MANAGING CLIMATE RISKS IN AFRICA: INSIGHTS FROM SOUTH AFRICA AND ETHIOPIA

By

Ibrahim Zainab Adepeju

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Abstract

Climate change undermines the development progress and prospects of developing countries, and this is particularly true for many African countries whose long-term objective has been achieving economic growth and development. Climate change poses many risks to the social, economic, and environmental well-being of these countries and will worsen poverty and inequality, reduce agricultural productivity, exacerbate water stress in water scarce countries on the continent which will in turn threaten hydropower generation. The double challenge facing many African countries is adapting to climate change impacts while growing their economies. Adaptation has been described as "development in a hostile climate", and development labelled as a form of adaptation. Many African countries recognising the far-reaching consequences that climate change will have on development agendas have begun to merge development and climate change considerations in responding and planning for adaptation. This thesis provides insights into climate change adaptation in some of these countries- South Africa and Ethiopia by exploring three crosscutting issues- adaptation planning, institutions and governance of climate change, and climate (adaptation) finance.

Key Words: Climate Change, Adaptation, Africa, South Africa, Ethiopia

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List of Abbreviations and Symbols

AF	Adaptation Fund
AFDB	African Development Bank
APP	African Progress Panel
ASAP	Adaptation for Smallholder Agriculture Programme
CRGE	Climate Resilient Green Economy
CRM	Climate Risk Management
CO2e	Carbon Dioxide Equivalent
DEA	Department of Environmental Affairs
DRM	Disaster Risk Management
EPA	Environmental Protection Authority
EPACC	Ethiopian Programme of Adaptation to Climate Change
FAO	Food and Agriculture Organization (United Nations)
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
INDC	Intended Nationally Determined Contribution

IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Countries
LDCF	Least Developed Countries Fund
LTAS	Long-Term Adaptation Scenarios
MEF	Ministry of Enviroment and Forests
MOFED	Ministry of Finance and Economic Development
NAMA	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Programme of Action
NAS	National Adaptation Strategy
NCCRP	National Climate Change Response Policy
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
PACJA	Pan African Climate Justice Alliance
PMO	Prime Ministers Office
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change

UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
WHO	World Health Organization

Chapter 1

1. Introduction

1.1 Background of the Study

Africa is highly susceptible to climate change impacts despite contributing the least to factors that drive global climate change (Besada & Sewankambo, 2009). In other regions of the world, recent climate change concerns revolve mostly around reducing GHG emissions; however, in Africa, concern mainly involves adapting production to fluctuating and declining economic prospects. In addition, major adverse effects of rising temperature are expected to occur globally in the future and are uncertain in other regions; however, some of these adverse effects are already evident in Africa (IPCC, 2014b; Collier, Conway & Venables, 2008). Climate change is already occurring in Africa; this is evident in the persistent and increasing droughts in East Africa, unprecedented floods in West Africa, and increased ocean acidity in Southern Africa coasts. Considerable changes in weather patterns and extreme climate events compromise water security, energy security, agricultural production, and food security which then destabilises development efforts and fosters poverty across the continent (Besada et al., 2009). Many African countries are undergoing processes of economic growth which are considered high sources of CO_2 emissions. It is postulated that emissions from developing nations will likely outpace emissions from developed countries within the first half of this century due to increasing economic activities and population growth (Chandler et al., 2002). In the process of development, it is necessary for African countries to develop their climate

change adaptation and mitigation capacities; not doing so may undermine their development efforts. Sarkar (2012) asserts that climate change goes beyond an environmental issue and should be addressed as a development issue as well as a key factor for sustainable development. Climate change could impact development efforts, causing Africa to continue to fall behind the rest of the world in development (Lalthapersad-Pillay & Udjo, 2014).

Various aspects of climate change and related impacts will persist even if anthropogenic greenhouse gas emissions are reduced at a rapid rate (IPCC, 2007b), with severe impacts for the vulnerable countries with low adaptive capacity (Ayers & Forsyth, 2009). Climate change is expected to result in extreme weather events, drought, sea level rise, shifting seasons, rising temperatures, and flooding (Jalloh et al., 2013); in Africa these changes are expected to worsen already existing issues of poverty, food, and water insecurity, as well as impede economic development (Adenle et al., 2017), thus amplifying the risks climate change poses in Africa. Climate risk management raises questions regarding how to assess and respond to risks from climate change (Granderson, 2014). It represents a process for incorporating climate information into decision-making to minimize potential harm (Travis & Bates, 2014). According to IPCC (2014c), climate change adaptation and mitigation are congruent approaches for minimising and managing climate risks, as considerable reduction in GHG emission in coming decades can result in lowered climate risks, improve prospects for effective adaptation, reduce mitigation costs and challenges, and promote climate resilient development. Because present climate

change concerns in Africa revolve mostly around adaptation (Adenle et al., 2017; IPCC, 2014b; Collier et al., 2008), this research will focus primarily on adaptation planning and implementation in Africa. Adaptation efforts and initiatives are therefore imperative in Africa to tackle climate change impacts, build resilience and reduce the risks brought about by climate change. For example, all aspects of food security ranging from access to food, utilization and price stability are expected to be affected by climate change (IPCC, 2014a). Science should support these efforts, recognising Africa as a region with a rapidly growing population and profound reliance on subsistence agriculture as a means of livelihood, and considering the difficulty and uncertainty linked with agriculture and food security, climate science must support adaptation decision-making across the board to meet the needs of the increasing populace in the region (Lobell et al., 2008).

Adaptation refers to efforts of societies to cope with the negative effects of climate change, and capitalize on opportunities (UNFCCC, 2007). The IPCC described adaptation as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects." (IPCC, 2014d, p. 118). This thesis will employ the definition from Adenle et al. (2017, p. 190) which defines adaptation as "efforts across scales to build resilience and reduce vulnerability to the impacts of climate change". This definition is most appropriate for this thesis because it factors in both vulnerability and resilience building, thus promoting the need to manage climate change risks in Africa.

About 70% or more of the African population depends on agriculture and most are constrained by limited adaptive capacity-human, technology, and technical expertise (Besada & Sewankambo, 2009; Collier et al., 2008; Hellmuth et al., 2007), thus making the continent highly susceptible to climate change impacts. This thesis, taking into consideration the uniqueness of Africa, seeks to highlight and explore the issues surrounding climate change adaptation in Africa with the objective of making recommendations to improve adaptation planning and implementation across the continent. To achieve this, my work will draw from the extensive literature on climate change adaptation and climate risk management in Africa. It will also explore adaptation policies in two case studies- South Africa and Ethiopia to determine the current status of climate change adaptation in Africa.

1.2 Problem Statement

The 2017 World Economic Forum Global Risks Report ranks climate change as the second greatest priority facing the world behind rising wealth and income disparities and ahead of increasing polarisation of societies, rising cyber dependency, and an ageing population. Climate change is also interconnected with these five priorities as it heightens each of these risks and vice versa. The climate change phenomenon transcends environmental concerns and has become an economic, social and political issue (WEF, 2017; DEA, 2017a). Adenle et al. (2017) assert that there is a growing body of literature on adaptation initiatives at the national level (Conway & Shipper, 2011; Schilling et al., 2012). Climate change awareness and adaptation initiatives are gaining ground in Africa,

and the responses of communities, supported by international development organisations and civil society show capacity for innovative responses to climate change in Africa (Adenle et al., 2017); however, there are concerns about the ability of human systems to adapt to climate change, due to the degree of estimated impacts, inadequate attention to adaptation, and prevailing vulnerabilities (Adger & Barnett, 2009; Berrang-Ford et al., 2011). Extreme events in developed countries have brought to light inadequacies in prevention and preparedness (Ebi & Semenza, 2008; Hulme, 2003; Berrang-Ford et al., 2011); how much more vulnerable are developing nations to climate change risks under which the United Nations World Economic Situation and Prospects (UN, 2014) classifies most African countries? Many factors ranging from poverty, low levels of education, limited infrastructure, lack of technology and information among others compound the impacts of climate change in developing and hinders the capacity to cope with climate risks. In Africa, both climate change impacts and non-climatic conditions increase vulnerability across the continent (EU Commission, 2006).

Furthermore, the recognition of climate change as a development problem (Sarkar, 2012), compounds the African development challenge as economic growth and development will become more difficult under conditions of climate variability (Lalthapersad-Pillay & Udjo, 2014). The potential for development in Africa is immense as higher education increases rapidly and more people enrol for university education (UNESCO Institute for Statistics, n.d). Education is broadly accepted as a key catalyst for economic growth and tertiary education is increasingly being recognised as vital to

economic growth (Bloom et al., 2006). UNICEF (2016) asserts that education is crucial to meeting the Sustainable Development Goals (SDGs) as it will have transformative effects on other goals. African economies have sustained unprecedented rates of economic growth since the start of the new millennium (AFDB, 2014). By 2015, real GDP grew by an average of 3.6%, higher than the global growth rate of 3.1%. At this growth rate, Africa remained the second fastest growing economy in the world and many African nations were among the world's fastest growing economies; GDP is expected to continue to rise save for few setbacks (AFDB, 2017). Climate change risks will worsen existing challenges of poverty in Africa, foster food and water insecurity, impede economic development, as well as delay investment in renewable energy sources.

Morton et al. (2014) argues that the severity of climate change impacts will surpass the capacity of African farmers to tackle them alone leaving Africa in an impasse. Moreover, the IPCC (2014a) asserts that livelihood approaches to managing climate risks to food production have increased considerably in Africa; however current adaptations will be inadequate for managing long-term risks. The African demography is dynamic with its population anticipated to double by 2050 making it a necessity to increase food production to meet the demand of its growing population (FAO, 2014; Adenle et al., 2017). Although national governments across the continent are beginning to respond to climate change and initiate adaptation policies and governance systems, overall adaptive capacity on the continent is regarded to be very low (IPCC, 2014b). The need for climate change adaptation in Africa is urgent and enormous, requiring governance, co-ordination,

and better promotion of the awareness of the need to adapt to gain traction across and beyond Africa (Adenle et al., 2017; Moss et al., 2013; Sherman and Ford, 2014). Berrang-Ford et al. (2011) asserted that a closer look at adaptation reports in Africa revealed most reports are focused on adaptation initiatives in East African countries and Southern Africa showing that adaptation needs more attention in Africa. A closer look at Africa shows that many countries including Ghana, Ethiopia, Morocco, and South Africa have included climate change issues in national development planning and implementation across various sectors; and as such other countries across the continent can learn from their experiences (Africa Foresight, 2017). Furthermore, all African countries except Libya have presented a pledge internationally, showing commitment to climate change issues. Lessons can be learned from the experiences of countries who have incorporated climate change issues in national development plans. For this thesis, my focus will be on the experiences of South Africa and Ethiopia.

Climate change adaptation efforts face many challenges in Africa ranging from institutional, technical, political, economic to socio-economic factors. For instance, insufficient historical information on weather and climate plagues most African nations, thus distorting climate change projections and data in Africa (Adenle et al., 2017). This has far reaching consequences as international bodies such as the United Nations Framework Convention on Climate Change (UNFCCC) make vital decisions and projections using information which are readily available mainly from developed countries, often leaving out developing countries, particularly Africa, due to unavailable

data and trajectories (Besada et al., 2009). IPCC Summary for Policymakers (2014a) recognises that although there has been a surge in climate change publications from developing countries, they account for only a small fraction of the total.

Another key challenge facing climate change adaptation in Africa is financial constraints with cost of adaptation expected to surpass US$50 billion per year (UNEP, 2015). More recent UNEP reports estimate that adaptation costs in developing countries including Africa will be between $280 and $500 billion per year by 2050 (UNEP, 2016). Adaptation finance is expected to rise in the future, and many developing countries are already experiencing an adaptation finance gap, a gap that is expected to widen over the period of 2030 – 2050 (UNEP, 2016). While climate finance mobilized by the UNFCCC will indemnify some of the costs associated with adaptation, this is far from enough to meet the needs of African countries (Adenle et al., 2017). The mobilization of new and additional climate finance is necessary to bridge the adaptation finance gap (UNEP, 2016).

This thesis recognizing the need for African counties to adapt to climate change to meet their development agenda seeks to explore and establish the present status of adaptation policies in Africa, and adaptation planning and policy. Additionally, it aims to draw lessons from the experiences of select African countries such as South Africa and Ethiopia to make recommendations that may drive more successful climate change adaptation policies across Africa.

1.3 Purpose Statement

Climate change poses a great risk to Africa and will further worsen prevailing conditions of overpopulation, environmental decline and poverty as well as impede predictable economic development across the continent. Adaptation efforts and reports so far have focused mainly on Southern and Eastern Africa (see Berrang-Ford et al., 2011); but adaptation efforts require leadership and co-ordination of adaptation across the board to tackle and manage climate change risks throughout Africa. As current forerunners of adaptation in the continent, Ethiopia and South Africa through their experiences and strengths can provide leadership and guidance to the other African countries.

1.4 Research Questions

Africa is highly vulnerable to the impacts of climate change, the need for adaptation is formidable while adaptive capacity is low. This thesis seeks to explore the present status of climate change adaptation in Africa and provide insights on requirements for more successful adaptation. The salient research question guiding this thesis is what could we learn from the current status of climate change adaptation [policies] in Ethiopia and South Africa that could benefit other countries in Africa? To answer this overarching research question, three sub-questions will be examined for clearer understanding;

1. What are the key climate-related risks in Africa?
2. What key factors are required to manage and implement climate change adaptation initiatives successfully in Africa?

3. What are the barriers to climate change adaptation in Africa and how can they be surmounted?

1.5 Research Objective

Climate change is happening and is driven by factors such as population size, economic activity, land use patterns, energy use. Vulnerable regions in Africa are exposed to risks of climate change impacts; this is mainly because Africa is characterized by a rapidly growing population, poverty, heavy reliance on agriculture as well as slow economic growth and development. Some of these factors foster anthropogenic emissions while others limit the capacity to adapt to climate change and its impacts. Climate change impacts often undermine human development and economic growth (Stringer et al., 2014), climate change adaptation is imperative to managing climate change risks in Africa. The UNFCC has recognised the challenges facing adaptation in low income countries under which most African countries fall, resulting in the creation of the National Adaptation Programme Action (NAPAs) which is used to determine priorities regarding adaptation assistance for the Least Developed Countries (LDC). NAPA has been instrumental in identifying, prioritizing, and managing climate change risks in Africa; yet it has shown weakness by not engaging various and diverse stakeholders in decision-making regarding adaptation in Africa. Some have recommended the introduction of new NAPAs or different policies to address this problem (Adenle et al., 2017). However, to change direction and develop more successful adaptation policies, it is necessary to identify current efforts and identify key ingredients required for better management and

implementation of climate change adaptation initiatives. Climate change adaptation is critical to managing climate change risks in the 21st century and risk management is necessary for effective adaptation. Climate risk management is already being practiced at various levels and scales across Africa; however, there is capacity for improvement and the need to synthesize local, regional, and national efforts to yield better results.

This thesis will explore climate risk management and its role in adaptation planning and policies in Africa by examining climate change adaptation planning and policies in South Africa and Ethiopia. The objective of this research is to determine the status quo of adaptation policies in Africa with specific focus on South Africa and Ethiopia. To achieve the abovementioned objective, it is necessary to identify the risks as well as the responses on how risk management is being incorporated into adaptation planning and policies in case study countries of focus in this study. In addition, this study seeks to identify and investigate the key factors that are necessary for the successful management and planning of adaptation initiatives.

1.6 Thesis Outline

Chapter 1 will introduce the research problem, purpose statement as well as give background information on climate change adaptation and climate risk management. In addition, research questions and objectives guiding the thesis will be stated. Chapter 2 will critically explore climate change, risk management and Africa as presented in previous research with the aim of establishing the risks climate change poses to Africa and the expected impacts on key sectors. This chapter will further describe case study countries

(South Africa and Ethiopia) and identify major risks/vulnerabilities. Chapter 3 will identify the research methods employed and present the proposed conceptual framework for the study. Chapter 4 explores barriers to climate change adaptation, and Chapter 5 will identify main risks and vulnerabilities and explore climate change adaptation planning and implementation, institutions and governance of climate change, and climate finance in case study countries, South Africa, and Ethiopia. Furthermore, this chapter summarises findings about vulnerabilities and climate change adaptation strategies and policies. Chapter 6 discusses actors necessary for increasing capabilities for climate change adaptation. Concluding comments and recommendations are offered at the end of chapter 6.

Chapter 2

2. Literature Review

2.1 Climate Change, Risk Management and Africa

In article 1 of the UNFCCC, climate change is defined as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC, 1992, p. 3). Climate variability refers to variations of the climate system- atmosphere, oceans, land surface over varying periods of time (Hellmuth et al., 2007). The distinction between weather and climate is also pertinent; weather being the phenomena of wind, rain, clouds, sunshine, and daily temperature while climate refers to average weather conditions over longer periods of time (Norford, 2009). Human-induced climate change is occurring, causing risks to both human and natural systems (IPCC, 2014a). Risk is defined as "the potential for consequences where something of value is at stake, where the outcome is uncertain recognising the diversity of values" (IPCC, 2014a, p. 5). For this thesis, risk refers to the risks of climate change impacts. Risk of climate change impacts will be driven by the interaction of climate related extreme events, vulnerability, exposure of people and ecosystems and adaptive capacity. Vulnerability is defined as the "degree to which a system, subsystem or system component is likely to experience harm due to exposure to a hazard either a perturbation or stress/stressor" (Turner at al., 2003, p. 8074). According to Yuan et al. (2015) vulnerability represents a mismatch between exposure, sensitivity and adaptive capacity.

Vulnerability to climate change embodies sensitivity to climate risks as well as the lack of the capacity to cope and adapt to climatic changes and Africa is vulnerable on both levels (Connolly-Boutin & Smit, 2016, IPCC, 2014a, p. 5).

The IPCC anticipates that climate change will severely impact developing countries in many ways both in the near-term and in the future. For example, the availability and supply of water will be affected which will then distort agricultural production and further threaten food security and agricultural incomes. Loss of income from agriculture will encourage poverty and impede economic development (IPCC, 2014b).

Future climate change impacts will result in the increased possibility for austere, widespread, as well as irrevocable risks for human and natural systems. Anthropogenic GHG emissions driven by factors such as economic activity, population size, energy use, land use patterns, and climate policy, among others should be mitigated to reduce climate risks, however climate change adaptation is necessary to cope under pervasive and prolonged climate change conditions (IPCC, 2014a).

2.2 Climate Change and Risk Management

Risk management involves a review of relevant risk information and uses the consequential information to select risk management options (Renn, 2008). This is one of the options available for coping with climate change impacts and plays a central role in climate change adaptation – highlighting preparedness and recommending strategies to cope with climate change risks, depending on the magnitude on the extent of damage

(Yuan et al., 2017). The UNFCCC points out that climate risk management epitomizes three aspects of the risk management process: (i) risk assessments for informed decision-making; (ii) risk reduction, planning, and preparation; and (iii) risk sharing, pooling, and transfer in the context of adaptation (UNFCC, 2011; Egeru, 2016). Risk of climate change stems from the interaction of hazard, vulnerability, and exposure. Here, hazard refers to the possible occurrence of a climate related physical event or trend or physical impact which may result in damage and loss of life, infrastructure, livelihoods, ecosystems, or environmental resources. Vulnerability, on the other hand encompasses predisposition to harm as well as low adaptive capacity, while exposure refers to the increased chances that one may be adversely impacted due to socio-economic factors, culture, location, or habitat among others (IPCC, 2014c. p. 5).

There are salient steps without which risk management cannot be carried out. Risk assessment typically precedes risk management and is regarded as an estimate of the potential harm a climate change risk may cause; oftentimes risk assessment encompasses concern assessment, which involves an analysis of the threats that the public associates with a specific climate change risk (Klinke & Renn, 2012). Climate information is essential to developing policies to tackle climate change risks and build adaptive capacity.

Climate information and knowledge are key to risk management, policymakers rely on climate information in their decision-making process. Accessing, retrieving, and applying evidence-based information on climate change is key in developing effective climate change risk policies that can guide in decision-making. Furthermore, knowledge,

both scientific and local is deemed essential during the risk management process; synthesizing climate information and knowledge from various sources will result in the development of more effective climate policies (Yuan et al., 2017). Effective climate risk management addresses climate variability manages climate-related risks and takes advantage of opportunities. It also promotes climate awareness and fosters use of climate information among relevant stakeholders (Egeru, 2016; Hansen et al., 2007). It is important to integrate scientific and local knowledge into risk management approaches to provide diverse and in-depth insight into the climate change adaptation process, as well as improve the usability of climate information (Egeru, 2016).

