DATE	01 February 2020

DATE 02 February 2017 **CHAIRPERSON** J. Knight
(Professor J Knight)

cc: Supervisor : Professor C Vogel

DECLARATION OF INVESTIGATOR(S)

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

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

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

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Appendix 5: Limpopo Premiers Office Ethics Clearance Certificate

CONFIDENTIAL

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE PREMIER

Office of the Premier

Research and Development Directorate

Private Bag X9483, Polokwane, 0700, South Africa

Tel: (015) 287 6564, Email: mokobl@premier.limpopo.gov.za

LIMPOPO PROVINCIAL RESEARCH ETHICS

COMMITTEE CLEARANCE CERTIFICATE

Meeting: **24th May 2018**

Project Number: LPREC/14/2018: PG

Title: Assessing the Role of Learning Systems in Supporting Local Government Climate Change Adaptation

Researcher: M.D Murambadoro

Department: Local Economic Development, Environment and Tourism (LEDET)

Dr Thembinkosi Mabila

Chairperson: Limpopo Provincial Research Ethics Committee

The Limpopo Provincial Research Ethics Committee (LPREC) is registered with National Health Research Council (NHREC) Registration Number **REC-111513-038.**

Note:

i. **This study is categorized as a Low Risk Level in accordance with risk level descriptors as enshrined in LPREC Standard Operating Procedures (SOPs)**

ii. **Should there be any amendment to the approved research proposal; the researcher(s) must re-submit the proposal to the ethics committee for review prior data collection.**

iii. **The researcher(s) must provide annual reporting to the committee as well as the relevant department.**

iv. **The ethical clearance certificate is valid for 12 months. Should the need to extend the period for data collection arise then the researcher should renew the certificate through LPREC secretariat**

CONFIDENTIAL

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE PREMIER

TO: MRS R MOKOBANE

FROM: DR T MALATJI

DEPUTY CHAIRPERSON: LIMPOPO PROVINCIAL RESEARCH COMMITTEE (LPRC)

DATE: 24th MAY 2018

SUBJECT: ASSESSING THE ROLE OF LEARNING SYSTEMS IN SUPPORTING LOCAL GOVERNMENT CLIMATE CHANGE ADAPTATION

RESEARCHER: M.D MURAMBADORO

Dear Colleague

The above researcher's research proposal served at the Limpopo Provincial Research Committee (LPRC) meeting on the 24th May 2018.

The committee has noted that the candidate has displayed the understanding and application of scientific research. The chosen methodology is appropriate for the problem. The committee is satisfied with the research proposal.

Decision: The research proposal is granted full approval.

Regards

Deputy Chairperson: Dr T Malatji

Secretariat: Mr Edward Malindi

Date: 07/06/2018

CONFIDENTIAL

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE PREMIER

TO: MRS R MOKOBANE

FROM: DR T.E MABILA

DEPUTY CHAIRPERSON: LIMPOPO PROVINCIAL RESEARCH ETHICS COMMITTEE (LPREC)

DATE: 24th MAY 2018

SUBJECT: ASSESSING THE ROLE OF LEARNING SYSTEMS IN SUPPORTING LOCAL GOVERNMENT CLIMATE CHANGE ADAPTATION

RESEARCHER: M.D MURAMBADORO

Dear Colleague

The above researcher's research proposal served at the Limpopo Provincial Research Ethics Committee (LPREC) meeting on the 24th May 2018.
The committee is satisfied with ethical considerations captured in the research proposal.

Decision: The research proposal is granted full approval and ethical clearance

Regards

Chairperson: Dr Thembinkosi Mabila

Secretariat: Mr Edward Malindi

Date: 13/06/2018

Appendix 6: Limpopo Provincial Government Permission Letter

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

22/08/2016

DEPARTMENT OF
ECONOMIC DEVELOPMENT, ENVIRONMENT & TOURISM

To whom it may concern

RESEARCH TITLE: ASSESSING THE ROLE OF LEARNING SYSTEMS IN SUPPORTING LOCAL GOVERNMENT CLIMATE CHANGE ADAPTATION

This letter serves to confirm that the researcher Miriam Murambadoro has engaged with the Limpopo Department of Economic Development Environment and Tourism Air Quality and Climate Change sub directorate on the proposed research with the title above and explained the study objectives. We have carefully considered the request and grant permission for her to undertake interviews and conduct workshops as necessary with relevant individuals within our organization.

