Smallholder Farmers' Perceptions of Climate Change, Vulnerability and Adaptation in the Context of Multiple Factors in the Tigray region of Ethiopia

Rahwa Gebremedhine Kidane

BA. (Honours) Haramaya University, Ethiopia

MSc. University of Copenhagen

Thesis submitted for the Degree of Doctor of Philosophy

Department of Geography, Environment and Population

School of Social Sciences

The University of Adelaide

June 2019

Table of Contents

List of Tables

List of Figures

Abstract

This study investigated perceptions, vulnerability and adaptation to climate change in the context of non-climatic factors, by focusing on smallholder farmers in the Tigray region, Ethiopia. A mixed-method case study approach was adopted to collect qualitative and quantitative data that included a survey of 400 smallholder farmers, focus groups, participatory rural appraisal techniques and interviews. The findings revealed that most farmers perceive changes in the local climate, and that various socio-psychological factors shape their risk perceptions of climate change. The findings also demonstrated that farmers and their livelihoods are vulnerable to both climatic and non-climatic stressors. Farmers are taking various forms of farm and non-farm related adaptation measures to respond to climatic as well as non-climatic stressors. However, some of their adaptation strategies – specifically migration, firewood extraction and irrigation – carried the risk of maladaptation.

The results revealed a deficit in planned adaptation efforts by the state and NGOs at the local level. At the government level, although the issue of climate change and adaptation needs are well recognized in various policy documents, the implementation of concrete adaptation actions at the local level is still lagging behind. This study found only two planned adaptation interventions – the natural resource management program and weather index insurance program, which are being implemented by the government and NGOs respectively. However, even these two interventions were found to create unintended (maladaptive) outcomes by rebounding vulnerability to the targeted farmers. Besides these two planned adaptation interventions, the findings indicate that the government's broad development policies (e.g. agricultural policies) are also increasing the risk of maladaptation by having a profound negative impact on the farmers' livelihoods.

Overall, the central argument of this study is that climate change should not be viewed as the only big problem confronting smallholder farmers in rural Ethiopia. The findings of this study have important implications for adaptation policy and practice, in Ethiopia and Africa more broadly. First, the findings emphasize the need to consider the non-climatic drivers of vulnerability in the design and implementation of planned adaptation programs and projects at the local level. In other words, planned adaptation efforts are likely to be successful if the climatic and non-climatic conditions farmers experience in everyday life can be addressed simultaneously. Second, the findings highlight that the risk of maladaptation needs to be carefully considered by the government when formulating adaptation policies or prior to the implementation of projects and programs to avoid negative outcomes on the targeted smallholder farmers.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

I give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

Signed: **Date: 28 June 2019**

Acknowledgements

I would like to express my deep gratitude to my supervisors Dr Thomas Wanner and Associate Professor Melissa Nursey-Bray, for their encouragement, timely guidance and constructive feedback during the writing process of this thesis. I owe you special thanks not only for your tremendous academic support, but also for providing me with constant emotional support following the death of my mother. It would never have been possible for me to take this PhD work to completion without your professional as well as personal support. I would also like to thank Dr Bill Winser for editing this PhD thesis.

I would also like to acknowledge the University of Adelaide for offering me a Beacon of Enlightenment Scholarship to pursue this doctoral study. I am also grateful to the School of Social Sciences and the Department of Geography, Environment and Population for providing me with funding to cover my fieldwork expenses in Ethiopia. Without this generous scholarship and fieldwork grant, this thesis would not have materialized.

I am deeply thankful to all the research participants who took the time to participate in this study. Special thanks to the farmers of Raya Azebo district for providing me with the necessary data I needed for this thesis and for their great hospitality during my fieldwork. I also thank everyone who assisted in data collection, especially Tesefaye, Birhan, Amanuel and Kiros.

My sincere thanks also go to my fellow PhD students, especially Madeleine, Masud, Gerald, Jerome, Mensah, Bride, Hannah, Ariane and Vera for their friendship and moral support. I would also like to thank all the administrative and academic staffs of the Department of Geography, Environment and Population (GEP) of the University of Adelaide, for their assistance and encouragement.

Finally, my deepest gratitude must go to all of my family, for their unconditional love, prayer and continuous support throughout my PhD studies and in my entire life. I am highly indebted to my lovely twin sister Miheret Kidane, for being there for me as sister and as a close friend. Above all, I thank God and His Mother Saint Mary, who have always been there to help me and without whom I could not have completed this work.