According to Hellmuth et al. (2007), there are three types of climate information – historical data which provides information about trends, climate variability and statistics as well as provide context for current data, real-time data which support short-term estimates of the outcomes of certain weather events, and climate forecasts which refers to climate projections ranging from medium to long-term climate change predictions, seasonal forecasts, and long-term weather estimates. Seasonal forecasts for example are very suitable for scheduling agricultural activities.

Climate change risks, like any other risk are usually characterized by uncertainty, it is therefore imperative to take into consideration the role of uncertainty in risk management. Uncertainty refers to the limitedness or the lack of knowledge necessary to assess and predict the likelihood of the occurrence of events and possible outcomes (Klinke & Renn, 2012; Aven & Renn, 2009). These uncertainties are attributed to nature,

recognised bias, and ambiguity. The natural system is complex and is characterised by uncertainty surrounding natural processes and human activities e.g. land use, socioeconomic development, and recognised bias which embodies gaps in knowledge and parameters, technology level, availability, and accuracy of data, and ambiguity infers that uncertainty arises from understanding and interpreting information resulting in the lack of a universally accepted truth, policymakers may make varied choices depending on personal opinions and preferences when faced with decision-making (Yuan et al., 2017).

Climate risk management is already in practice in Africa at various levels and with different success, however the continent is not yet profiting from all that climate science has to offer, because climate information often fails to reach policymakers, and when it does, may not be usable or even useful for decision-making (Hellmouth, 2007).

2.3 Climate Change and Africa

The African continent with a land size of about 30 million square kilometres is made up of 54 extremely diverse countries, with varying population sizes, topology, resources, cultures, and disparities in development experiences and performance. Despite these differences, all African countries face climate change risks which jeopardizes their socio-development efforts and prospects (Besada et al., 2009; Urama & Ozor, 2010). Africa houses some of the driest deserts, largest tropical rainforests, and highest equatorial mountains in the world (Urama & Ozor, 2010). The region which is expected to experience above average climate change in the 21st century has the largest share of impoverished and malnourished people; and is projected to have the largest population

growth rates. By 2050, the population is estimated to rise to 2.4 billion people from the current population of over 1 billion (Müller, Waha, Bondeau, & Heinke, 2014; Lutz & Samir, 2010; Christensen et al., 2007). The potential economic development in Africa is immense and economic growth will continue to gain momentum (AFDB, OECD & UNDP, 2017). In 2015, Africa's real GDP grew by an average of 3.6%, higher than the global growth rate of 3.1%. At this growth rate, Africa remained the second fastest growing economy in the world and many African nations were among the world's fastest growing economies. Because of falling oil prices in 2016, real GDP growth fell to an average of 2.2% from the previous year. However, in 2017, real GDP grew by an average of 2.4% and it is expected that it will grow by an average of 4.8% in 2018. (AFDB, 2017). From 2005 to 2010, many African countries experienced urbanization growth, ranging from an average annual urbanization rate of 2.4% in North Africa, 2.56% in Southern Africa, 4.02% in Central and West Africa, to 4.05% in East Africa. (UN Habitat, 2008; Yuen & Kumssa, 2011). Furthermore, African governments have scaled up spending on education to foster human development across the continent (AFDB, OECD & UNDP, 2017). According to Berrang-Ford et al. (2011), most of the climate change adaptation reports and initiatives coming from Africa is from Southern Africa and East Africa. Although countries across Africa have shown commitment to tackle climate change issues, some such as South Africa, Ethiopia, Ghana, and Morocco have incorporated climate change issues in their national policies. Unless efforts are taken to improve

adaptive capacity and integrate climate change considerations into development planning, climate change will impede development plans and action across Africa (AFDB, 2011).

Africa is already one of the hottest regions in the world, making it susceptible to warming (Simbanegavi & Arndt, 2014). The continent is warming faster than the global average and this trend is expected to persist. Distinct wet and dry seasons characterize the African climate, with the year to year variability of rainfall in sub-Saharan Africa affected by the sea surface temperatures of surrounding water (Hellmuth et al., 2007). With a vast landmass, climate change effects vary depending on location within the continent; and as such there is no Africa-wide climate effect. Some locations within the continent will become drier, while others will become wetter. Three major global drivers mostly determine the African climate - the Inter Tropical Convergence Zone, the El Niño–Southern Oscillation (ENSO), and the West African Monsoon. Although their interconnectivity is not fully understood yet, rising temperature influences their outcomes raising the occurrence and severity of floods, droughts, and other extreme events that they produce. Drier subtropical regions will become warmer than the moister areas; Northern and Southern Africa will become much hotter (4^{o} C or more) and drier with rainfall declining by 10%-20% or more (Collier et al., 2008). Eastern Africa including the Horn of Africa plus parts of Central Africa will experience an increase in average rainfall by 15% or more. Many regions across Africa are expected to experience more pervasive and prolonged droughts and floods (Collier et al., 2008; IPCC, 2014b). Western Africa has been experiencing a decline in annual rainfall since the 1960s while Southern and Eastern

Africa have become more susceptible to drought. As much as one third of Africans now live in drought-prone areas, mostly in the Sahel around the Horn of Africa, and Southern Africa (Lalthapersad-Pillay & Udjo, 2014; PACJA, 2009). Climate change in sub-Saharan Africa is likely to cause temperature rise, variations in rainfall intensity, unprecedented extreme events such as floods and droughts, and rise in desertification (Connolly-Boutin & Smit, 2016).

Climate change can be recognised as an equity issue (Osman-Elasha, 2009) or a development issue (Sarkar, 2012). From a historical perspective, developed nations are largely responsible for more than half of global GHG emissions (Chandler et al., 2002). The UNFCC report and supporting studies have shown that developing nations are the most susceptible to the adverse impacts of climate change and are constrained in their ability to adapt to climate change impacts (Althor, Watson, & Fuller, 2016). From an equity perspective, Africa's per capita GDP is less than half of the global average (AFDB, 2011) and accounts for the smallest share of global GHG emissions at 3.8% against emissions from other regions like China, United States and the European Union which stand at 23%,19% and 13% of global emissions respectively. The Africa Progress Panel (2015) estimates that the average Ethiopian will take 240 years to register the same carbon footprint as the average American. Despite the continent's low contribution to GHG emissions, Africa is one of the regions most susceptible to climate risks and the least equipped to adapt to climate change impacts. With agriculture accounting for about 30%-40% of the GDP in Africa, the continent relies heavily on agriculture as a source for food,

income, and employment (Sy, 2016). Africa's susceptibility to climate risks will be worsened by non-climatic factors ranging from widespread poverty, fast growing population, low levels of development and low adaptive capacity (Osman-Elasha, 2009).

Climate change will directly impinge on food security, and water availability, as well as increase the risk of flooding across Africa (UNEP, 2016). Numerous studies have revealed that climate change would adversely impact economic development in many African countries (Lalthapersad-Pillay & Udjo, 2014; Tol, 2010; Tang, Petrie & Rao, 2009; Adger, 2006). Africa has experienced unprecedented economic growth and development in recent years; however, climate change threatens future development gains and prospects (AFDB, 2014; Besada et al., 2009). Agriculture, which serves as a means of livelihood for most of the African population is highly dependent on climate and weather. Falling agricultural productivity will result in hunger, poverty, and will substantially affect the continent's GDP. Furthermore, variations in precipitation and extreme events such as drought because of climate change will result in water stress for the region, water scarcity will destabilize agricultural production as well as hydro-power generation and thus distort two sectors key for economic development in African countries (Africa Progress Report, 2015; Yohannes, 2016).

2.3.1 Vulnerability to Climate Change in Africa

According to the IPCC (2014a), vulnerability encompasses sensitivity or susceptibility to climate risks, and the inability to cope with the adverse effects of climate change, including climate variability and extremes. Economic, social, environmental,

political, and technological factors determine vulnerability. Economic factors play a central role in determining a nation's vulnerability, a strong economy serves as a safety net during extreme events and can respond swiftly to unfavourable conditions brought about by climate change impacts. At the household level, access to resources reduces vulnerability while low income constraints capacity to cope with climate risks. The higher income households earn, the more they can adapt and the more households with high income, the more a country can cope and build resilience to climate risks. The political economy of a country influences its vulnerability to climate risks, as a strong and stable political regime will reduce social vulnerability. The extent of dependence on natural resources such as water, land, forestry will determine vulnerability to climatic conditions. Natural resources-reliant livelihoods such as agriculture, forestry, fishing all depend on water availability, and as such dependence on such livelihoods increases vulnerability to climate change (Vincent, 2004). Africa is plagued by endemic poverty, hunger, and low levels of development, and these conditions increase the continent's vulnerability to climate risks (Osman-Elasha, 2009). Furthermore, many countries in sub-Saharan Africa are water stressed, and many more will suffer water stress in the future (WWAP, 2012). Reliance of more than two-thirds of Africans on rain-fed agriculture, means the people are highly vulnerable to changes in water regimes. Under conditions of climate change, variations in rainfall- periods of intense rainfall which sometimes results in flooding, as well as more occurrences of drought will increase the unpredictability of rainfall. These erratic rainfall patterns will reduce soil moisture, soil fertility, and cause shorter growing

seasons which will then result in declining income and poverty. Water insecurity undermines food security by threatening food availability and accessibility and fosters poverty, as it affects agricultural production- a major source of income for many inhabitants of Africa (Connolly-Boutin & Smit, 2016). In addition, many African countries depend on hydropower for energy generation; water scarcity will severely affect electricity production and result in substantial losses for African economies (Besada et al., 2009).

South Africa is particularly vulnerable to climate risks because of its reliance on climate-sensitive resources, poverty, and the interconnected impacts of Acquired Immune Deficiency Syndrome (AIDS). The country is already experiencing water stress, erratic and pervasive rainfall, and cycles of droughts (DEA, 2011). Climate related impacts, such as rising temperature and unpredictable rainfall, are already apparent in South Africa and will continue over the next two to three decades. Climate change is expected to directly affect most sectors – losses because of extreme weather events, destabilization of food and water security, adverse effects for human settlements, human health, and ecology and biodiversity. These adverse effects will be worse for the poor who largely depend on climate-sensitive sectors such as agriculture, water, settlements, biodiversity, and ecosystems (DEA, 2016a). For instance, for a country like South Africa that is faced by water stress, water availability is a central climate-related vulnerability which will have far reaching consequences for the country's people, economy, and ecosystems. The

country's water issues have a ripple effect on key sectors such as agriculture and electricity.

Ethiopia is extremely susceptible to climate change impacts due to economic, social, and environmental factors. Reliance on natural resources, poverty and inequality, rapid population growth, chronic food insecurity, environmental degradation, as well as frequent drought cycles increases the vulnerability of the country to climate change. Agriculture, water resources and human health sectors are especially vulnerable. When the livelihood approach is applied, small-scale rain-fed farmers and pastoralists are the most vulnerable to climate change (Gashaw, Mebrat, Hagos, & Nigussie, 2017), due to low adaptive capacity (Weldegebriel & Gustavsson, 2017). Low level of development of water infrastructure and rapid population growth which increases the demand for water resources exacerbates the vulnerability of the water sector to climate change (Weldegebriel & Gustavsson, 2017). The infrastructure sector has also been identified as highly vulnerable to climate change impacts in the country (Climate Risk and Adaptation Country Profile: Ethiopia, 2011).

2.3.2 Climate change and Poverty

Poverty and climate change are two critical issues in the 21st century and both are essential to achieving sustainable development. Africa has the largest number of people living in extreme poverty, a number which has only fallen slightly since 1990 with a total of 330 million living in poverty in Sub-Saharan Africa. The average income per capita in most countries on the continent is lower than it was 30 years ago, with many African

countries having very low income per capita or GDP per capita when compared with the rest of the world (Osman-Elasha, 2009). According to the UN Human Development Index, 22 of the 24 countries identified as having "Low Human Development" are from sub-Saharan Africa (WHO, 2012). Poverty has been described as the primary cause of hunger in Africa and poverty itself is brought about by poor economic conditions, rapid population growth and environmental degradation due to climate change and other extreme events. Despite unprecedented economic growth in Africa in recent years, many Africans remain locked in a vicious cycle of hunger and poverty (AFDB, 2014).

Agriculture is the principal driver of higher poverty levels under conditions of climate change (Hallegatte et al., 2015). Dependence of about 70% of the African population on rain-fed agriculture for income, food, and employment (Hellmuth, 2007) will increase poverty levels in climate change conditions. Agriculture is highly dependent on climate and weather conditions, as well as rainfall which are all expected to be adversely affected by climate change (Yohannes, 2016). Rising temperatures and variations in rainfall will reduce agricultural productivity and natural resources, and lead to water stress. Climate related extreme events such as flooding will result in damages to infrastructure and loss (Tanner & Mitchell, 2008). Furthermore, climate change impedes efforts to reduce poverty (Besada & Sewankambo, 2009), as lower agricultural productivity will result in loss of income and adversely affect economic growth (Tanner & Mitchell, 2008). Poverty reduction will not be possible if the effect of climate change on the poor is not taken into consideration in development planning (Hallegatte et al.,

2015). Poverty reduces the choices and options available to people, thus increasing susceptibility to climate change risks and impacts. Extreme climate change events such as flooding and/or drought can overwhelm a poor community and further reduce its capacity to cope (Hellmuth et al., 2007).

2.3.3 Climate Change and Energy

The energy sector contributes significantly to GHG emissions, with over 80% of the African population depends on traditional biomass for cooking (IEA & UNEP, 2007; UN, 2007). More than 600 million Africans do not have access to electricity and many more may still lack access to electricity by 2030 (APP, 2017). Practices such as felling of trees for firewood and charcoal for cooking, deforestation caused by illegal logging, and "slash and burn" farming methods have all contributed to biodiversity reduction in Africa. Solid biomass accounts for two-third of Africa's total energy consumption; the continent's dependence on non-renewable energy sources for domestic energy supply results in degradation of the ecosystem posing a threat to the wildlife and the natural forest, and consequentially the livelihoods of many. According to the World Energy Outlook access database, the average electrification rate in Africa is 35%, with urban and rural electrification rates of 59% and 17% respectively, making sub-Saharan African the most electricity-poor region in the world (Brandoni & Bošnjaković, 2017; WEO, 2016). By and large, sub-Saharan Africa houses more than half of the people who lack access to electricity, and about one third of those who depend on traditional biomass (APP, 2017).

Hydro is the primary source of energy generation in many African nations and accounts for 70% of power generation across the continent (APP, 2016); climate change because of its impact on hydropower, could have far reaching consequences on energy generation in Africa. The African Energy Commission (2008) states that 70% of Kenya's installed capacity of 885 MW comes from hydro, 93% of Zambia's 1,786 MW, 63% of Uganda's 580 MW, and 58% of Tanzania's 655 MW. Climate change is already occurring in Africa causing prolonged droughts which impacts electricity generation negatively. The impact of drought on the energy sector is overwhelming, resulting in shortfalls in hydro-power potential and capacity for electricity generation across Africa. Climate change can affect hydroelectric generation in many ways, ranging from lower water levels in catchment areas to decreased capacity for hydro-power generation. Furthermore, it will affect the ability of many African countries to meet the energy needs of their rapidly growing population and lead to rising electricity tariffs (Besada et al., 2009). Most of East Africa and West Africa already is suffering high levels of power outages during the dry season (APP, 2015). There are various instances of such losses in African countries, some of which will be outlined below.

In 2007, the water level in the Akosombo dam in Ghana dropped beneath the minimum level of 240 feet causing hydro generation to fall below the electricity needs of the country and resulted in load-shedding countrywide (Karekezi et al., 2009; Besada et al., 2009). The country's three hydro-power plants were unable to meet rising energy

demand because of low level of water in the dams, and the country spent $1.2 billion on alternative emergency power (APP, 2015).

Lake Victoria in Uganda between 2004 and 2006 experienced falling water levels to 10.4 metres below the average of 11.5 metres; this caused hydro-electric generation to decline by over 100 MW. The deficit in generation because of load-shedding in the country contributed to the drop in the country's GDP growth rate from the projected 6.2% to 4.9% in 2005/2006 (MEMD, 2006). A costlier energy source, thermal energy, was brought in which led to rising electricity costs by as much as 100% in 2006. Thermal energy has turned out to be too expensive for consumers and the government has had to subsidize thermal energy to the tune of $50,000 annually (Besada et al., 2009).

In Tanzania, between 1997 and 2005, climate change related drought caused the Metera dam to fall to its lowest water levels, causing a 17% decline in hydro-generation. Power load-shedding was established which then brought about negative effects in the commercial and industrial sector. Like Uganda, Tanzania introduced thermal energy to meet up with deficit in energy generation (Besada et al., 2009; Karekezi & Kithyoma, 2005). In 2011, the country experienced power cuts due to reduced electricity generation because of insufficient water levels at the hydro-power dams. This resulted in a 1% fall in GDP growth (APP, 2015)

Kenya experienced drought between 1999 and 2002 which destabilized hydroelectric generation considerably. By 2002, energy generation capacity had fallen by 25% and the consequential cumulative deficit in generation estimated between 1.0 and

1.5% of aggregate GDP (Karekezi & Kithyoma, 2005). Costlier fuel-based energy generation and power rationing was introduced in Kenya from 1999 to 2001(Besada et al., 2009).

Ethiopia experienced over six months of power cuts between 2006/2007 because of drought induced low water levels in hydro dams (Besada et al., 2009; Karekezi & Kithyoma, 2005).

These severe and pervasive droughts across Africa have decreased water inflows in rivers, adversely impacting energy generation which often resulted in substantial load-shedding which then caused colossal losses to affected economies. Energy deficits result in rising cost of doing business in Africa which has negative consequences for African economies. Climate change has tremendous effect on energy generation without which African economies will experience declining economic growth. Power shortages and black outs cost many African countries 2% of their GDP and as high as 5% in severe situations (APP, 2015). The alternative to hydropower is thermal power which is costlier and is often complemented with government subsidies and rising electricity prices (Besada et al., 2009). Policies that promote environmental conservation and link climate change adaptation with energy infrastructure and renewable energy supply are necessary to reduce the risk of energy insecurity in Africa (Besada et al., 2009).

2.3.4 Climate Change and Agriculture / Food Security

Agriculture is highly dependent on weather and climate and thus susceptible to climate variability and change (Yohannes, 2016). Globally, agriculture is a key driver for climate change, accounting for about 14% of GHG emissions (DEA, 2016a). Most African countries depend largely on agriculture except for economies that rely on mining and oil exports such as Nigeria, Cameroon, Congo, Botswana, South Africa, Zambia, and Zimbabwe (FAO, 2012). Agriculture accounts for 20%-40% of GDP in most African economies. 94% of African agriculture is rain-fed and only 6% depends on irrigation (Speranza & Scholz, 2013). By the end of the 21st century, arable land in Africa is predicted to fall between 1%-18% because of climate change (Zhang & Cai, 2011). Climate change affects agriculture in many ways; variations in average temperatures, precipitation, and climate extremes (droughts, floods) will affect soil erosion, changes in the nutritional quality of some food, changes in growing seasons, and many others (Yohannes, 2016). Besides the Middle East, agricultural yields and production in Africa is expected to be compromised by climate change than any other region (Vivid Economics & AFDB, 2012). Climate variability and extreme weather events are uncommon to Africa, however factors such as poverty and heavy reliance on agriculture enhance the impacts of these in the region (Hellmuth et al., 2007). Even if average global temperature is kept below 2^{o}C, the risk of drought in Southern and Central Africa, and flooding in the East will persist (Sy, 2016). This will result in higher prices of food and lower yields thereby destabilizing food security and crop yield as well as increase the number of malnourished

people (UNEP, 2016; IPCC, 2014a). In sub-Saharan Africa, severe drought is already undermining subsistence agriculture and livestock rearing, making it necessary for pastoralists to adapt to variations in water regimes to sustain food security. Expected impacts of climate change on sub-Saharan agriculture range from shortened planting seasons, decline of farmlands suitable for agriculture and reduced agricultural yields (Connolly-Boutin & Smit, 2016). The total crop production is likely to fall by as much as 10% - 20% in yields across all crops and regions by 2050 (Connolly-Boutin & Smit, 2016; Kotir, 2011; Thornton et al., 2011). The situation is expected to be more severe in West Africa with an estimated decline of 20-50% in agricultural output by 2050, due to unpredictable variations in rainfall (Connolly-Boutin & Smit, 2016). Low agricultural productivity is the main cause of land degradation in Africa, as farmers attempt to increase yield by cultivating more land (APP, 2015). Diminishing agricultural production and activities will result in severe consequences for human and economic development, fostering food insecurity in regions with the highest poverty rates in the world (Sy, 2016).