Regards.

Phumudzo Thivhafuni
Air Quality and Climate Change
Department of Economic Development Environment and Tourism, Limpopo

Tel: 015 295 7203
Cell: 079 499 4428
Fax: 015 295 4836

Appendix 7: Background Information Document

Background Information Document: Stakeholder Workshops and Interviews

ASSESSING THE ROLE OF LEARNING SYSTEMS IN SUPPORTING LOCAL GOVERNMENT CLIMATE CHANGE ADAPTATION

This project by a researcher at Council for Scientific and Industrial Research (CSIR) and PhD Student at Wits university attempts to assess the role that learning systems can play in connecting the scientists, policy and decision makers, so that the experiential knowledge is recognised and becomes tangible, and as a result, climate change information and policy can be more reflective, transparent and useable. As part of this research, the researcher will be conducting workshops and interviews with municipal stakeholders in order to get a better understanding of how learning systems operate and to improve the effectiveness with which learning systems support integration of climate change information into operations on climate change adaptation at local government level.

Background to the project

Local government officials at municipal level are central in making decisions around spatial planning, land use management and land development. The local level is also where the impacts of climate change are usually experienced and as such local authorities are central to addressing these impacts so that communities can effectively cope and adapt to change including climate change and variability (Roberts, 2008). The mayor of EThekwini (James Nxumalo) among others, for example, has acknowledged the role of local governments in building resilience, reducing risk and climate proofing their infrastructure and services (ICLEI, 2012).

Effectively building such climate change adaptive capacity is, however, not an easy task as this is usually juxtaposed against other policy goals and social pressures. Municipalities in are often under-resourced to deal with climate change as well as the other service delivery issues. Without effective implementable measures to reduce vulnerability, the risk of disasters will also increase and this has the potential to magnify the uneven distribution of risk between both the poor and those with wealth.

Climate change is complex global problem driven by competing anthropogenic and natural drivers and it requires coordinated efforts by role-players at different levels of government. Local government official's organisations have their own knowledge and also have different knowledge sources at their disposal which influence how they learn.

Changes therefore need to occur in terms of how climate science information is both produced and communicated to such user groups to ensure that this new knowledge is used to inform decisions taken on climate change response given the conflicting concerns for the environment and the economy. The overall aim of this study is to enhance learning around climate change adaptation whilst also building the resilience of local governments/actors to the adverse impacts of regularly recurring hazards as well as new unknown hazards

Objectives of the study

The research specific objectives are to;

- Improve understanding of knowledge creation, flows and uptake of climate change related knowledge by cities and local municipalities to adapt to climate stressors.
- To identify some of the challenges and opportunities of effective knowledge flows and learning in local contexts
- To improve the effectiveness with which learning systems can be supported to enhance effective integration of climate change information into local government operations. This includes making recommendations on how to overcome the barriers that local governments face and highlight the opportunities that are available through formal and informal learning systems to enhance adaptation

Purpose of stakeholder interviews

As part of this research, the researcher will be conducting municipal workshops and interviews with municipal stakeholders from the province involved in climate change related work to inform various sections of this study. The purpose of these interactions which will also inform all subsequent stages of the project will be to:

I. Fill any gaps in knowledge by identifying the flows of information used for making adaptation decisions at municipal level; the various actors and agents in the climate change adaptation landscape, identifying those that are major 'actors' and those that are 'minor' actors in the knowledge enterprise
II. Identify factors that enable and/ or disenable actors from playing critical roles in the climate change landscape in municipalities.
III. Get a better understanding of how the learning systems operate in a particular municipality to be advised by the provincial government
IV. What is good and has worked for various learning systems in the case study municipal area
V. Identify what else would be needed to improve climate change adaptation at local government level in Limpopo

Outputs of the study

The main outputs of the study are;

1. Publications of research chapters as part of the PhD requirements

2. Conference papers and popular articles

Contact person: Miriam Murambadoro

Researcher/Wits University PhD Candidate

Natural Resources and the Environment

Council for Scientific and Industrial Research

Tel: +27 011 358 0010

Email: mmurambadoro@csir.co.za

Appendix 8: Consent Form

Consent to participate in interview

Project title: Assessing the role of learning systems in supporting local government climate change adaptation