Dedication

To my late mother, Tsega Berhe

Acronyms

ADLI	The Agricultural-Led Industrialisation Strategy
AGRA	Alliance for a Green Revolution in Africa
AIC	African Insurance Company
CSA	Central statistical agency
CRGE	Climate Resilient Green Economy Strategy
CRS	Climate Resilience Strategy
CSI	The Coping Strategy Index
DAs	Development Agents
DEWS	Drought early warning system
DFID	UK Department for Foreign International Development
DPPC	The Disaster Prevention and Preparedness Commission
EFDRE	Federal Democratic Republic Of Ethiopia
EPA	Environmental Protection Authority of Ethiopia
EPE	Environmental Policy of Ethiopia
EPACC	Ethiopia's Program of Adaptation to Climate Change
EPCC	Ethiopian Panel on Climate Change
EPRDF	Ethiopian People's Revolutionary Democratic Front
ETB	Ethiopian Birr
FAO	The Food and Agriculture Organization of the United Nations
FCS	The Food Consumption Score
FDG	Focus Group Discussion
FDI	Foreign Direct Investment
GES	Green Economy Strategy
GHGs	Green House Gas Emissions
GTP	Ethiopia's Growth and Transformation Plan
HARITA	Horn of Africa Risk Transfer and Adaptation
HDR	Humanitarian Requirements Document
HRW	Human Rights Watch
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ILC	International Land Coalition

IRI	International Climate Institute
LDC	Least Developed Countries
MEFCC	Ministry of Forest, Environment, and Climate Change
MDG	Millennium Development Goals
MFEC	The Ministry of Finance and Economic Cooperation
MOANRM	Ministry of Agriculture and Natural Resource Management
MOEF	Ministry of Environment and Forest
MOFED	Ministry of Finance and Economic Development
MOWE	The Ministry of Water and Energy of Ethiopia
NAPA	National Adaptation programme of Action
NAP-ETH	National Adaptation Plan
NIC	Nyala Insurance Share Company
NMA	The National Meteorological Agency
NRM	Natural Resource Management
NPC	National Planning Commission
PASDEP	Plan for accelerated and Sustainable Development to End Poverty
PRA	Participatory Rural Appraisal
RCC	Relief and Rehabilitation Commission
RDAE	The Rural Development and Agricultural Extension department
REST	The Relief Society of Tigray
RLAUP	Rural Land Administration and Use Proclamation
SDPRP	Sustainable Development and Poverty Reduction Program
TBOARD	Tigray Bureau of Agriculture and Rural Development
TEPLAUA	Tigray Regional Program of Plan on Adaptation to Climate Change
UNFCCC	UN Framework Convention on Climate Change
WFP	World Food program
WII	Weather Index Insurance Program
WoFED	Woreda Finance and Economic Development

Chapter 1: Introduction

1.1 Statement of research problem and justification

Climate change is the most difficult challenge facing our earth in the 21st century (Glatzel et al., 2015; Feulner, 2017). The Intergovernmental Panel on Climate Change (IPCC) has reported that climate change has led to frequent hot periods, sea level rise and heavy rainfall across many parts of the world since 1950 (IPCC, 2014a). In Africa, climate scientists have noted the rise of extreme temperature in most regions (Seneviratne et al., 2012; Niang et al., 2014). Due to climate change, shifts in rainfall patterns, as well as frequent drought and flood events, are more common over the continent of Africa (Washington et al., 2006; Douglas et al., 2008; Masih et al., 2014).

In Ethiopia, average annual rainfall has declined, while average annual temperature has increased by 1.65°C between 1955 and 2015 (G. Abebe, 2017). The country has experienced seven serious droughts since the early 1980s, five of which caused famines (World Bank, 2010). The worst drought in over five decades has occurred just recently in 2015 (FEWSNET, 2015). Indeed, Ethiopia has been ranked seven among the top nine nations which were at extreme risk of climate change in 2015 (Maplecroft, 2015). The Tigray region of Ethiopia is one of the most vulnerable regions to the impacts of climate change (Deressa et al., 2008). Rainfall patterns in the Tigray region are highly variable and most parts of this region including the Raya Azebo district, face severe and recurrent droughts (Meze-Hausken, 2004; Gebrehiwot & van der Veen, 2013).

Climate change is arguably one of the biggest threats to smallholder farming in Africa. Particularly, rain-fed agriculture is one of the most vulnerable sectors to climate change in the continent (Serdeczny et al., 2017). According to the IPCC projections, decline in precipitation and rise in extreme temperatures will be expected in many African countries, which will have a potential negative impact on agriculture and food security (Niang et al., 2014). Africa's smallholder farmers are amongst the most vulnerable to climate change and they are also more likely to suffer from future changes in climate (Komba & Muchapondwa, 2018; Harvey et al., 2014; Glatzel et al., 2015).

Although farming communities in Africa are continuously exposed to climatic risks (e.g. floods, droughts, rainfall variations), they are also vulnerable to other non-climatic factors which affect their lives and livelihoods in various forms (Paavola, 2008; Eriksen & Silva, 2009). The non-climatic factors that affect smallholder farmers' livelihoods and which also contribute to their vulnerability are termed as stressors (Bunce et al.,2010; McDowell & Hess, 2012). Across Africa, some of these non-climatic stressors experienced by rural communities include – lack of accesses to basic livelihood assets (such as land), crop pests and diseases, lack of employment opportunities, poor rural infrastructure, poor market conditions, agricultural policy changes, limited climate and agricultural information (Tschakert, 2007; Bunce et al., 2010; Mubaya et al., 2012; Harvey et al., 2014). In Ethiopia, for example, rural farmers who lost their land access due to large-scale agricultural investment purpose are exposed to food insecurity and income loss (Shete & Rutten, 2015).