Persistent and pervasive flooding, droughts, and loss of arable land will result in lower yields and loss of livestock. For example, in the Horn of Africa's pastoralist areas at the Ethiopia-Kenya-Somalia border, austere and prevalent droughts have resulted in loss of livestock affecting about 11 million people, while causing a huge crisis and resettlement of pastoralists (Besada et al., 2009). Of the thirty-six countries worldwide facing food insecurity, twenty-one are from Africa, with nearly one-third of the continent's population experiencing severe hunger (UN, 2009). Food insecurity, due to

poor yields will result in the inability of subsistence agriculture to meet local food demand as well as lead to restriction of crop export in international agricultural markets. These effects may limit the ability of African agriculture able to adapt and meet the demands of the international agriculture market, which will in turn impede development efforts (Besada et al., 2009).

Food and Agriculture Organization (FAO) defines food security as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996, p. 2). According to FAO (2016), food security encompasses four elements which will be crippled by climate change: food availability, food accessibility, food utilization, and food system stability. Food availability refers to the quantity, type, and quality of food available for consumption and is influenced heavily by agricultural production (Connolly-Boutin & Smit, 2016). Physical location and the occurrence of moderate warming (a rise of 1^{o}C to 3^{o}C) influence food availability, and cereal yields grown in regions in Africa characterised by dry and tropical climate will be severely affected, with maize produce expected to fall by 6.9% (Lalthapersad-Pillay & Udjo, 2014; FAO, 2010). Food accessibility entails the capability to access food in the required amount, type, and quality. It is influenced by variations in the distribution of food in the market and at the household level. Access to food is determined by factors such as income level, access to resources and trade policies (Connolly-Boutin & Smit, 2016). Food utilization embodies the safety, nutritional, and

social value of food; diseases and pests that are expected to affect plants and animals are pertinent in discussions about food utilisation (Connolly-Boutin & Smit, 2016; FAO, 2010). Food system stability represents the state of agriculture, which is threatened by land degradation, rain-fed conditions, and low investment (Lalthapersad-Pillay & Udjo, 2014; Stamoulis & Zezza, 2003). Food availability is regarded as essential, but it is not adequate for accessibility, which is also crucial but not enough for utilization i.e. food may be available but may not be accessible; it may also be accessible but may not meet the conditions of utilization such as nutritional requirements (Connolly-Boutin & Smit, 2016).

Foreign investors have increasingly purchased or leased African lands for agricultural production; this may give a false representation of food production in Africa whereas the produce belongs to investor countries and may not necessarily benefit Africans (Besada et al., 2009; Lorenzo et al., 2009).

2.3.5 Climate Change and Water Security

Water is vital to human existence – for domestic purposes and economic activities and development. As such, variations in water supply from overland flow can have overwhelming consequences in regions such as Africa where many people depend on local rivers for water (De Wit & Jacek, 2006). Thus, achieving water security has become a key objective in Africa (Holmatov et al., 2017). Major natural resources such as water are dispersed unevenly across the African continent, with a large share of the continent's water resources contained in a few large basins and almost all the river basins are

transboundary, which may lead to water conflicts and eventually trigger water scarcity on the continent (Urama & Ozor, 2010; De Wit &Jacek 2006; Ashton, 2002).

Many African countries live under water stress which means their water usage exceeds 20% of their renewable water resources, and demand often exceeds available water resources (NASAC, 2014; Urama & Ozor, 2010). Most current and prevalent challenges faced in sub-Saharan Africa arise from or revolve around water issues (Brandoni & Bošnjaković, 2017; Freitas, 2015), for instance too much water too little water, or unusable water poses great threat for agricultural production (Oestigaard, 2011; Urama & Ozor, 2010). Agriculture accounts for 70% of water consumption globally, and in Africa, as much as 86% of freshwater goes towards agricultural production (NASAC, 2014; UNEP, 2008). In addition, flooding is the most common disaster in North Africa, the second most rampant in Central, East and South Africa and the third most prevalent in West Africa (Urama & Ozor, 2010; UN, 2006) Water security is defined as the "the capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability" (UNU, 2013, p. 1). Climate change and population growth further threatens water quantity and quality in sub-Saharan Africa (Holmatov et al., 2017). Fifteen countries in sub-Saharan Africa housing a population of approximately 400 million people suffer

from water scarcity or water stress, and by 2050, the number is expected to double to more than 800 million people (PAI, 2012).

Climate change will worsen pressure to regions in Africa already experiencing the challenge of unsustainable water resource and is likely to change the hydrological cycle, temperature balance and precipitation patterns; variations in the hydrological cycle affect food security and economic development (ACPC, 2013; Oestigaard, 2011; Urama & Uzor, 2010). Expected climate change impacts on water resources in Africa range from variation in the distribution and frequency of rainfall, drought, flooding, drying-up of rivers, receding of water bodies, melting of glaciers among others. Climate change results in adverse alterations in ground and surface water supply, hydropower generation, industrial uses, and agricultural uses (Urama & Ozor, 2010, pp .4 &10). An average increase in global surface temperature of 2ºC above pre-industrial levels will result in variations in weather patterns and will cause water insecurity for approximately 1 billion to 2 billion people (Lalthapersad-Pillay & Udjo, 2014; Niasse, Afoud & Sygna, 2004). Average land temperature of many regions in Africa is expected to rise above 2ºC, especially in arid regions. Climate change will decrease water availability and cause rising hydro-climatic variability thereby raising the risk of extreme events. The combination of declining rainfall and rising temperatures is expected to cause a fall in agricultural production and consequentially compromise food security especially since sub-Saharan Africa depends largely on rain-fed agriculture (Brandoni & Bošnjaković, 2017; IPCC, 2014a). One third of Africans live in drought prone areas with about 220 million people expected to be

exposed to drought yearly. Even without climate change, current population trends and water use patterns show that many countries in Africa, especially Northern Africa, will surpass the limits of their economically usable land-based water resources before 2025 (ACPC, 2013; IPCC, 2007a). North and East Africa are particularly physically water scarce, making their people in these regions prone to water insecurity. Although population growth is a key driver of water stress, climate change would contribute significantly to water stress in Africa (Speranza & Scholz, 2013). Water stress occurs when "the demand for water exceeds the available amount during a certain period or when poor quality restricts its use". Water stress results to the deterioration of fresh water resources as both the quality and quantity are significantly affected (Ahluwalia, 2013, p. 2; EEA Website, n.d). Water scarcity on the other hand refers to a situation where water resources are inadequate to meet long-term average requirement, i.e. a persistent water mismatch – low water availability combined with water demand that surpasses the natural recharge (EU Commission, 2007).

Climate change and variability will further threaten water availability, water accessibility and water demand in Africa. About 75-250 million and 350-600 million people are estimated to be at risk of increasing water stress by the 2020s and 2050s respectively in Africa. Most of the African population, particularly those residing in rural areas depend on groundwater for domestic supply. Variations in precipitations may cause water scarcity in some regions, for instance it has been estimated that groundwater recharge rates in West and Southern Africa may decline by 50% -70%. The combination

of changes in the flow of streams and rising temperatures is also predicted to have adverse impacts on water quality and freshwater ecosystems (Africa Progress Report, 2015).

2.3.6 Climate Change and Development

Africa faces the biggest development challenges of any continent, and the climate crisis emerged from the joint evolution of economic growth and GHG emissions. Addressing the problem should integrate solutions for both development needs and climate change. For many developing countries especially African economies, the climate issue is a development issue (Banuri, 2009). Climate change is an urgent issue, exacerbated by electricity generation, changes in land use (especially deforestation), and agriculture responsible for major GHG emissions (Stern, 2006). Because of low levels of industrial development in Africa, the continent contributes the least to global GHG emissions. Yet within Africa, climate change is expected to slow down economic growth and and pull resources away from development (Science for Environment Policy, 2014). Of the forty-seven nations on the UN's list of least developed countries, thirty-three are in Africa (UN, 2018). Sub-Saharan Africa is highly vulnerable to climate variability as two-thirds of its surface area is desert or dryland; droughts and floods are likely to increase under climate change conditions. Climate change will negatively influence economic growth in Africa (Africa Foresight, 2017); reduced precipitation in sub-Saharan Africa in the 20th century partly contributed to slow growth in the region (Barrios, Bertinelli, & Strobl, 2010; Brown et al., 2010; Hallegatte, 2015). Rising temperature in the second half of the 20th century may have resulted in reduced growth for poor countries especially in

the agricultural sector (Dell, Jones, & Olken, 2012). The future of development in many poor countries, especially agriculturally dependent ones, relies largely on water, with both inadequate rainfall (drought) and excessive rainfall (flooding) resulting in substantial consequences for development (Ludwig et al., 2009). Furthermore, the level of energy utilization in an economy and investment in efficient energy sources is directly indicative of a country's level of development. Electricity use per capita is less than 2%, and electricity consumption is worsened by low supply and a defective form of energy supply. Low levels of electrification significantly diminish socioeconomic advances and development in Africa (Ejim-Eze & Filho, 2015). Moreover, rapid economic and population growth, urbanization trends will further result in rising GHG emissions in Africa (Sy, 2016) thus making climate change adaptation essential. Based on these trends, development plans to tackle poverty and food insecurity must consider future climate change impacts. If climate risks are not managed, climate change will setback development gains and threaten the security of current and future generations. There has been a global shift from development to sustainable development, and even without climate change, development that is economically, socially, and environmentally sustainable is difficult to attain.

Many resource sectors, such as agriculture, energy, and water in which development efforts are focused, are climate sensitive and will benefit from the assimilation of climate information to drive effectiveness. Oftentimes, climate policies and initiatives fail to take into consideration climate change within the context of

development needs. Development is contingent on many factors ranging from climate, provision of infrastructure, diversification and strengthening of livelihoods through increased agricultural productivity and better access to market and market information. The incorporation of climate information into development efforts will lead to an integrated approach, combining scientific and local knowledge to achieve results and minimize vulnerability to climate change and variability (Hellmuth, 2007).

2.4 Managing Climate Risks - Adaptation

Alongside mitigation, climate change adaptation is the principal response for addressing the climate change problem. Climate change adaptation is necessary to address the impacts of climate change that are already happening, build resilience to future adverse impacts and promote climate resilient socio-economic development. In previous years, reducing GHG emissions- mitigation has been the central focus of many climate change international discussions and negotiations, however in recent times, more significance has been attached to the climate change adaptation agenda. Recognizing that many developing countries, especially the LDCs who are highly vulnerable to climate risks were already facing the consequences of climate change, the Convention of Parties (COP) under the UNFCCC introduced NAPA to address urgent and immediate climate change adaptation priorities. International negotiations on climate change declared that climate change adaptation should become a priority just as much as mitigation, and so focus began to shift towards the incorporation of climate change adaptation into economic, social, and environmental policies and actions (UNFCCC, 2013). The 2015 Paris Agreement

addressed climate change adaptation and included several provisions to advance adaptation, emphasizing the need for balance between adaptation and mitigation finance (UNEP, 2016). Article 7.1 of the Paris Agreement states that "Parties hereby establish the global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2" (UNFCCC, 2015, p. 25). This goal is to reduce the increase in global average temperature to below 2^{o}C above pre-industrial levels and restrict temperature increase to 1.5^{o}C above pre-industrial levels. The Agreement called for parties to embark on adaptation planning and action, and prepare progress report every five years (UNFCCC, 2015).

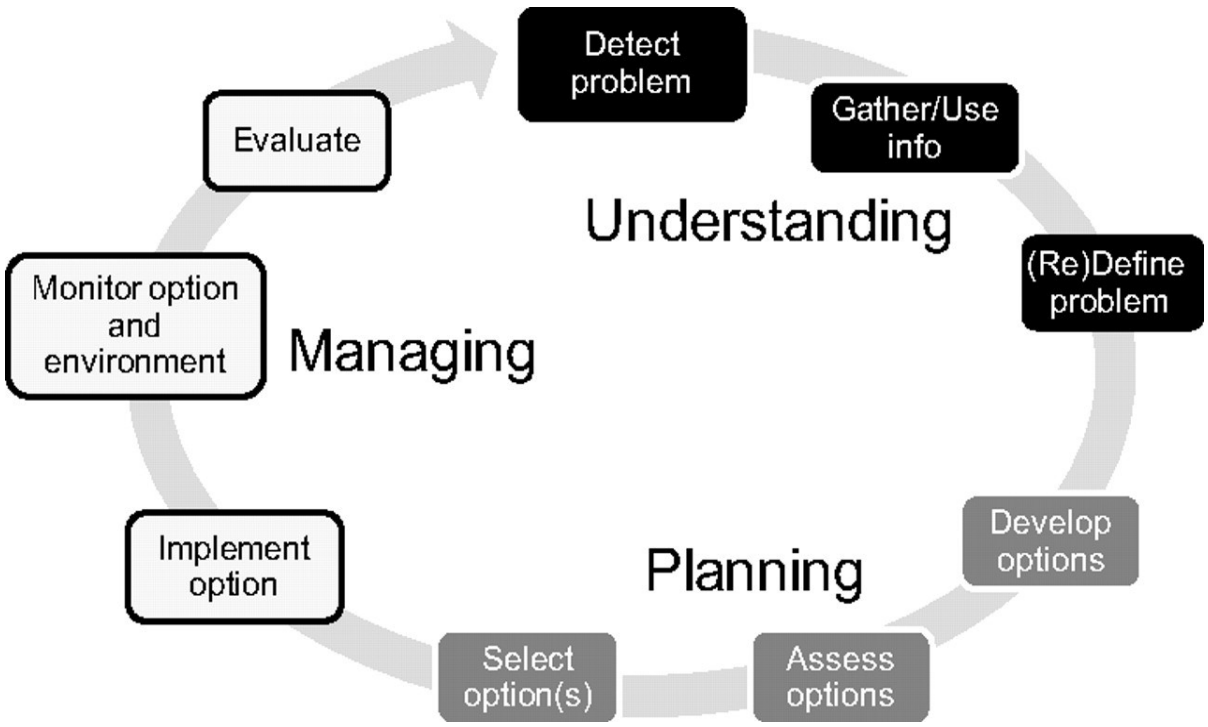
Climate change action at the national level is growing, with many developing countries formulating climate policies and incorporating climate change considerations into development plan. This is also true for many countries in Africa, with many national governments introducing governance systems for adaptation. Several factors can motivate a country to prioritze climate change adaptation action and develop a national adaptation strategy. Political pressures, compelling evidence/information, and/or significant events can motivate government and other influential stakeholders to act on climate change. International climate change negotiations, occurrence of extreme weather events, economic costs of inaction, cases of adaptation actions in other countries, and in certain cases, the opportunities presented by climate change can serve as motivating factors for

carrying out climate action ((Biesbrock et al., 2010, p. 442; Tompkins & Amundsen, 2008).

The economies of many developing countries depend largely on climate sensitive sectors such as agriculture, water, forestry, and fisheries. Climate change risks can have adverse effects on all sectors and levels of society. Therefore, reducing vulnerability to climate change impacts has become imperative for these countries – many of which have limited capacities to cope with climate risks. Indeed, climate change adaptation remains a part of the central focus of sustainable development policy agenda for many developing countries. Climate change adaptation plans and policies are being formulated at various levels of government and are also being incorporated into development plans. This is also true for Africa as many national governments are introducing systems to govern climate change adaptation (Mimura et al., 2014).

Adaptation is "an iterative process of defining a problem, planning, and implementing action, and monitoring and reviewing these actions, in the light of new or changing risks, regulations, policies, and/or new information about a given system response" (Bowyer, Schaller, Bender, & Jacob, 2015, p. 71). Fig 2.1 below represent the subprocess of adaptation process.

Figure 2.1 Phases and Subprocess of the Adaptation Process



Source: Moser & Ekstom, 2010, p. 22027

The IPCC defines climate change adaptation as the "the process of adjustment to actual or expected climate and its effects" (IPCC, 2014a). This adjustment can come in form of interventions that strive to capitalize on opportunities brought about by climate change and interventions that aim to avoid/manage risks and threats from climate change (UNEP, 2016). Adaptation depends on climate science which is then interpreted and incorporated into decision-making. It entails making business or lifestyle changes to accommodate and reduce potential threats and risks, as well as capitalizing on opportunities that may arise because of climate change. The size and scale of the

adaptation problem will determine whether it will be addressed by making small changes or larger transformations. Adapting in the near-term is necessary to cope with immediate and urgent climate risks and ensure that objectives are met in the long-term (Bowyer et al., 2015). Importantly, adaptation is characterized by uncertainties- ranging from uncertainty about future climate change, uncertainty surrounding sensitivity to changes in climate and non-climatic conditions, to uncertainty about the efficacy of adaptation strategies that may be implemented. It is therefore necessary to identify and consider these uncertainties when developing adaptation strategies (Bowyer et al., 2015).

Climate change adaptation is "multiscalar, relevant at local, national and inter-national levels; multi-actor, comprising actions throughout society; and multitemporal, therefore requiring carefully structured responses" (Conway & Mustelin, 2014, p. 340). Despite these complexities, adaptation is often framed as a local issue and execution of adaptation programs assigned to local governments, communities, and households. Adaptation at the local level prioritizes present climate risks with little attention to long-term climate risks which may have more dire consequences and are usually beyond the capacity of communities and individuals, requiring coordinated action from higher agencies and the national government (Conway & Mustelin, 2014). Climate change impacts vary across countries and regions, and as such climate change adaptation should consider economic, cultural, and political factors (Nkoana, Verbruggen, & Hugé, 2018).

2.5 Tools for Decision-making, Planning, and Implementing Adaptation

Many tools are used for decision-making, planning, and implementation of adaptation. Tools that support decision-making are present in both top-down and bottom-up forms. Top-down tools include scaled simulated climate scenarios for regional level projections and is typically supported by expert opinions and are applied using multi-criteria optimization methods including cost benefit analysis among others. The bottom-up approach involves vulnerable groups or communities assessing their own impacts and vulnerabilities. Participation of stakeholders is crucial to this approach and social and institutional activities can be organized to address issues identified during the engagement process. The uncertainty surrounding climate change complicates adaptation planning and implementation, and as a result a multidisciplinary effort is essential for adaptation planning. The integration of a monitoring, modelling, and Geographic Information System (GIS) is beneficial to adaptation planning and implementation. The complexity, multiscalar, and interdisciplinary nature of climate change impacts necessitates the use of the computer-based modeling approach to understand future climate change and variability. Some of the planning tools that have been developed include the European Spatial Planning Adapting to Climate Events Project (ESPACE) and the Species Forecasting System (ISFS) (Mimura et al., 2014).

Communication tools are instrumental to the success of adaptation implementation. These tools range from peer-reviewed publications, policy briefs, TV and radio forecasts, posters, and internet and are necessary for communication among information developers

such as scientists, trainers, project implementers, and government agencies. At the national/subnational level, TV, radio and internet broadcast, blogs, and high-level summits have been central in creating awareness about climate change issues. Discussions by community members, learning-by doing, and hands-on exercises have also served as effective dissemination channels at the local level. Monitoring and early warning systems has been vital to adaptation at the local level. Proponents of Disaster Risk Management (DRM) have proven that successful warnings of future extreme events are usually accompanied by information on the risks posed by the hazards and by potential strategies and pathways to lessen damage. Early warning systems is comprised of many approaches ranging from satellite information, and climate modeling to local level early warning based on traditional knowledge and techniques. Early warning systems are useful tools for developing strategies to cope and adapt to climate change (Mimura et al., 2014, p.884-885).