I volunteer to participate in a research project aimed at improving understanding on knowledge creation, flows and uptake of climate change related knowledge by cities and local municipalities to adapt to climate stressors. The details of the project have been explained to me and all of my questions have been answered to my satisfaction. I understand that;

1. My participation in this project is voluntary. I understand that I will not be paid for my participation.
2. I may withdraw and discontinue participation at any time without penalty to myself or my organisation.
3. I will be one of approximately 10 people who will be interviewed for this study
4. If at any point I feel uncomfortable in any way during discussion/ interview session, I have the right to decline to answer any question or to end the interview.
5. Participation in this research will include being interviewed by the researcher and the interview will last approximately 1 hour
6. I can choose the following to be used to capture the discussion (Tick appropriate)
   a. Audiotape can be used ☐
   b. I prefer for notes to be taken ☐
7. The researcher will not identify me by name in any reports based on the information provided in this interview and that my confidentiality as a participant in this study will be protected at all times. Subsequent uses of records and data will be subject to standard data use policies which protect the anonymity of individuals and institutions.

Contact the Researcher: If you have questions or concerns about this research, please contact: Miriam Murambadoro mmurambadoro@csir.co.za 011 358 0010. You can also contact the Wits faculty member supervising this work: Prof Coleen Vogel Coleen.Vogel@wits.ac.za 011 717 6603

Name of Participant	**Date**	**Signature**
_____	_____	_____

Researcher

I _____ declare that I explained the information given in this document and in the Participant Information Sheet to *the participant named above*. [He/she] was encouraged and given ample time to ask me any questions.

Signature of Investigator/Interviewer	**Date**
_____	_____

Appendix 9: Semi-Structured Interview Questionnaire

Interviews questions for local government officials

1. What are some of the immediate challenges/problems faced by your municipality?
2. Do you consider climate change to be a current or a future risk for your municipality?
3. What is your understanding of climate change and climate change adaptation?
4. Have you in any way experienced extreme weather events associated with climate change? (If yes give examples of how you or your work has been affected)
5. To your understanding does your department engage in any efforts geared towards reducing the impacts of climate change? If yes how?
6. Who are the actors/agents who make decisions on the activities/actions that are related to climate change adaptation? Tick all that are relevant

☐ **International organisations** (Give examples in space below)

.....

☐ **National departments** (Give examples in space below)

.....

☐ **Provincial department** (Give example of specific department in space below)

.....

☐ **Municipal administration**

☐ **Municipal council (councillors)**

☐ **Traditional leaders**

Community Property Association Executive

☐ **Academics (Give examples in the space below)**

.....

☐ **External consultants and research institutions (Give examples in the space below)**

.....

☐ **Civil society**

☐ **Community**

☐ **Other** (please provide details).....

7. What are sources of information are used to decide on these projects/activities? (Tick all that are relevant).

☐ **Municipal reports** (give examples in space below)

e.g.....

☐ **Policy documents** (give examples in space below)

e. g.....

☐ **Academic papers and journals** (Scientific papers)

☐ **Internet** (give examples of specific websites in space below)

e.g. .....

☐ **Forums/Networks** (give examples in space below)

e.g.....

☐ **Social Media** (give examples in space below)

.....

☐ **Traditional leaders and community**

☐ **Other** (please explain)

.....

8. Which information sources do you find more effective or easy to use to inform planning and implementation of climate change related issues?
9. How is knowledge around climate change shared within your municipality?
10. Are there any factors that make it difficult for you to apply information from any of the information sources when you have to plan and implement climate change related projects/activities?
11. What do you suggest could be done to improve learning amongst decision makers and those responsible for implementing climate change adaptation related projects/activities?

Appendix 10: Workshop 2 Key Guiding Questions

1. When planning and making decisions on climate change what are your sources of information and support (actors, materials and other resources) and how does this information flow?
2. From the actors above, what kind of information or support do they provide? (money, giving command, training and capacity building, policy information, scientific information, etc)
3. What goals do actors who provide CCA information support? (e.g. community development, poverty alleviation, climate change, service delivery, environmental, other)
4. How important is this actor in CCA learning? (major or minor actors and influence towers)
5. What are the linkages between these actors? (who supports who and who disturbs who)
6. Are there other actors with whom you share the same goals with who are currently not supporting your municipality?
7. Are there minor actors who share the same values with local municipalities that you feel their role should be strengthened to enhance CCA at local level?
8. If you lived in an ideal world with everything, you need to implement CCA, what support structures would be in place to ensure effective CCA decision making and implementation.