2.6 Adaptation Strategies and Approaches

Climate change adaptation action can be carried out through the actions of individuals, communities, and governments. Climate change adaptation strategy are defined "as a general plan of action for addressing the impacts of climate change, including climate variability and extremes" (Niang-Diop & Bosch, 2005, p.186). Such strategies include a combination comprise of policies and measures that have the central objective of reducing vulnerability to climate change impacts. The strategy can be "wide-ranging at a national level, focusing on climate change adaptation across sectors, regions,

and vulnerable populations, or it can be limited, focusing on just one or two sectors or regions" (Niang-Diop & Bosch, 2005, p.186). Adaptation strategies and actions can range from "short-term coping to longer-term, deeper transformations, aim to meet more than climate change goals alone, and may or may not succeed in moderating harm or exploiting beneficial opportunities" (Moser & Eskrom, 2010, p. 22026).

2.6.1 Adaptation and Disaster Risk Management

The IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) (IPCC, 2012) identified similarities and differences between climate change adaptation and DRM. Climate change impacts and DRM have key roles to play in climate change adaptation- DRM involves managing hazards from extreme events and dealing with the uncertainty of climate change. Some researchers have proposed that DRM be merged with climate change adaptation to avoid duplication of efforts and promote more coordination and integration. The approach of merging DRM with climate change adaptation highlights the importance of linking development and disaster reduction and prevention, which can help minimize the risk of unplanned consequences of adaptation if combined with existing development agendas, policies, and governance structures. Furthermore, this approach will also drive support for adaptation at all levels of government. When DRM and adaptation are incorporated into a development agenda, it can assist in tackling social vulnerability to climate change while offering opportunities for adaptation (Mimura et al., 2014).

DRM promotes participatory approaches and the use of local knowledge in planning and implementing disaster risk reduction and prevention and climate change adaptation (Mimura et al., 2014). A combination of top-down and bottom-up approaches and using low-regret strategies in DRM and adaptation planning and implementation will minimize development pressures, build climate resilience, improve livelihoods as well as social and economic well-being. Low-regret measures are typically associated with low costs under all plausible climate scenarios. This is beneficial under current and future climate change scenarios and lay the foundation for addressing projected trends in exposure, vulnerability, and climate extremes in national and regional adaptation plans (Mimura et al., 2014; Füssel, 2007).

2.6.2 Adaptation and Development

Stern defines adaptation as development in a more hostile climate (Stern, 2009). Development is a form of adaptation as it improves adaptive capacity, in the same vein, adaptation to possible climate stressors is a form of development by improving resilience and consequentially result to progress for economic and social indicators (Milman & Arsano, 2014). Social dimensions of adaptation drive attention towards the relationship between adaptation planning and implementation and development. Adaptation is necessary for responding to climate change and other multiple stressors. Linking development issues, policies and agendas with adaptation planning can help minimize the unplanned consequences of adaptation. Furthermore, framing development as a public safety issue will encourage more action at all levels of government (Mimura et al., 2014).

Chapter 3

3. Methods

3.1 Qualitative Research Method/Approach

The research questions a research seeks to answer determine the methods and approach it will adopt. This thesis uses a thorough literature search of secondary sources (government policies and statements, official reports, and websites) to collect data that will help answer the research questions: what the vulnerabilities are, and the responses (private and public, like actions by NGOs, industry agents or governments) (Gelling, 2015).

A case study is important to provide the context of the analysis by focusing on the case to answer the why, what, and how questions. In the literature, different authors refer to case study as an approach, a method or a strategy. Qualitative case study approaches use an array of data sources to aid the exploration of an occurrence of interest to gain extensive, multifaceted understanding of the phenomenon within its real-life context; the case study is a commonly used research design in various disciplines including the social sciences. (Baxter & Jack, 2008; Crowe et al., 2011). The case study is described as an "empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly

evident" Yin (2003, p. 13-14). Case studies are preferable for answering "why", "what" and "how" research questions (Yin, 2003). The collective case study approach is an instrumental case study extended to other cases; an instrumental case study is typically used to provide insight into an issue or draw a generalization from the case study to facilitate the understanding of the issue of interest. The collective case study involves the study of more than one case to investigate a specific issue as well as get a broader understanding of the issue (Stake 1995; Zucker, 2009; Crowe et al., 2011). Qualitative a case study often involves assessment of specific programs or interventions. It sometimes requires collecting opinions from individuals or group of individuals to answer research problem (Starman, 2013; Simons, 2009). The latter was not possible or considered given the scope (country-wide literature) of the work.

The case study approach is appropriate for this thesis because it is preferable for answering "what" and "how" questions. The purpose of this research is to explore and determine the current policies of climate change adaptation in Africa; to achieve this, it is imperative that adaptation policies and activities in selected case study countries be investigated to draw conclusions and infer generalizations. A case study will provide in-depth insight into climate change adaptation in select African particular. An examination of climate change adaptation policies and activities in South Africa and Ethiopia may influence climate change adaptation and drive it to gain traction in other countries. Although diversity within and between African countries are high, the whole continent is highly vulnerable to climate risks with 7 out of 10 countries worldwide most susceptible

to climate change from Africa (Africa Foresight, 2017). South Africa has a middle-sized economy while Ethiopia is an emerging economy (UNEP, 2016). This study wishes to explore the adaptation initiatives in both sizes of economy in Africa, hence the choice of South Africa and Ethiopia as the two case study countries. Furthermore, South Africa's leadership in international negotiations is quite notable in Africa (WRI, 2009), possessing a sophisticated earth system science research program that bolsters the climate change scenarios developed for the Southern African region and being arguably the most advanced in the whole African continent (Ziervogel et al., 2014). On the other hand, East Africa represents the region in Africa with the highest number of reports on climate change adaptation (Berrang-Ford et al., 2014) with Ethiopia giving climate change issues significant attention. Ethiopia is often mentioned as one of the most extreme cases of countries vulnerable to climate change risks (Conway & Schipper, 2011). In addition, the availability of literature, information and materials from the two selected case study countries make them appropriate for this research.

3.2 Data Collection and Sources

Document analysis involves the review of existing documents to acquire exhaustive understanding of their content or elucidate more in-depth insights into the subject matter. These may be government documents like government reports, budgets and academic documents like dissertations, among others. These sources are referred to as secondary sources and the data retrieved are known as secondary data (References). Document review is an appropriate investigative method for this thesis because of its relevance,

availability, cost-effectiveness, and ease of access. This thesis will collect data primarily from secondary data sources ranging from books, reports, and publications from the UNFCCC, IPCC, government documents and other online publications. This thesis will use keywords ranging from climate change, adaptation, risk management and Africa to retrieve relevant information for data analysis.

Using secondary data can sometimes be cumbersome particularly when data is not retrieved from an official data archive as these unofficial sources are oftentimes poorly documented, making it difficult to evaluate and determine their quality and validity as reliable sources of information for academic as well as official research. Official data archives serve as the major sources of information, as they are established to obtain, archive, and disseminate data for secondary research (Hox & Boejie, 2005).

Secondary data collection is cost effective in that it uses existing data to generate new knowledge as well as less time-consuming in comparison with primary data collection (Stewart & Kamins, 1993). The use of secondary data is laden with certain challenges including but not limited to finding and retrieving data relevant to the researcher's research questions and ensuring the data meets the quality requirements and methodological criteria of current research (Hox & Boejie, 2005).

Weimer & Vining (2005) grouped documents into four categories - (1) journal articles, books, and dissertations; (2) publications and reports of interest groups, consultants and think tanks; (3) government publications and research documents; and (4) the popular press. Desk-based methods of internet searches - Google scholar, Memorial

University physical and e-library will be used to access these existing pools of documents and discussions about climate risk management and adaptation in Africa.

This thesis will use national government document ranging from the adaptation component of the Intended Nationally Determined Contribution (INDC) submitted to the UNFCCC as the key guide to track climate change adaptation action in the case study countries. This thesis will also focus on the formalized and comprehensive climate change response of these two countries, developed by the government for use by policymakers. These government documents of South Africa and Ethiopia may differ in structure and focus, but they provide a detailed and coherent overview of key vulnerabilities, impacts, strategies, and measures to address climate change adaptation in the countries.

3.3 Data Analysis (Qualitative Content Analysis)

Lathlean (2010) describes qualitative analysis as an "ongoing and iterative" process that starts at the commencement of data collection and goes throughout the entire data collection process. Qualitative content analysis will be used for data analysis in this research. Content analysis refers to the systematic coding and categorization of large textual information with the aim of identifying trends and patterns of words used, their frequency, structures, and discourses of communication (Vaismoradi et al, 2013). Hsieh & Shannon (2005) define qualitative content analysis as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" (p.1278). Content analysis does not only focus on collection of records and data but also concerns itself with establishing an

understanding of the meaning of the information collected. Content analysis can be qualitative or quantitative; however, this thesis will be employing qualitative content analysis for data analysis.

The effectiveness of content analysis is determined largely by the coding process Hsieh & Shannon (2005). Coding involves reviewing, processing, and categorizing gathered information into codes (Datta, 2011). According to Hay (2005), coding has three key functions (i) refining and summarizing sizeable amounts of data (ii) organizing data and (iii) analyzing data. A coding structure is formed where codes will be categorized into themes and concepts depending on the linkages between them, this is done to condense data and highlight pivotal themes or patterns from the data. Coding in content analysis usually involves the development of coding schemes to guide decision-making in the analysis of content; a coding scheme represents logical, scientific, and systematic rules of data analysis (Hsieh & Shannon, 2005). Coding is an ongoing and reflexive process as codes are developed and revised all through the research process based on new information and emerging themes (Hay, 2005; Datta 2011)

3.4 Conceptual Framework

The objective of this study is to assess the status of climate change adaptation in Africa. To achieve this and answer the research questions posed, this study will critically explore the national adaptation plan, policy, and strategy of two case study countries - South Africa and Ethiopia. The work focusses on specific crosscutting issues surrounding climate change adaptation. Numerous studies have identified various factors that

embolden governments and policymakers to act on adaptation, foster support for action, identify policy strategies, and eliminate barriers to adaptation (Adenle et al., 2017; Moser & Ekstrom, 2010). The research does not have the ambition and resources to explore all emerging and crosscutting issues or the impacts that climate change will have on all sectors in the country. It will identify and focus on three crosscutting issues and sectors that have been identified as being vulnerable to climate change impacts; these are considered central to the current economic structure and future development prospects of both countries. Climate change is expected to have substantial and direct impacts on three key sectors in South Africa- agriculture, water, and energy (DEA, 2016a). Meanwhile in Ethiopia, the agriculture and water sectors are particularly vulnerable to the climate change risks (Weldegebriel & Gustavsson, 2017; USAID, 2016). Consequently, in chapter 5, this thesis will explore climate change adaptation plans, policies, and strategy for these key sectors in South Africa and Ethiopia.

3.4.1 Adaptation Planning

The need for climate change adaptation has become evident and plans, strategies and responses are increasingly being developed. There is heterogeneity in planning for adaptation because of disparities in resources, needs, values, and perceptions among and within regions. This diversity is evident as countries adopt different approaches as well as from differences in knowledge and information about climate change adaptation across communities. National governments are usually responsible for leading climate change adaptation planning and action; however, collaboration with subnational and local

governments is essential in planning climate action. National level coordination facilitates policy-making and legislation and drives action at the subnational level as well as sectors crucial to national development. Furthermore, in many countries, the national government will coordinate budgetary allocations and financing mechanisms to address climate change (Mimura et al., 2014). Planning adaptation responses require a risk-based approach which often takes a longer-term perspective towards adaptation planning, although the uncertainty surrounding climate change complicates risk assessment (Adaptation Future, 2016). Climate change impacts and DRM are central to the early phase of adaptation planning and implementation. Climate change adaptation is multifaceted and context-dependant, and as such there is no single approach for planning for adaptation. The top-down approach is technical, and science-driven depending on scientific research and climate model predictions to assess climate risks, and the bottom-down approach encourages participation from various and diverse stakeholders relying on knowledge and expertise from local stakeholders to assess climate risks and vulnerabilities are the two most common approaches to climate change adaptation. These two approaches can be combined to strengthen climate change adaptation planning and implementation (CCME, 2016; Mimura et al., 2014).

3.4.2 Institutions and Governance of Climate Change

Climate change considerations cut across institutional, political, and social dimensions. Moreover, adaptation governance is multilevel, often cutting across various sectors and actors and stakeholders (Adaptation Future, 2016). Institutions such as

governments, international treaties, and markets shape most relevant climate-related decisions and actions (National Research Council, 2010). Institutions can be grouped as public, private, or civic; and these are further divided into formal (constitutions, rules, regulations, laws, rights, etc.) and informal (behaviour codes, cultural norms, traditions) institutions (Ampaire et al., 2017; Adjei-Nsiah et al., 2015). Institutions are guided by tangible formal procedures, laws, and regulations that regulate and control actions among relevant actors. Formal institutions are largely responsible for adaptation planning and implementation; however, the participation of informal institutions, through engagement with various and diverse stakeholders, is also required (Mimura et al., 2014). Therefore strengthening institutions is critical to effective adaptation. Institutions are defined as "rules of the game" that shape behavior, interaction, as well as organizational structure. These institutions are usually socially formed and are regulated by political, social, cultural, and economic interactions (Adjei-Nsiah et al., 2015; Jones, 2010).

According to Mimura et al. (2014), institutions play a central role in facilitating the transition from planning to implementation of climate change adaptation and have been cited often in the literature as a barrier to mainstreaming climate change. Several institutional dimensions ranging from multilevel institutional coordination between differing political and governmental levels in society, principal actors and stakeholders that are responsible for initiating, coordinating, mainstreaming, and driving climate change adaptation are essential to adaptation design and implementation. Furthermore, horizontal interaction between sectors, policies, actors, political aspects to planning and

implementation, to coordination among various and diverse actors such as government, private sector, and civil society to increase representation and support for climate change adaptation, will either serve as barriers or facilitate climate change adaptation planning and implementation in both developed and developing countries (Mimura et al., 2014). National and sub-national governments are usually responsible for coordinating climate change adaptation responses- planning, developing policies, and implementation guidance. Local governments, however, play key roles in tackling issues surrounding climate change adaptation. Multilevel institutional governance between different levels of government is necessary for the success of climate change adaptation planning and implementation. Also, of noteworthy importance is collaboration among government, private sector and civil society in planning and responding to climate change adaptation (Mimura et al., 2014).

Poor description of the roles and responsibilities of the different levels of government and sectors constrains climate change adaptation. Clear and coherent policies and regulations are required to promote the institutionalization of local climate actions. Cross sectoral collaboration, exchange and organizational learning can drive institutional change and facilitate mainstreaming and horizontal coordination across sectors and departments (Mimura et al., 2014). Findings concerning governance of climate change adaptation in Sub-Saharan Africa and Latin America reveal that policy implementation is hindered by fragmentation in sectoral planning as well as lack of coherence between national and local adaptation planning and policies (Ampaire et al., 2017). Linking climate

change adaptation planning and strategies and local development needs and adopting low-regret strategies can improve local adaptation strategies and implementation (Mimura et al., 2014).

3.4.3 Climate (Adaptation) Finance

Most developing countries are characterized by low adaptive capacity, inadequate financial resources, and poor technology advancement in the face of climate change. Climate change threatens the development prospects and poverty alleviation goals of developing countries. A central objective of climate governance is the provision of financial resources to support the developing counties that are vulnerable to climate change (Morita & Matsumoto, 2015). Climate change cannot be efficiently addressed without developed and developing nations investing in low carbon technologies and climate resilient practices (Frankheuser, Sahni, Savvas, & Ward, 2015). Such financial support is often referred to in the literature as "climate finance" (Buchner, Falconer, Hervé-Mignucci., Trabacchi, & Brinkman, 2011b; Haites, 2011).

The UNFCC, in accordance with the polluter pays principle, necessitated developed nations to provide financial and technological assistance to developing countries. There is no universally agreed definition for climate finance (CFU, 2017; Buchner, Brown & Corfee-Morlot, 2011a). Stadelmann (2013) defines it as "international financial payments directly or indirectly mobilized by industrialized country governments that cover cost of climate change mitigation and/or adaptation in developing and emerging countries" (p. 13). Adaptation financing refers to financial resources mobilized to support climate-

resilient development (Mimura et al., 2014). Adaptation funding is a key element in promoting adaptation measures in developing countries, and financial support for adaptation has been one of the major agendas in the UNFCCC negotiations on adaptation (Morita & Matsumoto, 2015). Climate finance is required to fund initiatives that respond to climate change impacts such as coastal erosion, flooding, and droughts (CFU, 2017). Climate change adaptation finance can take one of four forms- international public finance, public domestic finance, private international finance, or private domestic finance (UNEP, 2016). The international community's commitment to climate finance- mitigation and adaptation has been delivered through various funding mechanisms including those under the UNFCC, and several other bilateral and multilateral channels. Sub-saharan Africa has commandeered a huge share of adaptation funding, accounting for as high as 42% of funding (CFU, 2017; Mimura et al., 2014; Conway & Mustelin, 2014).

Private financing for climate change adaptation can either be debt or equity. Debt refers to loans and bonds, and is usually paid back with interest, and equity involves transferring ownership rights through stocks and other assets. Private finance can also come in the form of export credits- insurance, guarantees or other support that drives the competitiveness of a developing country's exports, and foreign direct investment which is only relevant to a few sectors and countries. Sources of private finance include several financial institutions such as international banks, insurance companies, equity, and pension funds, among others. Adaptation finance can also come from civil society and social investors (Mimura et al., 2014).

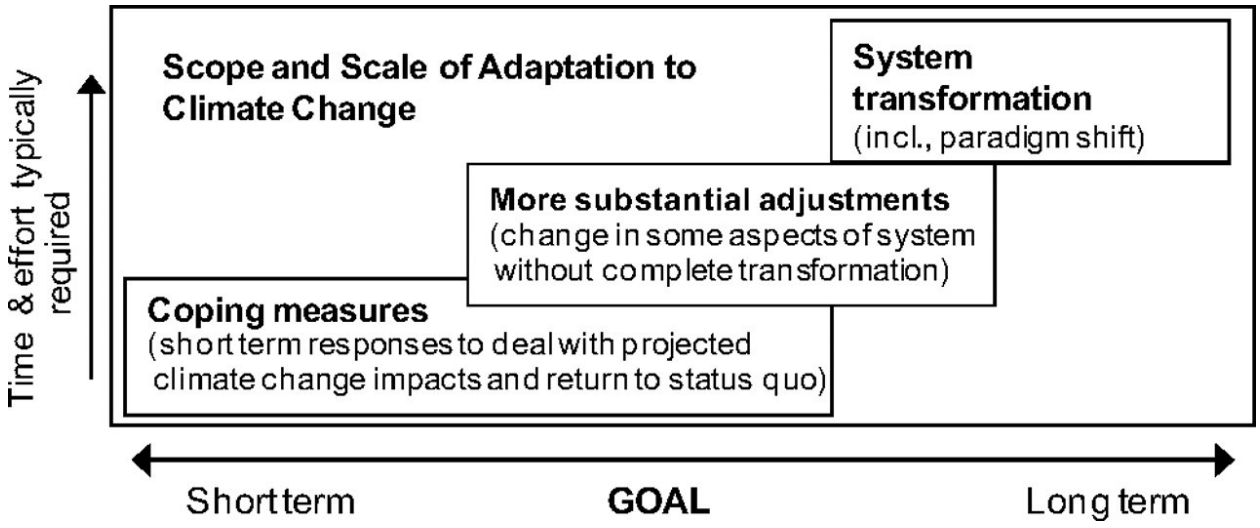
This study will explore these three abovementioned crosscutting issues in South Africa and Ethiopia. Adaptation planning will be examined in the most vulnerable sectors in the two case study countries, institutions and governance of climate change will focus on identifying the institutions that are tasked with adaptation initiatives as well as governance and coordination among them, while climate finance will explore sources of finance for adaptation in these countries.

Chapter 4

4. Barriers to Climate Change Adaptation

The IPCC Fourth Assessment Report (4AR) recognizes barriers and limits associated with climate change adaptation. Barriers and limits are climatic and non-climatic factors that hinder adaptation. While limits refer to obstacles that are seemingly insurmountable, barriers are difficulties that can be overcome with proactive action, changes in thinking, and related shift in institutions, resources etc. With enough resources, political will, and social support, many barriers can be overcome; however, others will undermine climate change adaptation action (Moser & Ekstrom, 2010; IPCC, 2007b).

Figure 4.1 Scope and Scale of Adaptation

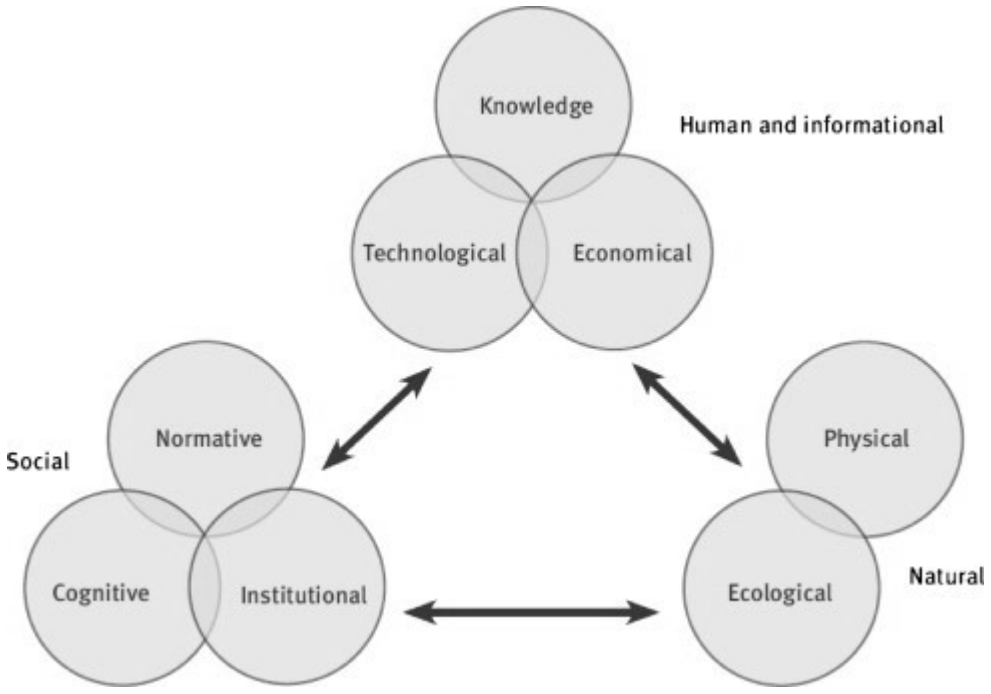


Source: (Moser & Ekstrom, 2010, p. 22027)

Barriers differ across sectoral, spatial, and temporal scales, and in the same vein, across different phases of the adaptation process (Mimura et al., 2014). With intentional and planned adaptation, the scope and scale of adaptation greatly influence the number

and types of barriers triggered and encountered, by choosing different adaptation actions or pathways (Fig 4.1). Some barriers will be simpler to overcome than others; for example, barriers associated with system transformations will be more challenging to address than planning and implementing near-term measures to tackle climate-related extreme events (Shackleton et al., 2015; Moser & Ekstrom, 2010). This chapter will explore institutional/political, financial, technological, and socio-cultural barriers to climate change adaptation, as they relate to the two case studies. Fig 5.2 below displays various barriers and limits to climate change adaptation. This thesis will however, focus on barriers to adaptation.

Figure 4.2 Conceptual Analysis of Limits and Barriers to Adaptation



Source: (Jones, 2010, p.4)

4.1 Institutional/Political Barriers

Institutions are central to addressing climate change adaptation, particularly at the local level, providing channels of shaping social and individual interactions within the society (Antwi-Agyei, Dougill & Stranger, 2015). Low-income developing countries are often characterized by a weak institutional environment. Multilevel institutional coordination is challenging, particularly when roles and responsibilities between levels and actors are unclear. Climate change cuts across institutions and does not follow clear rules and set responsibilities, thus increasing the risk of failure. Furthermore, horizontal coordination between actors and policies is central to institutionalizing climate change adaptation. Institutional rigidity can hinder this, as unwillingness to change past policies and traditions can limit the extent to which systems can learn or adapt to climate change (Mimura et al., 2014). Although private stakeholders can hold sectarian interests and raise questions of whose voices are getting represented, private sector and civil society involvement in climate change adaptation can improve effectiveness and improve representation in the process (Mimura et al., 2014).

Many African countries have adopted the top-down approach to adaptation, with many national climate responses decided by the national government. Institutional barriers can be related to political barriers (Antwi-Agyei et al., 2015). Political dimensions to adaptation planning hinder climate action, especially when there is an apparent conflict between addressing climate change and realizing development objectives; this can be challenging for policy-makers. The financial cost of adaptation is usually expressed in

monetary terms, while the benefits of adaptation are expressed in non-monetary terms, making it difficult to convince political leaders and the general public of its importance (Masters & Duff, 2010). The absence of political will and urgency as well as support to address adaptation means that climate change is not at the top of policy agendas and concerns. Stakeholders and actors who are interested in climate change either as individuals or representatives of a group are central to the adaptation process. For example, traditional leaders are needed to gather rural support for climate change adaptation initiatives. Local knowledge, social networks, and traditional institutions are usually disregarded as important by the formal institutional, technological, and financial frameworks during adaptation planning at the national level. This lack of ownership and continuity of the adaptation process, and inadequate collaboration with stakeholders' hamper adaptation planning and implementation (Masters & Duff, 2010).

A study in Kenya reveals that political dimensions of local adaptation should consider how power relations as well as the interplay of informal institutions, such as clans, and government institutions influence local negotiation (Mimura et al., 2014; Eriksen & Lind, 2009). For example, some responsibilities that should be handled at the local level are in the hands of the central government, thus limiting decision-making power of the local government who is unable to hold the central government accountable (Ampaire et al., 2017).

4.2 Financial Barriers

According to historical global emissions, Africa requires climate change adaptation funding of between $7-15 billion yearly by 2020 (UNEP, 2016; Schaeffer et al., 2013). In a below 2ºC world, adaptation costs on the continent can rise to $50 billion yearly by 2050, and double to $100 billion/year by 2050 under a scenario where warming is more than 4ºC by 2100. Future cost implications relative to Africa's growing GDP puts adaptation costs to as much as 6% of African GDP by 2100 under a scenario where warming is more than 4ºC but estimates for a below 2ºC world stand at less than 1% of GDP (UNEP, 2016; Schaeffer et al., 2013). Climate change adaptation has direct and indirect financial implications which are often beyond the capacity of many African countries. Even with international financial support, the ability to source and absorb funds differ across countries. Many recipient (developing) countries have established national climate finance mechanisms to receive funding from various donors to coordinate and match donor interests with national priorities. Unfortunately, the readiness of many countries to receive and absorb this finance is in question, as many low and middle-income countries face difficulties in accessing the funds (CFU, 2017; Antwi-Agyei et al., 2015).

Despite the progress made to mobilize and scale up climate finance, the amount deployed to Africa is less than the estimated climate finance needs across the continent. Factors such as limited access to climate finance as well as weak institutional environment to attract climate investment hinder access to international climate finance (Africa Climate Fund et al, 2017). Henders et al. (2013) reported lack of inter-agency coordination in most

African countries which resulted in duplication of efforts. International climate finance is characterized by complexity and is often murky and challenging to navigate. For example, farmers in Ethiopia have stated that inability to access credit facilities was a major barrier to the implementation of climate change adaptation strategies (Antwi-Agyei et al., 2015).

4.3 Technological Barriers

Technological barriers obstruct climate change adaptation in Africa, especially as the level of technological advancement in Africa is low. Technological advancement is one of the four main agriculture adaptation pathways (Antwi-Agyei et al., 2015). Technological developments such as the development of new crop varieties, early warning and monitoring systems, and irrigation techniques are necessary for adaptation in the agriculture sector. Technology is used and implemented within relevant socioeconomic, legal, and institutional frameworks, which are absent in many African countries. Low technical expertise in climate modelling also constrains climate change research and adaptation (Antwi-Agyei et al., 2015). The success of technological interventions at the local level depends largely on its suitability to meet local needs. It is pertinent that communities be involved in the choice, planning, and the deployment of technology, as this will foster ownership and cooperation. Technological interventions should therefore be rooted in the institutional, social, and economic foundation of communities (Lobo, n.d). A study in Uganda reveals that limited technical capacity in the public sector hinders adaptation planning and access to available climate finance (Ampaire et al., 2017).

4.4 Socio-Cultural Barriers

Social barriers to adaptation focus on social and cultural processes that govern peoples' reactions to climate change and variability. Social barriers can be cognitive, normative, or institutional. Institutions in this context refer to "rules of behaviour" that guides belief systems, behaviour, and organizational structure. Cognitive barriers refer to psychological processes that determine peoples' reactions to risks associated with climate change, and normative barriers which comprise cultural norms and shared values that shape climate change actions and regulations such as tribal/indigenous and religious belief systems (Antwi-Agyei et al., 2015; Jones, 2010).

Cultural practices, beliefs, and value systems of individuals or communities shape perception towards climate, and consequently can impact adaptation strategies. A people's culture influences the decision to adapt, identify risks, and implement measures to cope with the risks. These norms, beliefs and practices are usually place-based and dynamic and vary from community to community (Antwi-Agyei et al., 2015).

Chapter 5

5. Climate Change Adaptation in South Africa and Ethiopia

5.1 South Africa

South Africa has a population of more than 50 million people. Although a middle-income country, the country is fraught with socio-economic inequality. South Africa exports energy to Namibia, and imports water from Lesotho. The country shares the major Limpopo river system with Botswana, Mozambique, and Zimbabwe, and the Orange river with Lesotho and Namibia (DEA, 2016b).

All states in Southern Africa face the challenges of food security, limited water supply or limited access to water resources, rural and urban poverty as well as other development issues. Climate change is a major concern in South Africa and poses substantial risk to the country's food security, water resources, infrastructure, ecosystem, and biodiversity. The country is prone to climate-related extreme events-droughts, floods, and veld fires. About fifteen million of the country's population have been affected by droughts between 1980-2013, which is the highest number of people that have been affected by a climate-related disaster in the country. When compared with other African countries and even globally, South Africa's contribution to GHG emissions is significant. This is mainly because it is an energy-intensive, fossil-fuel powered economy (CPLO, 2017; Ziervogel et al., 2014; DEA, 2011).

Even with the UNFCCC's objective of limiting average global temperature increase to below 2^{o} C above pre-industrial levels, the potential impacts of climate change in South

Africa are widespread and cataclysmic. Under more conservative emission scenarios than existing international trends, it is projected that by mid-century the South African coast will warm by 1° to 2° C, and the interior will warm by 2° to 3° C. By 2100, warming is expected to reach around 3 to 4° C along the coast and 6 to 7° C in the interior. Rising temperature will adversely affect human health, as well as water-sensitive sectors such as agriculture, mining, and the energy sector (DEA, 2011).

South Africa's GDP may reduce by as much as 66% by year 2100 because of climate change impacts. Trends of sustained warming and drying is expected to have substantial effect on subsistence farmers as they rely largely on rain-fed agriculture. In the same vein, climate-related extreme events will adversely affect the poor, thereby intensifying poverty and inequality (DEA, 2016). High levels of poverty and disparity in the country will intensify climate change risks and limit adaptive capacity worsening development prospects in the country. Like in many countries, climate change in South Africa was initially framed as an environmental issue rather than a development issue in South Africa. Urgent socio-economic developmental needs and susceptible ecosystem in the country have made climate change adaptation necessary. Thus, adaptive responses that lower vulnerability to current and future climate change risk is essential to achieve development goals (Ziervogel et al., 2014). Furthermore, the interdependence of the water, food, and energy sectors are increasingly being recognized, this ought to promote more holistic approaches to policy planning and implementation (DEA, 2017a).

South Africa's climate action was informed based on the conclusion by the UNFCCC that the climate is warming at an alarming rate, and that anthropogenic GHG emissions are putatively responsible for this warming trend. Climate change, which is considered one of the greatest threats to sustainable development if not addressed can undermine the country's development efforts and prospects. Furthermore, although the country recognizes that there will be costs associated with climate change adaptation efforts, it will be beneficial for the economy and socially in the short and long-term. Also, some studies have stated that the costs associated with early action are less than the costs of delayed action or inaction (DEA, 2011).

5.2 Adaptation Planning

South Africa is focused on developing adaptation interventions that are concerned about risk and vulnerability reduction, without which the effects of climate change will be catastrophic. Effective adaptation will need to be backed by early warning and forecasting for risk reduction, medium-term climate projections to facilitate the identification of challenges ahead of time, and long-term climate forecasting that describes future climate change conditions and patterns (DEA, 2011). Collaborations and communications with the UNFCCC after 2001 resulted in the incorporation of adaptation agenda into national policy development. South Africa's National Development Plan 2030 frames the climate issue as a development issue and many government departments across all levels of government- national, provincial, and local, are starting to introduce climate change strategies and policies (Ziervogel et al., 2014).

Although there is growing academic interest in adaptation to medium or long-term climate changes in South Africa and internationally, most adaptation responses concentrate on reducing vulnerability and improving capacity to adapt to present-day climate risks. Other than on a small scale (sectoral or local), there have been relatively few practical experiences to execute adaptation activities to cope with long-term climate change. South Africa's 2011 National Climate Change Response White Paper is the first clear attempt at outlining the national government responsibilities towards climate change adaptation (Ziervogel et al., 2014). South Africa's overall approach to responding to climate change is driven by the needs of the country and is tailored to meet the needs of relevant organizations or sectors. It is also developmental, and prioritizing adaptation and mitigation responses that are beneficial for economic growth, risk assessment, poverty reduction, and employment creation. The country's climate change response is transformational, empowering, and participatory as it seeks to implement innovative climate change policies at a "scale of economy" and transition to a low-carbon and competitive economy. The national climate change policy aims to achieve the afore-mentioned by financing investments that support its climate change response, as well as promote sector and skills development. The transition will be supported and facilitated by policies that empower and foster participation of all citizens by shifting to a more sustainable lifestyle and livelihood. Furthermore, the responses are dynamic and evidence-based focusing on the implementation of no-regret policies and measures which are influenced by continuous research. Policies and measures are monitored and evaluated to

make room for adjustments and fast-track successful initiatives on a larger scale. South Africa's response enables the incorporation of sector-related climate change responses into appropriate sector planning processes and development agenda at the national, provincial, and local level (DEA, 2011). South Africa, because of limited experience with climate change adaptation monitoring and adaptation has prioritized climate change adaptation monitoring and evaluation at the national level and is carrying out research to develop a system of monitoring and evaluating adaptation (Ziervogel et al., 2014).

South Africa's 2011 National Climate Change Response Policy (NCCRP) includes a risk-based approach to identify and prioritize climate change adaptation interventions (DEA, 2011). The policy is structured around certain strategic priorities ranging from risk reduction and risk management. It entails prioritizing short-term climate change adaptation responses that focus on urgent and immediate climate risks, further research is then conducted to inform the development of medium to long-term climate risk and vulnerability management measures. Another priority for the country is to mainstream climate change planning and responses into key sectors and across all levels of government. Technology research, development, and innovation is also a priority for the country as the promotion of research, investment in adaptation, as well as energy-efficient technologies will improve the country's capacity to make projections about climate change risks and impacts (DEA, 2011).

South Africa's 2011 national policy stance on climate change focuses on the need to identify and quantify risks ensuing from a range of emission scenarios to guide planning

and practice. The NCCRP highlights the need to prioritize scientific research, generate knowledge, develop early warning systemss to improve the likelihood of detecting climate change impacts timely (Ziervogel et al., 2014; DEA, 2011). The government has started working on adaptation responses for key sectors in the economy; and a sub-Committee of The Inter-Government Committee on Climate Change (IGCCC) will be created to conduct climate risk analysis on all sectoral plans. This risk-based process to sectoral plans will eventually result in the identification and prioritization of main short- and medium-term adaptation interventions. The process will also bring to the fore adaptation responses that require coordination between different sectors and/or departments (DEA, 2011)

Long term adaptation planning involves reducing the adaptation deficit which is exposure and sensitivity to climate variability and observed changes (Ziervogel et al., 2014). The National Department of Environmental Affairs in 2013 established the Long-Term Adaptation Scenarios (LTAS) project to address this problem. The LTAS are to create national and sub-national adaptation scenarios under various future climate change conditions and development pathways. The objective is to facilitate the integration of climate resilience into future development planning. Furthermore, climate science in South Africa has focused on mechanisms that influence inter-annual and decadal variability and how climate change might affect these mechanisms. Another key focus is the connections between local and remote drivers of rainfall variability (Ziervogel et al., 2014).

In September 2016, South Africa submitted its Intended Nationally Determined Contributions (INDC) to UNFCCC. The adaptation component of the report comprises of various goals to achieve the adaptation objectives and implementation plans. These goals include developing and operationalizing a national adaptation plan, incorporating climate change considerations into national development agenda at various levels of government, building institutional capacity for climate change response planning and implementation, establishing early warning, vulnerability, and adaptation monitoring systems for key sectors and geographic areas that are vulnerable to climate risks, developing a vulnerability assessment and adaptation needs framework, and communicating past investments in climate change adaptation (DEA, 2017a; USAID, 2016). A National Adaptation Strategy (NAS) which is one of the six goals in the adaptation component of South Africa's Nationally Determined Contributions (NDC) is currently being formulated to guide adaptation efforts, as well as link the efforts more clearly to national development goals (DEA, 2017a; INDC, 2015).

5.2.1 Agriculture

Climate change impact assessments in the agricultural sector in South Africa have concentrated on staple crops and key commodities such as maize. The Agricultural Technical Report of LTAS outlines risks and opportunities for the agricultural sector (Ziervogel et al., 2014). Agriculture is the principal consumer of water and is highly susceptible to changes in water variability (DEA, 2011). Some central concerns include the possibility of increased irrigation demand, as most parts of the country may encounter

rising average annual irrigation demand between 4% - 6%. LTAS projections reveal mostly negative impacts for major cereal crops, including maize for the summer rainfall region, and wheat for the winter rainfall region. Crops sensitive to changes in temperature may have been affected by climate change impacts, however farmers have responded by using shade netting and evaporative cooling, or shifting to alternative crops (Ziervogel et al., 2014).

Unlike most of the rest of Africa, South Africa's agriculture depends largely on irrigation. Only 12% of the land is considered suitable for rain-fed farming and less than 3% of the land is deemed truly fertile (DEA, 2017a). South Africa Traditional and commercial input-intensive agriculture is associated with many negative environmental, economic, and social externalities which undermine it as a sustainable model. Agriculture is however a major contributor to South Africa's GDP and employment, accounting for about 12% and 30%, respectively of GDP and employment in the country. A climate resilient response to agriculture recognizes that beyond food, agriculture should provide environmental and socio-economic benefits. Some of the key responses for the agriculture sector range from the integration of agriculture into climate resilient development planning in the rural areas, to the use of early warning systems to provide timely cautions of adverse weather, and occurrence of pest and diseases, as well as educating and creating awareness in rural areas and linking it to agricultural extension activities (DEA, 2011). The plan for the agriculture sector is to develop a Climate Change Response Strategy in line with the National Adaptation Strategy by 2019, as well as to assimilate priorities of

the strategy into South Africa's 2019 Mid-Term Strategic Framework (MTSF). Implementation priorities for the agriculture sector range from identifying Flagship Projects to addressing main vulnerabilities to be included in the 2019 Mid-Term Strategic Framework (MTSF), as well as developing Disaster Risk Reduction Strategy and Instruments for the agriculture sector in 2020 (DEA, 2017a).

5.2.2 Water

Water is the main medium through which climate change impacts are being felt in South Africa (DEA, 2017). South Africa is water scarce and has one of the lowest run-offs in the world. Furthermore, 98% of the country's available water resources are already allocated and the country is already dealing with water stress. This situation is expected to be exacerbated by future drying trends, cycles of droughts as well as erratic and excessive rainfall. The water problem facing South Africa is not only an issue of water availability, the country also faces an issue of water quality. The quality of freshwater resources in the country has been falling steadily due to the growing population. As high as 40% of the freshwater systems are in a critical condition while 60% are threatened. Under an unmitigated emissions pathway, preliminary projections under the wide range of scenarios generated for runoff range from a 20% decrease to a 60% increase by as early as 2050, while under constrained emissions scenario projections of runoff range from a 5% decrease to a 20% increase (DEA, 2017a; DEA, 2016a).