Appendix 11: A Sample of Existing Policy Framework that can Support Climate Change Adaptation

Policy	Scope
Constitution (RSA, 1996)	• Section 24 of the Constitution states that everyone has the right: (a) to an environment that is not harmful to their health or wellbeing; and (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures. Adaptation is one way for protecting the socioecological system from the impacts of climate change • Section 152(1)b and Section 152(1)d) mandates municipalities to 'ensure the provision of services to communities in a sustainable manner' and 'promote a safe and healthy environment' (RSA, 1996) • Schedule 4B and 5B of the Constitution list competencies that municipalities should have, and these can be used to integrate adaptation into municipal operations for example building regulations, firefighting services, municipal planning, municipal health services, municipal roads, storm-water management systems and water and sanitation services (RSA, 1996)
National Environmental Management Act Act 107 of 1998	• The act adopts the principle of sustainable development to minimise impacts on the environment and on humans that result from for example climate change • It also integrates environmental justice to ensure that adverse environmental impacts (e.g. climate change) shall not be distributed in such a manner as to unfairly discriminate against any person, particularly vulnerable and disadvantaged persons, for example, the poor and people living in informal as well as rural settlements (RSA, 1998a)
Disaster Management Act (Act 57 of 2002)	• The Disaster Management Act provides for an integrated and coordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery • It also provides for the establishment of national, provincial and municipal disaster management centres • The Act also requires municipalities to create a municipal disaster management advisory forum that would coordinate the municipality's disaster management actions • Municipalities are also required to develop a disaster risk management plan which is a key component of the municipal IDP. The plan highlights the hazards that affect the municipality and what the municipality will do reduce the risk of disaster through for example adaptation and early warning systems. (RSA, 2002)
Municipal Systems Act (Act 32 of 2000)	• A municipality may exercise executive and legislative authority within its boundaries to implement relevant national and provincial legislation and passing by-laws. Municipal by-laws should not contradict provincial and national legislation • Section 23(1)(c)) states that municipal planning should *contribute to the progressive realisation of the fundamental rights contained in section 24 of the constitution*. This includes the right to an environment that is not harmful to one's health and well-being • In the context of adaptation as a municipality can enforce the upcoming Climate Change Bill and Draft National Adaptation Strategy as well as enact by-laws to support water demand management, environmental conservation and disaster risk management • States that disaster management plans should be a key component of municipal Integrated development Plans (IDPs) (RSA, 2000)
Spatial Planning and Land Use Management Act (Act 16 of 2013)	SPLUMA is a tool that is set to *aid inclusive developmental, equitable and efficient spatial planning* (RSA, 2013:3). Adopts principles that are relevant for adaptation • Principle of spatial efficiency- land development must optimise the use of existing resources and infrastructure and decision-making procedures must be designed to minimise negative financial, social, economic or environmental impact • Principle of spatial resilience- flexibility in spatial plans is accommodated to ensure sustainable livelihoods

	• Principle of justice past spatial and other developments imbalances must be redressed through improved access to and use of land. Spatial development planning and land use management to include the informal and rural settlements • Principle of spatial sustainability" – promote land development that is within the fiscal, institutional and administrative means of South Africa, protect prime and unique agricultural land, comply with environmental laws and limit urban sprawl SPLUMA mandates municipalities to develop, approve and review of Integrated Development Plans, Spatial Development Framework and a land-use scheme (RSA, 2013)
Water Services Act (Act 108 of 1997) National Water Act (Act 36 of 1998) National Water Resource Strategy 2	• WSA requires local governments to include in their IDP specifics of existing and proposed water conservation, recycling and environmental protection measures. In the context of climate change, it is of essence that water resources are protected, and measures are put in place to protect people rights to access water in the face of droughts and changes in rainfall patterns (RSA, 1997) • The NWA has regulations to ensure that the country's water resources are used, developed, conserved, managed sustainably and equitably for everyone's benefit. Local governments are envisaged to play a role in engaging communities to take part in integrated water resource management initiatives (Haigh *et al.,* 2010) • The strategy emphasizes the sustainable management of water resources in light of climate change (DWS, 2014). Local government officials have a role to play in managing water loss and water use demands in municipalities