The country's variable climate and climate change will have austere consequences for water resources, as rising temperatures will cause parts of the country to be drier,

leading to increased evaporation which will consequentially affect water availability. The country shares four of its main river basins with bordering countries- Botswana, Mozambique, and Zimbabwe, and the Orange river with Lesotho and Namibia. These shared catchments accounts for about 60% of South Africa's surface and around 40% of its average total river flow. Current projections reveal that by 2050, the country will surpass the limits of economically viable land-based water resources (DEA, 2011).

Furthermore, reduced water availability in the country will substantially affect other sectors- human health, agriculture, mining, forestry and energy- that depend on water resources. There must be a balance amongst major competing users of water resources whilst safeguarding access to potable water for people. Rainfall, which is likely to become more variable, and the increase in the occurrence of extreme events such as droughts and flooding will lead to a much more variable runoff regime. Downscaled climate modelling shows that the western and interior part of the country will become drier, and the eastern part is expected to become wetter. Excessive rainfall intensity will result in scouring in rivers and sedimentation in dams which may affect water supply and water infrastructure (DEA, 2011). Rising climate variability and climate extremes will affect both water quality and availability. The country has been facing bouts of drought since 2015, which resulted in reduced agricultural yields and water restrictions, and consequently affected food and water security (DEA, 2017). Changes in water supply and availability will have adverse consequences for people, ecosystems, and the economy (DEA, 2011).

The short-term climate change adaptation plan for the water sector was developed through the National Water Resource Strategy which played a central role in the government's Integrated Water Resource Planning process. The Integrated Water Resource Planning process guides and inform the maintenance of the water balance reconciliation strategies for water management areas. The process is applied to water supply systems of about 75% of the country's population and the areas that generate over 80% of South Africa's GDP (DEA, 2011). In the medium to long-term, the Water for Growth and Development Framework was established and has a planning horizon up to 2030. This focuses on the role of water resources in poverty reduction and safeguarding the constitutional right of people to safe and reliable water supply, as well as on the role of water in sectors crucial for the country's economic development. South Africa has a two-fold approach to adaptation planning in the water sector, the first is to use climate change as a channel for tackling inadequacies in the water sector and promoting the execution of effective and sustainable water resources and services management measures in the short-term. Secondly, to have a long-term strategic focus on adaptation and adopt proactive approaches to managing water resources (DEA, 2011). Some of the key responses for the water sector include the incorporation of climate change issues in the short to long-term water planning processes across key sectors, the management of water adaptation measures from a regional perspective in view of the transboundary nature of main rivers in the country, the exploration and exploitation of new and unused water resources, and the reduction of the vulnerabilities of communities and sectors at greatest

risk from water-related climate change impacts, among others (DEA, 2011). The plan for the water sector is the development of the National Water Resource Strategy by 2020 which will be informed by the National Adaptation Strategy and the Climate Change Response Strategy for the Water Sector. Implementation priorities for the water sector include the identification of priority areas for Ecosystem-based Adaptation (EbA) for inclusion in South Africa's 2019 Mid-Term Strategic Framework (MTSF), and the identification of Flagship Programmes to implement that address water quantity and quality issues (DEA, 2017a).

5.2.3 Energy

South Africa's economy is highly energy-intensive mostly because of the dependence on mining activities such as extraction and processing. The climate change and energy discussion in the context of South Africa has focused largely on mitigation, i.e. the need to curtail GHG emissions and the shift from non-renewable energy sources to renewable energy, low carbon technologies that promote energy efficiency. Although the impacts of climate change have not been studied extensively in South Africa; nevertheless; climate change poses a risk to South Africa's coal-dominated energy sector. Water is essential to coal mining as many processes ranging from coal extraction, dust control, coal washing, to slurry dam evaporation, require large volumes of water. Thermal energy generation from coal-fired power-plants requires large volumes of water for plant operations, and for processes such as steam cycle, cooling, air pollution control, and disposal of by-products (DEA, 2017a; DEA, 2016a).

Variations in water availability in river catchment areas and changing flow regimes because of climate change will put hydropower facilities at risk. Several regions in the country are already experiencing water stress which will be worsened under climate change. For many of the river basins, water is being drawn faster that it can be naturally replenished. For coal mines and coal-fired power stations to receive enough water, water supply will have to be augmented from far away plants, through pipelines and pumps. This results in higher costs which will escalate under climate change because of more pressure on limited water supply (DEA, 2017a; DEA, 2016a).

Eskom, South Africa's power utility has a climate change policy as well as a climate change strategy. Eskom uses approximately 2% of South Africa's water for electricity generation (water in the coal mining sector is excluded) and uses in seven seconds the same quantity of water that an average South African household will use in a year (DEA, 2016a). Eskom has conducted a climate change risk and vulnerability assessment and has developed climate change adaptation strategies for its operations; however, there is a need for the Department of Energy to conduct assessment and develop strategies for the whole sector at the national level of government. Few local governments have established climate strategies for the energy sector. Given the key role of South African municipalities as energy service providers, climate change adaptation in the energy sector at this level of government should be tracked and evaluated. The national plan for the energy sector includes the Integrated Energy Plan and the Integrated Resource Plan which operationalized the National Energy Act of 2008 and Section 34 of the Electricity Act.

The current plan is to develop the Climate Change Response Strategy for the Energy Sector by 2020 and align South Africa's Mid-Term Strategic Framework (MTSF) for 2019 with the National Adaptation Strategy and Climate Change Strategy. Adaptation priorities for the energy sector include supporting the implementation of resilience measures by Eskom (DEA, 2016a; DEA, 2017a).

5.3 Institutions and Governance

Climate change governance in South Africa is shaped by various international, national, and sub-national bodies. Climate change projects are implemented across all levels of government- national, provincial, and local. At the national level, the Department of Environmental Affairs (DEA) is tasked with climate change policy planning and implementation. The DEA is responsible for international negotiations involving climate change and, oversees the preparation of the National Climate Change Act, National Climate Change Response Policy and the National Adaptation Strategy, the revision and proliferation of climate change legislation, the establishment and enforcement of legal and regulatory institutions, as well as the allocation of resources to address climate change. Although the DEA is the nodal department, it works with other governance structures, institutions, and departments to implement the National Adaptation Strategy. National departments in charge of climate related sectors are assigned the responsibility for incorporating climate change into their policies and programmes. Asides from government departments, public sector enterprises such as Eskom play key roles in the country's economic infrastructures /industries, and as such are tasked with developing

adaptation plans. These government departments in conjunction with related parastatals, several interdepartmental and institutional structures, aim to increase coordination and align national efforts on climate change and development. Intergovernmental collaboration and cooperation are regulated by South Africa's Inter-Governmental Relations Framework Act (2005), and coordination between the national and local governments is enabled through the South African Local Government Association and the Department of Cooperative Governance and Traditional Affairs (CoGTA) (DEA, 2017a; DEA, 2016a).

Every province has a provincial environmental department that oversees the environmental issues and is tasked with formulating and administering climate change responses. Key sectors such as water, fisheries, energy, and mining are the constitutional responsibility of the federal government, and as such the provincial climate change response for these sectors is led by the provincial offices of the related national departments. Climate change response capacity is limited at the provincial level, and as such mitigation and adaptation efforts are not clearly differentiated. Many actions necessary to respond to climate change fall under the responsibility of the local government. The National Disaster Management Framework has existing institutional arrangements empowers municipalities to respond to climate change. Under this, the Municipal Disaster Management Centre is responsible for establishing a progressive risk profile for municipalities. Furthermore, the Municipal Climate Change Support Programme has been introduced to foster capacity building and strengthen institutional

structures around climate change. The local government's role in responding to climate change is also spelt out in South Africa's Let's Respond Toolkit- created to empower local governments to use the existing mandate to effectuate climate change resilience. It has also become a central tool to influence the mainstreaming of climate change into the integrated development planning process at the local level (DEA, 2017a; DEA, 2016a).

Regarding coordination of climate change actions within the government, both horizontal (coordination within and across the different departments) and vertical (coordination among the different levels of government e.g. national, provincial, and local) coordination exists. At the national level, institutional and legislation fragmentation hinder horizontal coordination. Furthermore, many of the national government departments, except the DEA, do not regard climate change as a priority. The NCCRP addresses this and advocates alignment across government levels; the DEA is also in the process of developing a Monitoring and Evaluation Framework for climate change adaptation to guide integration; however, the translation of policy to implementation is lacking. Vertical coordination faces challenges that are inherent to the structure, design, and function of the different levels of government, which has not been brought about by climate change (DEA, 2016a).

The roles of the different levels of government and other relevant stakeholders are clearly articulated; the DEA is responsible for coordinating all activities and collaborating with all stakeholders on adaptation; and climate-related national departments are tasked with developing sector adaptation plans and strategies as well as reporting on

implementation. Provincial governments are responsible for developing provincial adaptation strategies and providing updates and reports; and local governments will work with provincial governments and will also reporting on the implementation of the provincial strategies. Climate-related government agencies are tasked with developing strategies and operational plans for adaptation and providing periodical reports on implementation. In addition, business and civil society are responsible for developing strategies and operational plans for responding to climate change, and reporting periodically on implementation efforts (DEA, 2016a).

5.4 Climate (Adaptation) Finance

Responding and adapting to climate change requires financial resources. Adaptation finance refers to "all resources that finance the cost of transitioning South Africa to climate resilient economy and society which is inclusive of both climate specific and climate relevant financial resources, public and private, domestic and international" (DEA, 2017a, p. 57). The costs associated with climate research, technology transfers, monitoring systems, and capacity building should be included in adaptation finance because they are key elements of adaptation. South Africa's climate responses are contingent upon the availability of and access to international climate finance and investment. Financing the cost of adaptation in South Africa involves creating and/or accessing mechanisms such as climate funds, and investment strategies and frameworks. The country recognizes the need to complement domestic resources with international resources such as the ones developed under the UNFCCC to finance the cost of adapting

to climate change, building capacity, and transitioning to a climate resilient economy. The country aims to capitalize on potential sources of financial assistance such as bilateral and multilateral funds, among others. The country, however, does not yet possess an effective and transparent system to record funds expended on adaptation and mitigation. There is also no complete database of adaptation and mitigation projects, making it problematic to track and monitor where climate funds are spent and difficult for decision-makers to clearly identify investment needs (DEA, 2017a; DEA, 2016a).

South Africa's DEA is responsible for environmental, climate and sustainable development policy and works through the Intergovernmental Committee on Climate Change to integrate climate action into broader government structures and processes. The DEA collaborates with other national departments and the Multi-Stakeholder Technical Working Group to facilitate a comprehensive financing partnership between the private and the public finance sector. Financial institutions such as the Development Bank of Southern Africa, The Banking Association of South Africa, insurance companies and micro-finance banks all represent sources of potential adaptation funding. The National Business Initiatives guide South Africa's private sector climate change agenda by providing relevant information and research about climate change risks and opportunities, thereby aiding in capacity building. Although there is no coherent budgeting process or funding for climate change action, adaptation initiatives are spread across government departments in South Africa and these initiatives may not necessarily be tagged as adaptation projects (DEA, 2016a). In some cases, it is impossible to separate whether

funding, particularly international climate financing, contributes towards a lower carbon economy (mitigation) or to climate resilience (adaptation) (DEA, 2016b).

Climate change adaptation is primarily financed through direct budgetary allocations for expenditure on research programmes and activities that contribute directly to building resilience. Special funds are not set aside to finance climate change adaptation at the provincial and local levels. Some provinces have however identified ways to raise money to finance climate change related objectives and imperatives. Despite the lack of a standardized funding mechanism in South Africa, the country still benefits from many formal and informal international climate finance (DEA, 2016a).

South Africa's Green Climate Fund presents the country with the opportunity to access financial support to drive the national climate change response (DEA, 2017b). Green Climate Fund (GCF) serves as a financial mechanism within the UNFCCC and the fund supports developing countries in formulating adaptation and mitigation strategies (DEA, 2016a). To fully benefit from the opportunities presented by the GCF, a national GCF Strategic Framework was developed to facilitate clear engagement with the GCF and ensure that investments are aligned with national climate change priorities (DEA, 2017b).

South Africa is a key beneficiary of international climate finance and has received 17% of the multilateral funds approved for sub-Saharan Africa since 2003, which stands at approximately $600 million. Most of the international finance received by the country is targeted at mitigation and has supported Eskom's renewable energy program (CFU,

2017). Some of the funding mechanisms targeted at adaptation in South Africa, both multilateral and bilateral, include:

The Adaptation Fund is established under the UNFCCC to support adaptation projects and initiatives in developing countries which are party to the Kyoto Protocol and are highly vulnerable to climate change impacts. South African National Biodiversity Institute (SANBI) is tasked with using the fund which is particularly directed at vulnerable communities. The fund is being used to finance the uMngeni Resilience Project which costs about US$7.5 million, and the Community Adaptation Small Grants Facility Project which costs about US$2.4 million (DEA, 2017b; DEA, 2016a).

The Global Environment Facility (GEF) is also a financial mechanism under the UNFCCC which supports the execution of multilateral environmental agreements. The GEF is the most significant source of climate finance for South Africa, and it dispenses other UNFCCC funds, such as the Least Developed Countries Fund and the Special Climate Change Fund (DEA, 2016a).

There are several other financing mechanisms, such as the United Kingdom's International Climate Fund which helps developing countries to adapt to climate change and promotes low-carbon growth. Germany's International Climate Initiative funds and supports climate change mitigation and adaptation projects to facilitate private investments; and Japan's Fast Start Finance funds sustainable economic growth in developing countries. South Africa has benefitted from the abovementioned funding

mechanisms but is yet to benefit from the Adaptation for Smallholder Agriculture Programme (DEA, 2016a).

The private sector through investments in sustainable farming practices and building ecological infrastructure promote adaptation activities. Financing climate change adaptation can also come in the form of grants, equity, concessional and non-concessional loans, and debts. These instruments or a combination of these instruments can be used by both the public and private sectors to finance adaptation (DEA, 2017a).

5.5 Ethiopia

Ethiopia, the second most populous country in sub Saharan Africa has a population that is approaching 100 million (Irish Aid, 2016). Although the economy has experienced rapid economic growth in recent years, averaging almost about 11% per year from 2004/05 to 2012/13, the per capita income has stayed below the average in sub Saharan Africa. An estimated 7 million of the population remain food insecure particularly in drought prone areas. Agriculture is the pillar of the economy and employs approximately 80-85% of the population; it also accounts for between 40-45% of total GDP, with livestock and livestock products accounting for about 20% of agricultural GDP (Echeverria & Terton, 2016; Irish Aid, 2016). Approximately 16.4 million hectares, or 14.6% of Ethiopia's total land mass is arable land; and about 8 million hectares of the 16.4 million hectares are used for agricultural production. Drylands cover approximately 75% of the total landmass in Ethiopia with about one third of the Ethiopian population residing in drylands (Chinasho et al, 2017). About 84% of the Ethiopian population lives in rural

areas and relies on agriculture and natural resources for their livelihood (Echeverria & Terton, 2016; Milman & Arsano, 2014).

Ethiopia's per capita emission of less than 2-ton CO2e is low when compared with other countries such as United States and Australia with more than 20 ton. The country's total emission of about 150 Mt CO2e is negligible and makes up less than 0.3% of global emissions (Weldegebriel & Gustavsson, 2017). The country has a long history of coping with extreme weather events; particularly because of its location in the Sahel Region – a region prone to unstable precipitation and unpredictable climatic-related events, the country faces severe and pervasive drought (Nkoana et al., 2013). The country has experienced seven major droughts, five of which resulted in famines and about six major flood events since the early 1980's. The arid, semi-arid and dry sub-humid parts are the most affected by drought in the country (Gashaw et al., 2017; Milman & Arsano, 2014). Rising occurrence of extreme weather events in the 20th century heightened attention towards climate change issues in the country (Weldegebriel & Gustavsson, 2017). These extreme events have adverse impacts for the country's economy, food production, as well as livelihoods of people (Gashaw et al., 2017; Milman & Arsano, 2014). The World Bank predicted that climate change may cause the GDP of Ethiopia to fall when compared to a baseline scenario by 2% to 6% in 2015, and by up to 10% in 2045 (Gashaw et al., 2017).

The most sensitive sectors to climate change and variability in Ethiopia include agriculture, water, and human health. Agriculture accounts for about 80% of Ethiopia's emissions and next is the energy sector which contributes 15% to the country's total

emissions (Keller, 2009). Climate change is already happening in Ethiopia, and the country has experienced a rise in temperature of about 0.2° C per decade over the last few decades. This increase in temperature is now more distinct at about 0.4° C. There will be a rise in the number of "hot" days and "hot" nights in a year, these "hot" trends will persist in Ethiopia (Irish Aid, 2016). Rainfall has remained relatively steady over the last 50 years. Projections for future changes show that variations in precipitation are insignificant and uncertain while the temperature will continue to get warmer over the next few decades (Irish Aid, 2016; Keller, 2009). By the end of 2015, the country was facing its worse drought in fifty years because of the global El Nino, which adversely affected the two rainy seasons of the year. Between 1990 and 2006, the average annual temperature increased by 1.3° C. The UNDP climate change country profiles projected an increase in the average annual temperature by 1.1 to 3.1° C for Ethiopia by the 2060s (Echeverria & Terton, 2016; Irish Aid, 2016; McSweeney, Luzcano, & Lu, 2010).

5.6 Adaptation Planning

Ethiopia is part of the LDCs, and characterized by limited adaptive capacity, pervasive poverty, as well as inadequate human, infrastructural and economic conditions. The country's National Meteorological Agency developed a NAPA in 2007 as part of the LDC work. The objective of the NAPA was to identify priority activities to respond to urgent and immediate climate change adaptation needs. African countries including Ethiopia that are part of LDCs have submitted NAPAs at the time of writing (as of March 2018 – UNFCCC Database). These country-specific documents are provided by LDCs

under the guidance of the UNFCCC and are drawn up to expedite adaptation in the countries with most persistent climate-related vulnerabilities. (Irish Aid, 2016; Norford, 2009; UNFCCC COP7, 2002). Ethiopia's 2007 NAPA identified several priority climate change adaptation measures but water security, a major challenge facing Ethiopia, received little attention in the country's 2007 NAPA document. The Ethiopian Programme of Adaptation to Climate Change (EPA-CC) was developed to replace the NAPA and address its shortcomings (Adenle et al., 2017).

In 2011, Ethiopia introduced a green economy and climate resilient strategy through Ethiopia's Climate-Resilient Green Economy (CRGE). The objective is to realize middle-income status by 2025, while developing a green economy. The country aims to achieve economic development in a sustainable manner with the CRGE strategy following a sectoral approach. To achieve the goal of reaching the middle-income status, agricultural development will continue to be the basis for economic development. The CRGE which is Ethiopia's strategy for dealing with climate change adaptation and mitigation identified three complementary objectives for the country, promoting economic growth and development, reducing current GHG emissions and avoiding future emissions, as well as enhancing resilience to climate change. Ethiopia's long-term adaptation goal is to mainstream climate change considerations into its development objectives (USAID, 2016). Mainstreaming is a development-oriented approach to climate change adaptation and is often described as a holistic or "development-first" approach which promotes the integration of adaptation and mitigation needs into development agenda (Oates et al.,

2011). The CRGE comprises two components- climate resilience (adaptation) and green economy (mitigation). Building resilience in the agricultural sector is a priority under the climate resilient strategy of the CRGE, as agriculture is one of the mainstays of the country's economy (Amsalu et al., 2014). The two most noteworthy stressors for the country are drought and flooding. Consequently, Ethiopia's Intended Nationally Determined Contributions identifying several options ranging from increasing water use efficiency, increased agricultural productivity and diversity, as well as creating construction codes to reflect extremes in flooding in order to tackle these key stressors (USAID, 2016).

Ethiopia, through its Growth and Transformation Plan (GTP), has established resolute goals for economic development and poverty reduction because it recognizes that attaining these goals will depend largely on addressing and responding to current climate change, as well as preparing for future climate change. The GTP emphasized the need to improve natural resources conservation and management and promoted forestry sector activities ranging from multipurpose tree planting, to restoration of degraded lands through exclosures, among others (Kassa et al., 2015). Furthermore, the agricultural sector and the energy sector are central to the country's adaptation and development pathway (Milman & Arsano, 2014). Ethiopia has introduced policies and strategies to improve adaptive capacity as well as to reduce vulnerability to climate change. Ethiopia's NAPA shaped the CRGE (Gashaw et al., 2017). The responsibility of handling climate change has moved from the National Meteorological Agency to the Environmental Protection

Authority which has become a ministry and is responsible for establishing "Ethiopia's Climate Resilient Green Economy (Conway & Mustelin, 2014).

The country, through its NAPA, has identified twenty priority project ideas that could tackle its urgent and immediate adaptation needs. These projects aim to improve human and institutional capacity, as well as natural resource management, strengthen early warning systems as well as improve irrigation agriculture and water harvesting. The government has established adaptation measures in agriculture, hydropower, and roads. Some of the adaptation options include but are not limited to, increase of research for agriculture, increase of irrigated area, and adjusting plans for the development of hydroelectric power to suit the time or volume of investment (Gashaw et al., 2017, p.149). Adaptation plans and strategies for the current/near term range from the Climate Resilient Green Economy Strategy, National Adaptation Programme of Action, and the Ethiopia Programme of Adaptation to Climate Change to address climate change adaptation. Furthermore, nine regional and city adaptation plans, and five sectoral plans have also been developed. The country also has an agriculture sector adaptation plan (USAID, 2016). Since Ethiopia suffers from cycles of drought and flooding, the country's INDC identified plans and actions targeted towards adapting to droughts and floods. Other adaptation plans, and actions include establishing insurance systems against losses and damages caused by extreme events for citizens, particularly farmers and pastoralists, adopting an integrated pest management to address the impact of fire and pest epidemics

on livelihoods and ecosystems, and developing early warning systems and disaster risk management policies to promote resilience (USAID, 2016).

Ethiopia has started a broad hydro-power development program, ranging from major dams on the Blue Nile, Atbara, to Gibe Rivers. Some of the dams are arranged as cascades of dams in series and some as dams on parallel rivers (Gashaw et al., 2017). Some potential adaptation policy adjustments involve changing the scale and timing of planned projects and restricting the downstream flow as well as the irrigation flow. The cost of additional investment required to match Ethiopian base-energy production is assumed to be the adaptation cost for the energy sector (Gashaw et al., 2017).

5.6.1 Agriculture

Agriculture is the major contributor to GHG emissions in Ethiopia (Weldegebriel & Gustavsson, 2017). The central role of agriculture in the Ethiopian economy is apparent as it accounts for 41% of GDP, 90% of exports and employs about 85% of the population. Agriculture and forestry account for 50% and 38% of GHG emissions respectively. By 2030, the country plans to restrict its net GHG emissions to 145 Mt CO2e, which would represent a 64% reduction from the Business as Usual (BAU) emissions level in 2030. Climate change will cause the crop maturity period to shorten and reduce agricultural yields. This will adversely affect agriculture productivity with rainfall variability and consequential decrease in yields causing substantial loss to the Ethiopian economy. This loss is estimated at about 38% of the country's potential growth rate and an increase in poverty by 25%. The economy depends largely on agriculture, and climate change will

have negative consequences for agriculture and eventually cause the country's GDP to fall by 3% to 10% by 2025. Warmer temperature is beneficial to pastoral farming but is detrimental to crop farming in Ethiopia. Variations in precipitation due to climate change have adverse effect for agriculture, impacting both crop and livestock. As temperature rises and precipitation declines, revenue from agriculture will decline. The Ethiopian government has declared increasing agricultural productivity as a priority and has introduced policies to promote climate change adaptation through agricultural intensification (Weldegebriel & Gustavsson, 2017).

Climate change adaptation in the agriculture sector in Ethiopia has been happening and is not a new occurrence. Adaptive strategies have been practiced both at macro and micro scales. Some of the macro-level strategies range from early warning and response mechanisms, natural resource management-based adaptation mechanisms, safety net programs, to weather index insurance mechanisms. Micro-level adaptation in the agricultural sector include changing planting dates, increasing use of soil and water conservation techniques and/or soil erosion prevention programs, and increasing use of irrigation techniques, among others (Weldegebriel & Gustavsson, 2017).

Most empirical studies have focused on climate change adaptation in the agricultural sector at a micro-level. This is mainly because 90% of Ethiopia's agriculture is represented by small-scale, mostly subsistence farmers who rely on rain and traditional technologies. Agriculture, being mainly reliant on rain-fed agriculture and traditional technologies, will be affected by low water storage capacity. It is pertinent to develop a

long-term adaptation strategy that will facilitate transitioning from on-farm activities to more productive, more commercially viable agriculture and agro-industries in the rural areas (Weldegebriel & Gustavsson, 2017; Climate Risk and Adaptation Country Profile: Ethiopia, 2011). Climate change adaptation policy and efforts in the agriculture sector in Ethiopia should focus on improving farmers' knowledge about climate data and information as well as weather information so as to apply this knowledge to agricultural activities, introducing programs that encourage improved farming practices, such as drought resistant and early maturing crop varieties, encouraging small-scale irrigation and water harvesting in drought prone areas, and encouraging diversification of off-farm activities to increase alternative household income sources (Climate Risk and Adaptation Country Profile: Ethiopia, 2011).

Ethiopia's NAPA has identified several priorities for agriculture, such as improving rangeland resource management practices in pastoral areas and promoting farm and homestead forestry and agro-forestry practices in arid, semi-arid, and dry sub-humid regions (Climate Risk and Adaptation Country Profile: Ethiopia, 2011). The agriculture climate resilient strategy focuses on identifying the effect of current and future weather variability for the country, identifying the financial costs of strengthening climate resilience and adapting to the impacts of climate change and variability, as well as identifying means of financing and implementing climate action to build resilience (Amsalu et al., 2014).

Moreover, the country addresses cycles of drought and food insecurity in the country by introducing the Disaster Management and Food Security Agency, as well as by developing a National Policy and Strategy on Disaster Management (Irish Aid, 2017).

5.6.2 Water

Ethiopia has twelve main river basins and is believed to be the "water tower" of North East Africa (Climate Risk and Adaptation Country Profile: Ethiopia, 2011). The country is relatively water endowed when compared with many countries in Africa; however, the spatial and temporal distribution of water resources is disproportionate causing certain places and times of the year to experience dryness and water scarcity. Four major river basins- Abay (Blue Nile), Tekeze, Baro Akobo, and Omo and Omo Gibe- house between 80%-90% of the country's water resources. These rivers are in the west and southwest of the country and only about 30%-40% of the populace lives in these waters endowed regions. The country is unable to capitalize on its abundant water resources because of limited water storage capacity (Weldegebriel & Gustavsson, 2017; Climate Risk and Adaptation Country Profile: Ethiopia, 2011). Climate change is expected to decrease the run-off to Nile tributaries (Abay and Awash rivers) by up to one third. It is estimated that a 14% decrease of runoff will likely result in a 3% increase in rainfall and 1.7^{o} C rise in temperature, and a 11% runoff reduction is likely to result in a 6% increase in precipitation and 2.6^{o} C rise in temperature by mid-century. Decrease in run-off has significant consequences for flow into the hydropower generation

(Weldegebriel & Gustavsson, 2017; Climate Risk and Adaptation Country Profile: Ethiopia, 2011; Kim et al., 2008).

The rivers in the country present the characteristics of tropical rainfall-dependent flow regimes, with the spatial and temporal distribution of precipitation responsible for controlling the amount and intra- and inter-annual variability of water availability (Weldegebriel & Gustavsson, 2017). Ethiopia is regarded as economically and technically water-scarce, this is because the water sector is highly susceptible to climate variability, and this is worsened by demand by a rapidly growing population for scarce water resources (Weldegebriel & Gustavsson, 2017). Climate change will affect the country's water resources through reduction in river run-off, fall in capacity to generate energy, and increase in the occurrence of floods and droughts. Climate change can also make transboundary water management more difficult, it is imperative that transboundary water agreements recognize the significant effect of climate change on water resources and formulate and implement policies that will promote climate change adaptation (Arbour, Thomson & Zaky). Adaptation strategy and policy in the water sector in Ethiopia should include; carrying out assessments to track inventory of water quality and quantity for surface and underground water, promoting improved methods of water conservation, storage, and rational use, establishing watershed management and water conservation projects, using soil conservation measures that reduce soil erosion and protect water sources and introducing methods for flood protection and maintenance of flood control structures (Climate Risk and Adaptation Country Profile: Ethiopia, 2011). Water

resources in Ethiopia reveal that factors such as urbanization, development and intensification of the agricultural sector, and extraction and use of natural resources will have to step up to meet the water needs of a rapidly growing population (Weldegebriel & Gustavsson, 2017). Changes in land use in semiarid areas usually lead to severe alterations in the water balance and affect water demand. As a result, future water requirements and availability are closely associated to land use. Population increase coupled with climate change will worsen soil erosion, deforestation, desertification, degradation of water quality as well as depletion of water resources which will consequentially exacerbate the problem of food security in many developing countries, including Ethiopia (Weldegebriel & Gustavsson, 2017).

Of the eleven adaptation priorities identified in Ethiopia's NAPA, five were related to the water sector (Oates et al., 2011). They include reinforcing and improving the drought and flood early warning systems, developing community-based sustainable utilization and management of wetlands in some regions, creating small-scale irrigation and water harvesting schemes in arid, semi-arid, and dry sub-humid areas, achieving food security by embarking on a multi-purpose large-scale water development, and developing a community-based Carbon Sequestration Project in the Rift Valley System (Climate Risk and Adaptation Country Profile: Ethiopia, 2011). Adaptation strategies for water resources at the country level should encompass all the steps of the adaptation chain- prevention, improving resilience, preparation, reaction/ response, and recovery (Weldegebriel & Gustavsson, 2017).

The agriculture sector strongly depends on water resources, and as such adaptation in the sector to climate variability focuses on water usage and management. The country's EPACC adaptation priorities focused on expanding small-scale irrigation schemes with attention to medium- to large-scale irrigation, improve water shade management, and improve conservation and management of natural resources by increasing capacity (Echeverria & Terton, 2016).

5.7 Institutions and Governance

The National Meteorology Agency (NMA) and the Environmental Protection Authority (EPA) handled early climate change related initiatives in Ethiopia. The National Meteorology Agency was responsible for climate change negotiations until 2009 when this responsibility was moved to the Environmental Protection Authority. The EPA was responsible for producing the country's NAPA (National Adaptation Programme of Action) and NAMA (Nationally Appropriate Mitigation Actions) and has since been restructured to become the Ministry of Environment and Forests (MEF) (Amsalu et al., 2014; Martinez, 2011)

The CRGE strategy, along with required finance and institutional arrangements, are necessary to realize the country's goals of economic growth, reduced emissions and strengthened resilience (Amsalu et al., 2014). The CRGE strategy was developed under the leadership of Ethiopia's former Prime Minister Meles Zenawi. The lead institutions for the CRGE strategy include The Prime Minister's Office (PMO) which provides policy leadership, the Ministry of Finance and Economic Development (MoFED) which

administers the CRGE Facility and the financing of the strategy, and the Ministry of Environment and Forests (MEF) which is tasked with providing technical guidance for CRGE activities (Amsalu et al., 2014; Martinez, 2011). The Prime Minister's Office recommends laws and regulations and can approve environmental standards and directives. The Ministry of Environment and Forests (MEF) is responsible for carrying out independent measurements, reviewing, verifying, and implementing guidelines and procedures, as well as selecting proposals to consider for financial support. The Ministry of Finance and Economic Development (MoFED) is tasked with mobilizing financial support from international sources and ensure transparency and compliance with international agreements (Amsalu et al., 2014; Martinez, 2011).

Climate change is an economy-wide issue, and as a result the Ministry of Finance and Economic Development and the Ministry of Environment and Forest collaborate on implementing the CRGE strategy. Several climate related ministries such as the Ministries of Water, Irrigation and Energy, and the Ministry of Agriculture, among others, are involved with the coordination and implementation of the CRGE climate strategy in Ethiopia. Transformation of the institutional architecture of the government is necessary for the successful implementation of Ethiopia's CRGE strategy. CRGE units have been established in climate related ministries to coordinate sectoral planning and activities at the regional, state and community levels (Amsalu et al., 2014; Martinez, 2011).

Although Ethiopia's CRGE strategy is government led, many private sector and civil society organizations have also contributed to its implementation (Colvin & Mukute,

2018). The implementation of the CRGE is sector-based and has adopted the sectoral reduction mechanism (SRM). A three institutional arrangement supports the sectoral reduction mechanism (SRM) in Ethiopia: An Inter-Ministerial Council, the CRGE Technical Committee, and the CRGE Facility Secretariat. The Inter-Ministerial Council is made up of representatives from related ministries, the CRGE Technical Committee consists of high-ranking government officials from the related ministries and the National Planning Commission, and the CRGE Facility Secretariat is under the leadership of a state minister within MoFED, and others such as a director, coordinator, finance, and technical team who are responsible for carrying out various CRGE functions (Amsalu et al., 2014).

5.8 Climate (Adaptation) Finance

Excluding financial resources directed to the funding of climate change by the government to fully implement Ethiopia's INDC, the country will require international support and investments in the form of finance, capacity building and technology deployment (USAID, 2016; Eshetu et al., 2014). An estimation of the costs of adaptation to climate change in Ethiopia reveals that it could amount to an average of $258 million per year between 2010 to 2050, over and above existing pledges of Official Development Assistance (ODA) (Martinez, 2011). Substantial public investment is necessary for climate related government ministries and agencies to strengthen their capacity to successfully implement climate change programmes and projects at all levels of government. Climate change adaptation is primarily financed through direct budgetary allocations to ministries and agencies that are charged with implementing climate change

programmes. Ethiopia is responsible for most of the spending to address climate change (Eshetu et al., 2014). The second Africa adaptation gap report reveals that the average annual percentage share of climate change–related expenditure in the country between 2008 to 2012 was 15% of total government expenditure (Echeverria & Terton, 2016, p.30; UNEP, 2016).

To achieve the goal of becoming a middle-income country by 2025, the country established the CRGE Facility to fund and support the implementation of priority initiatives established in the CRGE. The CRGE Facility being a single financing mechanism, will successfully coordinate, administer, and manage international climate finance, donor funds, and domestic funds. The estimate of funding expected to be mobilized by the government of Ethiopia to implement the CRGE falls at $200 billion from various sources, ranging from international, national, public, and private, over the next 20 years (Eshetu et al., 2014). This Facility supports and facilitates climate change activities and financing in a systematic manner and serves as an engagement point where all relevant stakeholders and actors such as the government, private sector, civil society, and others can collaborate and make decisions and consequentially enhance aid effectiveness. Furthermore, the facility will also reduce transaction costs and duplication of projects (Eshetu et al., 2014).

The CRGE Facility is managed by the Ministry of Finance and Economic Cooperation, under strategic directions established by the Environmental Council and the CRGE Ministerial Steering Committee. The Facility comprises of two functional

components- financial and technical, and the Ministry of Finance and Economic Cooperation is tasked with the overall administration of the finance section, while the Ministry of Environment and Forests is responsible for the technical coordination. Funds channeled through the Facility will support ministries and regional governments in the implementation of planned programmes and projects, as well as support demand-driven initiatives by non-state stakeholders, such as civil society, who are in collaboration with federal and regional entities. About 75% of the Facility's fund will be targeted towards the implementation of government priorities, as specified in the CRGE strategy, and 25% will contribute to other activities identified by non-state actors (Simane & Bird, 2017; Eshetu et al., 2014).

The CRGE strategy calls for climate related expenditure of $7.5 billion annually for Ethiopia to address climate change, current budgetary allocations for climate related spending however stands at around $440 million annually while current financial resources mobilized from international sources stands are valued at $432 million reflecting a huge financing gap for the country (Echeverria & Terton, 2016). According to the Climate Funds Update Website, approximately $110 million has been approved as multilateral funds to Ethiopia between 2002 and 2017, this amount represents about 3% of total funding to sub-Saharan Africa over that period. The Least Developed Countries Funds (LDCF), the Adaptation Funds (AF), and the Adaptation for Smallholder Agriculture Programme (ASAP) account for most of the multilateral climate change adaptation finance in Ethiopia. As high as 27% of the multilateral fund to the country is

targeted towards energy generation and supply, particularly from geothermal and other renewable sources. Multilateral finance towards general environmental protection stands at 25%, and for forestry at 20%. Interestingly, the agriculture and water and sanitation sectors, which have been identified as priorities because of the high and direct vulnerabilities to climate change impacts, receive only 7% and 6% of the total multilateral funding in the country, respectively (CFU, 2017, Caravini et al., 2017).

Table 5.1 below provides a quick synopsis of the three crosscutting issues examined.

Table 5.1 Status of Climate Change Adaptation in South Africa and Ethiopia

Crosscutting Issues/Country	**South Africa**	**Ethiopia**
	Climate Risks ❖ Prolonged and pervasive droughts ❖ Increasing rainfall variability ❖ Rising temperature **Key Sources of Vulnerability** ❖ Reliance on fossil fuel (coal) ❖ High level of water insecurity ❖ Risk to agricultural productivity and livestock ❖ High poverty and inequality levels	**Climate Risks** ❖ Increased intensity of drought ❖ Increasing rainfall variability ❖ Rising temperature ❖ Environmental degradation **Key Sources of Vulnerability** ❖ Reliance on crop and pastoral farming for livelihoods ❖ High food insecurity

		❖ Rapid population growth
Adaptation Planning	**Adaptation Plans** ❖ National Climate Change Response Policy ❖ National Adaptation Strategy – Draft published in 2016 and 2017 respectively. **Plans/Priorities for Vulnerable Sectors** **Agriculture** ❖ Develop a Climate Change Response Strategy in line with the National Adaptation Strategy by 2019 ❖ Identify Flagship Projects to address main vulnerabilities in the sector ❖ Develop Disaster Risk Reduction Strategy and Instruments for the agriculture sector in 2020 **Water** ❖ Short-term plan-Develop National Water Resource Strategy ❖ Medium/Long-term plan – Develop Water for Growth and	**Adaptation Plans** ❖ Climate Resilient Green Economy Strategy ❖ National Adaptation Programme of Action ❖ Ethiopia Programme of Adaptation to Climate Change ❖ Agriculture sector adaptation plans **Plans/Priorities for Vulnerable Sectors** **Agriculture** ❖ Improve rangeland resource management practices in pastoral areas ❖ Promote farm and homestead forestry and agro-forestry practices in arid, semi-arid, and dry sub-humid regions ❖ The Agriculture Climate Resilient Strategy focuses on identifying the effect of

	Development Framework (ongoing till 2020) ❖ Develop a Climate Change Response Strategy for the Water Sector ❖ Align planning in the water sector with the National Adaptation Strategy ❖ Identification priority areas for Ecosystem-based Adaptation (EbA) for inclusion in the 2019 Mid-Term Strategic Framework (MTSF) Identify Flagship Programmes to implement that addresses water quantity and quality Develop an early warning system of variable time frames **Energy** ❖ Develop the Climate Change Response Strategy for the Energy Sector by 2020 ❖ Align the Mid-Term Strategic Framework (MTSF) for 2019 with the National Adaptation Strategy and Climate Change Strategy. ❖ Support the implementation of resilience measures by Eskom	current and future weather variability for the country and identifying strategies to finance and implement climate action to build resilience **Water** ❖ Reinforce and improve the drought and flood early warning systems ❖ Develop community-based sustainable utilization and promote management of wetlands ❖ Create small-scale irrigation and water harvesting schemes in arid, semi-arid, and dry sub-humid areas ❖ Promote food security by embarking on a multi-purpose large-scale water development project, and establishing national center for research and training on climate change ❖ Develop a community-based Carbon Sequestration

		Project in the Rift Valley System
Institutions/Governance	**Leadership of Climate Change Response** ❖ Department of Environmental Affairs **Horizontal / Vertical Coordination** ❖ Some key sectors are the responsibilities are the responsibilities of federal government departments, the provincial climate change response for these sectors is led by the provincial offices of the related national departments. ❖ National government plans national climate responses and negotiates international agreements ❖ Sub-national governments formulate and administers provincial climate strategies. ❖ Non-state actors- business and civil society to develop strategies and operational plans and report on implementation efforts periodically	**Leadership of Climate Change Response** ❖ Prime Ministers Office CRGE Strategy was championed by Former Prime Minister Meles Zenawi ❖ Ministry of Finance and Economic Development (MoFED) ❖ Ministry of Environment and Forests (MEF) **Horizontal/VerticalCoordination** ❖ The abovementioned institutions work with climate related ministries to plan and implement climate response. ❖ Subnational regions will work with federal level institutions to execute initiatives under the CRGE ❖ CRGE units have been established in climate related ministries to

		coordinate sectoral planning and activities at the regional, state and community levels ❖ Non-state actors- private sector and civil society organisations have since contributed to the implementation of the CRGE strategy
Climate/Adaptation Finance	**National Climate Finance** ❖ South Africa's Green Climate Fund Sources of Climate Finance ❖ Budgetary allocations for expenditure on projects and initiatives that contribute directly to building resilience. ❖ Some provinces have identified means of raising money to finance climate change related objectives and imperatives. **International climate finance** ❖ Multilateral- AF, GEF ❖ Bilateral- United Kingdom's International Climate, Germany's	**National Climate Finance** ❖ CRGE Facility Sources of Climate Finance ❖ Ethiopia is responsible as high as 80% of spending to address climate change **International Climate Finance** ❖ Multilateral- LDCF, AF, and ASAP account for most of the multilateral climate change adaptation ❖ Agriculture and water and sanitation sectors which have been identified as priorities because of high and direct vulnerabilities to climate change impacts

	International Climate Initiative, Japan's Fast Start Finance ❖ South Africa has received 17% of multilateral funds to SSA since 2003	receive 7% and 6%, respectively of total multilateral funding in the country.

Source: Author's own development from available/reviewed sources/ or from collected data.

5.9 Discussion

Climate change mitigation has always been a priority for South Africa; this is because of the country's reliance on non-renewable energy sources (Shackleton et al., 2016). The country's National Climate Change Response Policy (NCCRP) published in 2011 recognized the need to shift more focus towards adaptation, with the vision of transitioning to a climate resilient and lower-carbon economy and society. South Africa adopted the top-down approach to climate change adaptation planning and the NCCRP outlines a risk-based process to identify and prioritize adaptation strategies in the short, medium, and long-term. South Africa has since published a draft National Adaptation Strategy in 2016 and 2017, respectively. These drafts aim to incorporate development planning and climate change at all levels of government. South Africa's current draft National Adaptation Strategy (NAS) is expected to be the foundation for climate change adaptation, signaling a unified, coherent, cross-sectoral, economy-wide approach to responding to climate change adaptation. It reveals adaptation priorities for the country to facilitate coordination, guidance, and to serve as a point of reference to inform resource allocation. The NAS will also give direction to climate change adaptation responses at all

levels of government, assessing the extent to which development activities at all levels of government incorporate and mirror crucial adaptation priorities, and inform development planning at all levels of government. The country's NAS will also facilitate the fulfillment of international agreements, by demonstrating progress, coherence, and coordination of climate change adaptation policies and initiatives among systems, sectors, and levels of government (CPLO, 2017). Droughts, floods, and veld fires are the major drivers of climate-related disasters in South Africa and have severe consequences for rural areas and beyond (CPLO, 2017). The 2017 draft NAS has identified Disaster Management as necessary and has recognized the need to develop a Disaster Risk Reduction Strategy and Instruments for various sectors including agriculture, forestry, and fisheries, among others (DEA, 2017a).

The NAS places too much responsibility on the government and does not clearly spell out the roles of local actors, civil society, and organizations. Indigenous knowledge was not duly acknowledged in the NAS, even though many indigenous people live in rural communities and depend on natural resources for their livelihoods. The experience and knowledge of the indigenous people have been disregarded in the search for sustainable solutions to development and climate change issues (CPLO, 2017).

Like South Africa, Ethiopia is extremely vulnerable to drought (Gashaw et al., 2017; Milman & Arsano, 2014). Ethiopia is one of the first countries in Africa to develop a Climate-Resilient Green Economy strategy, adopting a top-down approach to adaptation planning. Although the country's CRGE strategy recognized the need for economic

development, climate change adaptation and mitigation, the strategy gave precedence to mitigation over adaptation. Climate change adaptation is complex, local, and process-based and largely influenced by politics, institutions, and culture (Weldegebriel & Gustavsson, 2017; Yimer, 2016). Adaptation should be a key focus for the country because of its high vulnerability to climate risks (Echeverria & Terton, 2016). The CRGE strategy was championed by Former Prime Minister Meles Zenawi and attempts to merge the country's development needs with climate change considerations, with the triple objective of driving economic growth and development, reducing emissions, and building resilience. Climate change adaptation is to be mainstreamed into sectoral and subnational planning and policies (Echeverria & Terton, 2016).

The agriculture and water sectors are interconnected and have been identified as the most vulnerable sectors to climate change in Ethiopia (Weldegebriel & Gustavsson, 2017). Agriculture is particularly vital, with the CRGE strategy built around intensification of the agriculture sector. The intensification and commercialization of agriculture focus on generating growth through more value-added systems of production. Irrigation is essential to reducing the risks associated with unpredictable and erratic rainfall. The objectives of the green economy strategy are to expand agricultural production, drive food security and livelihoods while reducing emissions (Yirgu et al., 2013). Despite the relevance of the agriculture and water sectors in Ethiopia, these sectors have received only 7% and 6%, respectively of the total multilateral finance provided to

the country while the energy and the forestry sectors have received 27% and 20% respectively.

The CRGE Strategy was shaped by lead institutions such as the Prime Minister's Office (PMO), the EPA, and the MoFED. Concern over the ability of the EPA to lead climate policy development and address complex issues such as adaptation resulted in its restructuring to the Ministry of Environment and Forests (MEF). The civil society has been instrumental in climate policy discussions within Ethiopia, aiding easy access to climate science. The private sector, on the other hand, has only been insipidly involved in climate policy (Yirgu et al., 2013). The strategy is constrained by weak institutional capacity and shortage or absence of means of monitoring, evaluating, and reporting activities (Echeverria & Terton, 2016).

Both South Africa and Ethiopia adopted the top-down approach to climate change adaptation; research however, reveals that fundamentally, climate change adaptation is driven by bottom-up initiatives that manifest local priorities and imperatives (Baudoin & Ziervogel, 2017).

In South Africa, institutional barriers to climate change adaptation at the subnational level come from three key sources- i) barriers that occur at the level of the individual and is determined by individual factors such as personal knowledge or values, ii) barriers that occur at the institutional and regulatory levels, necessitating responses that affect the "rules" of the institutions, and iii) barriers that stem from socio-cultural factors in which institutions are embedded, such as, societal values (Pasquini, Cowling, &

Ziervogel, 2013, p. 231). In Ethiopia, weak institutional support mechanisms result in a deficit of relevant climate information. Besides lack of information, other major barriers to climate change adaptation include lack of financial resources, shortage of water, as well as shortage of land for cultivation, among others (Tessema, Aweke & Endris, 2013). Successful farm-level adaptation in South Africa and Ethiopia depends on easy access to extension services and credit facilities. Beyond adoption of new technologies, policy-makers must ensure these services reach small-scale farmers (Bryan, Deressa, Gbetibouo & Ringler, 2009).

To successfully mainstream climate change, the national government should mandate the incorporation of climate change considerations into planning at all levels of government, and provide the resources required for the process. This may prove more effective than establishing a specialized and consequently isolated climate change unit. To improve the dissemination of information, there is need to expand the means for subnational governments and for individuals to receive climate-related information, local-level predicted impacts, and adaptation (including ecosystem-based adaptation) options (Pasquini et al., 2013). Easy access to financial and technological resources will drive climate action. Non-state actors such as the private sector and civil society-NGOs, local institutions, such as farmers associations, and the media will also play key roles in limiting barriers to climate change adaptation (Tessema et al., 2013; Bryan et al., 2009).

Chapter 6

Increasing Capabilities for Climate Change Adaptation

Research shows that many countries have embarked on adaptation activities, and many studies have identified barriers and challenges to adaptation planning and implementation (Mimura et al., 2014). There is the need to transform identified barriers and challenges to drivers of climate action and institutional change. Adaptive capacity is largely determined by technological resources and capacity, financial resources, human capital, and institutional capacity and structure (Burch, 2010).

Expanding and raising the capabilities of stakeholders can strengthen operational approaches for adaptation to climate change at different levels. The literature acknowledges four areas where improved capabilities can facilitate the creation of governance approaches for adaptation planning and implementation: (i) creating learning processes incorporating numerous information systems and experiences to expedite the development of a standard understanding and policies important for cross-institutional coordination and multi-stakeholder actions, (ii) improving monitoring and evaluation of adaptation planning and implementation actions presently limiting opportunities for learning and improvement of current and future adaptation action, (iii) enhancing cross-level coordination between government institutions at the national, subnational, and (iv)local levels, and engaging stakeholders from the assessment of vulnerability, to the planning and implementation of operational approaches of adaptation (Mimura et al., 2014).

These interacting factors enable the incorporation of climate change considerations to systems and sectors, and subsequent response planning and implementation happening at different spatial and temporal scales. They also promote the improvement of systems and institutions that facilitate coordination within the scale of governance, as well as clear and coherent allocation of roles and responsibilities particularly under conflicting time scales of intervention. Furthermore, these factors also enable addressing jurisdictional scales and directives across sectors, local, subnational, and national policies. Creating and enabling capabilities through coordination efforts broaden the adaptive capacity at the local level and increases the chances for larger governance networks to formulate policies. Representing varied and diverse perspectives is essential for successful adaptation to current and future risks (Mimura et al., 2014).

6.1 The Role of the Private Sector

The private sector includes various types of businesses, both formal and informal. These businesses can be small enterprises such as smallholder farmers, local businesses, through to multinational companies (Crick et al., 2016). The private sector significantly contributes to growth and development efforts in developing countries. In Africa, for example, the private sector generates two-thirds of the continent's investment, 75% of its economic output and 90% of its formal and informal employment (Crick, et al., 2016; AFDB, 2013). The private sector is central to climate change action in developing countries for many reasons, including the mobilization of financial and technical resources, ability to collaborate and influence relevant actors, such as the government,

civil society, and local stakeholders, and ability to develop innovative climate services and technologies. Attracting private investment to climate change adaptation and mitigation has emerged as part of the resource mobilization discussion. As estimates of finance required for adaptation rise, the private sector has been identified as central to mobilizing additional finance to address climate change (Biagini & Miller, 2013).

There is a mismatch between current public finance and climate adaptation costs, and this gap is expected to increase in the future. The private sector is pertinent to addressing this gap because of its dominance in core climate-related sectors. Many developing countries are incurring public debts and have limited public finance, thus future investments in technologies and services that increase resilience may lie with the private sector (CIF, 2016). Private sector action cannot, however, replace government adaptation action, government's policies, regulation, and support should guide private sector initiatives. Furthermore, the private sector is heavily immersed in many climate-related sectors such as agriculture, water, and energy without which economic development will not be possible for many developing countries. Private initiatives are necessary for adaptation activities in these sectors. These three actions are central to promoting the engagement of the private sector in responding to climate change in developing countries: i) raising awareness about climate risks and impacts- this action should focus on identifying potential risks, impacts, and strategies available for responding and driving the private sector to the realization that climate change is happening, and associated risks will have far-reaching consequences for them and the rest

of the world, ii) incorporating the private sector in national and international adaptation initiatives- governments can drive private sector involvement in climate change adaptation by providing relevant climate information, consciously adopting reasonable regulations, and giving economic incentives, iii) engaging the private sector in the development of products and services that minimize costs and impacts of climate change- climate change and climate risks presents a business opportunity to develop products and services to build climate resilience. The role of the private sector can take different forms, from acting as provider of technology, engaging partnerships with the government, to taking on the primary task of delivering adaptation services (Biagini & Miller, 2013).

6.2 The Role of Civil Society

Many countries have adopted the top-down approach to the climate change problem. Climate is however, locally experienced, and as such can only be successfully addressed by involving local actors and institutions. The adaptive capacity of communities is largely influenced by risk perception (the extent to which it recognizes climate change as a threat), the resources at its disposal, and the depth of social capital available to it (Lobo, n.d). Social capital here represents local institutions, which can be public, private, civic, formal, or informal. Civil society is a subcategory of these and is critical to building adaptive capacities within communities. In many countries, the role of the civil society in the development of climate change policies and strategies has been largely inadequate. Civil society organizations include but are not limited to various kinds of social and

economic organizations, Non-governmental Organizations (NGOs), and village councils, among others.

Despite the recognition that empowered citizens, groups, and organizations can drive climate change action, not much has been done to create a framework that facilitates and incentivize the participation of these stakeholders (Lobo, n.d). Engaging local institutions, groups, communities, and stakeholders, strengthening their capacities, and supporting them as participants in planning and policy-making processes is central to effective and efficient climate change adaptation. Because climate change impacts are usually experienced locally, local institutions and stakeholders are best suited to identify climate risks, plan for action and identify adaptation measures and strategies. Many civil society organizations interact with local agencies and communities and are best suited to prepare and help communities take on adaptive actions. In addition, members of civil society organizations, who are usually attuned with local concerns can unify and articulate priority concerns to governments, and other relevant agencies (Lobo, n.d).

The role of civil society in climate change adaptation is particularly noteworthy because they serve as mediators between national level institutions and policy-makers on the one hand, and their regional and local constituencies on the other. Civil society actors facilitate the implementation of national policies and regulations, while also raising public awareness and embarking on adaptation planning functions, such as disaster risk reduction, as well as mobilizing climate finance. Although public institutions may more expertise in climate science and impacts, civil society organizations are best placed to

identify and devise practical technical and social adaptive strategies and provide feedback to relevant public agencies, thereby creating effective partnership between the scientific and technology institutions, governance agencies, and local, national, and international institutions (Lobo, n.d).

In Africa, a Pan African Climate Justice Alliance (PACJA) has emerged to become the most prominent civil society platform in climate change and sustainable development. This platform has a membership of over 1000 organizations and networks in 45 African countries, which include community-based organizations, non-governmental organizations, faith-based organizations, farmers, and pastoralists' group, among others (Beer & Mwenda, 2016, p. 2). PACJA endeavours to coordinate and coalesce civil society initiatives on climate change advocacy across the continent. The platform collaborates and form strategic alliances with international allies, national governments, regional governments, and individuals, and have in recent times focused their climate change advocacy on national policy, climate justice, climate change finance, among others (Beer & Mwenda, 2016).

6.3 Conclusion

Many African countries' primary concern is economic growth and development, and the global climate change issue threatens the development progress and prospects of these countries. Those countries recognizing that climate change adaptation is paramount to achieving economic development under changing climatic conditions have started to plan for adaptation. Many of these countries vary in size, population, economic profiles,

and exposure to climate risks, nonetheless most share similar adaptation priorities. Agriculture, water, energy, human health, and disaster risk reduction are adaptation priorities for many of these countries. Many African countries have adopted varied and diverse strategies to respond to climate risks. For instance, Kenya has a National Climate Change Strategy, and a National Climate Change Action Plan. The country recently passed a Climate Change Bill and has published a draft National Climate Change Framework policy as well as a draft Climate Finance policy. Burkina Faso which is part of the LDCs, under the UNFCCC, has prepared a National Adaptation Programme of Action in 2007. The country has since published a National Adaptation Plan in 2015 and has created a National Council for the Environment and Sustainable Development under its Ministry of Environment and Sustainable Development to lead climate change planning and action. Ghana has adopted a bottom-up approach tasking districts and municipalities to include climate change considerations into their medium-term development planning. Local governments are responsible for developing community-level adaptation plans and disaster risk reduction strategies (Parry & Terton, 2016a).

The case study country South Africa has prepared a National Climate Change Response policy and published a draft National Adaptation Strategy. Ethiopia the second case study country being part of the LDCs, has prepared a National Adaptation Programme of Action in 2007 and has adopted the Climate Resilient Green Economy strategy to address climate change. A viable solution to tackling the double challenge of development and climate change is to incorporate climate change considerations into

development planning. Climate change adaptation in developing countries, including many African countries, is constrained by barriers ranging from institutional/political, financial, technological, and socio-cultural factors. These barriers impede adaptation planning, and even when plans have been developed to address climate change issues, these barriers limit the capacity for implementation. Driving climate change adaptation in Africa is therefore dependent on eliminating or minimizing some of these barriers and turning these factors into enablers of climate action across the continent.

A review of trends in adaptation planning in developing countries by Parry & Terton (2016b) reveals that adapting the agriculture sector to climate change impacts is a priority for many developing countries, and this is reflected in the large number of adaptation projects and programs targeted towards agriculture. This is especially important because many of these developing countries rely on agriculture as a source of employment and GDP growth and to meet their food security needs. For many developing countries, adaptation planning is inadequate at the sub-national level. Many sub-national institutions and actors lack the capacity to identify, mainstream and implement adaptation actions, and as such it is necessary to boost the capabilities of local governments, local institutions, and communities to take on more delegated roles as well as elucidating the roles and responsibilities of different levels of government, and improve coordination between them. Furthermore, in most cases, there is no standardized system to monitor and evaluate adaptation action. Such a system is necessary to measure the effectiveness of

current investments and identify gaps to better manage adaptation planning and implementation (Parry & Terton, 2016b).

Relative to GDP, sub-Saharan Africa faces the largest adaptation gap, and private sector investment is critical to filling this finance gap (CIF, 2016). Funding climate change adaptation is costly and often beyond the capacity of many developing countries. Climate finance is being mobilized through many sources and forms to address the challenge of financing adaptation in many developing countries. For Africa, even if scaling up international climate finance under the UNFCCC ensures that the continent mobilizes enough funds to address climate change adaptation, using these funds to successfully implement adaptation initiatives is largely influenced by broad and effective national and regional planning, capacity building and governance (UNEP, 2016). These countries will have to deepen initiatives and policies that promote the above for effective climate change adaptation across the continent.

This study will make some recommendations below to facilitate achieving more successful climate change adaptation planning and implementation in Africa. Successful adaptation action experience will increase the potential for adaptation to gain traction across the continent.

A robust institutional environment at all levels of government will enable effective climate change adaptation. Institutional barriers are interrelated with technological barriers limiting the capacity to access climate information necessary for adaptation. Strong collaboration and coordination among relevant institutions is vital to the success

of adaptation initiatives (Antwi-Agyei et al., 2015). Increasing institutional capabilities is strongly linked with institutional change and social learning. Building institutional resilience requires learning, self-organization, and flexibility which are central for navigating complex feedbacks and system changes (Leszczynska, 2012).

In the search for sustainable solutions to development and climate change, it is important for stakeholders to realize that adaptation actions occur within existing societal norms and cultural practices, thus the involvement of local actors and indigenous knowledge will increase the success of adaptation efforts. Climate change policies, regulations, and mobilization of financial and technological resources alone cannot resolve the climate change problem, a multi-stakeholder engagement of relevant actors, starting from the local, to the regional, and the national levels is necessary for successful climate action. The top-down approach to adaptation can hinder adaptation in the long-term because it fails to critically involve actors in policy design and implementation. Adaptation initiatives will appeal and be readily accepted by rural communities if it is infused with local knowledge, and cultural practices. Policy-makers should incorporate indigenous knowledge with scientific climate assessment in the planning and implementation of climate change adaptation strategies (Antwi-Agyei et al., 2015; Lobo, n.d; Shackleton et al., 2015). Due to the inadequacies of top-down approaches for climate change adaptation, bottom-up approach is garnering more attention from international bodies (Baudoin & Ziervogel, 2017).

The important role of subnational actors such as local governments and the private sector in driving climate change adaptation at the community and household level is increasingly being recognized (UNEP, 2016). Responding to climate change in Africa should engage all stakeholders and actors including government, the private sector and civil society. The private sector can facilitate climate action across Africa, and collaboration and engagement of private actors and stakeholders in climate risk, response, and adaptation needs should become a priority. Robust engagement of private actors in climate change adaptation efforts will allow for larger investments in vulnerability reduction, which will in turn fast-track the development of climate-resilient technologies and services in core sectors. Furthermore, involvement of the private sector in climate change issues and action will enhance resilience at the local level and promote long-term sustainability to private investments. From the business community perspective, thinking about natural disasters should evolve from "shared risk" to "shared value". Strong public-private partnerships will be beneficial for both partners creating business opportunities for the private sector and building social/community resilience to climate change. The government can lead this partnership by providing incentives for private investment as well as by enabling policies and a healthy institutional environment (Biagini & Miller, 2013).

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