It has been largely recognized that for interventions related to vulnerability to be effective, there is a need to understand the climatic and non-climatic drivers of vulnerability (O'Brien et al., 2009; Tucker et al., 2015). Nevertheless, with the exception of a few studies (Westerhoff & Smit, 2009; Nyantakyi-Frimpong & Bezner-Kerr, 2015; Antwi-Agyei et al., 2017), research attention in Africa largely focuses on identifying the climatic stressors that produce vulnerability in rural communities. However, a focus on climatic stressors alone limits a holistic understanding of the host of other non-climatic forces that combine to amplify the vulnerability of smallholder farmers to climatic stressors. In Ethiopia, climate change vulnerability research has largely focused on exposure to climate-linked risks and how these risks affect sectors such as the agriculture sector (e.g. crop, livestock) and natural resources (e.g. water and soil) (Mahoo et al., 2013; Regassa et al., 2010; Bewket, et al., 2015). There are still gaps in understanding of the climatic and non-climatic drivers of vulnerability at the local level, particularly from the knowledge and perspectives of smallholder farmers. Hence, this study seeks to provide an empirical understanding of the factors that produce vulnerability in the Raya Azebo district of Ethiopia and thereby offer valuable insights into measures that are required to reduce vulnerability and create adaptation opportunities.

Adaptation is essential to reduce vulnerability to current impacts and future climate change - linked risks (Adger et al., 2003; Ziervogel et al., 2006). This adaptation can be implemented by individuals and communities (often called *autonomous* adaptation) or it can be undertaken by governments and development agencies (*planned adaptation*) (Forsyth & Evans, 2013; Preston & Stafford-Smith, 2009). There is ample empirical evidence which suggests that smallholder farmers in Ethiopia (Kassie et al., 2013; Bewket et al., 2015; Alemayehu & Bewket, 2017; Belay et al., 2017) and elsewhere in Africa (Laube et al., 2012; Tambo & Abdoulaye, 2013; Kichamu et al., 2017; Assan et al., 2018) are taking adaptation measures in response to climatic factors (stressors). However, it is now widely recognized that adaptation can be triggered by climatic as well as non-climatic factors (Berrang-Ford et al., 2011; Ford et al., 2014; Adger et al., 2005). Despite this recognition, climate change adaptation research in Africa has neglected the non-climatic factors that drive smallholder farmers' adaptation strategies (Burnham & Ma, 2016). While climate change is an important motivating factor in farmers' adaptation decision-making, adaptation research that solely focuses on how smallholder farmers respond to climatic factors will not be adequate in informing planned adaptation initiatives that aim to address the issue of both climatic and non-climatic factors simultaneously. Hence, there is a need to study farmers' adaptation responses to climate change in conjunction with other non-climatic factors that also motivate adaptation actions. By examining farmers' adaptation responses to climate change within the context of non-climatic influences, this study aims to provide valuable knowledge that can be used to inform the development of effective planned adaptation policies and strategies in Ethiopia and elsewhere in Africa.

Autonomous adaptation will not be adequate to offset losses associated with variable climate conditions (Barry Smit & Pilifosova, 2003; Soubry, 2017). As a result, it is widely recognized that planned or policy-driven adaptation measures are required and have the potential to support smallholder farmers to adapt to climate change and build their resilience (Smit & Wandel, 2006; Berman et al., 2015; De Souza et al., 2015; Zougmoré et al., 2016;Tripathi & Mishra, 2017; Assan et al., 2018). Despite this increasing recognition, there is still poor understanding of if and how planned adaptation initiatives are currently being undertaken in developing countries, particularly in the continents of Africa and Asia (Ford et al., 2015). This research gap restricts understanding of developing countries' readiness as well as their capacity to tackle climate change and to assist smallholder farmers in their adaptation efforts.

For example, Ethiopia has formulated several adaptation policies and strategies such as the National Adaptation Plan of Action (NAPA) in 2007. However, little is known if this policy is translated into concrete adaptation action to support smallholder farmers at the local level. Using the case of the Raya Azebo district, this study seeks to address this research gap by assessing the status of planned adaptation interventions in Ethiopia and by examining whether barriers exist that constrain policy implementation.

An assessment of the outcomes of planned adaptation interventions is also a crucial task, since in some cases there is a possibility that planned adaptation initiatives could create unintended negative effects by increasing individuals' vulnerability rather than helping them to adapt to climate change (Juhola et al., 2016; Magnan, 2014). This possibility is commonly termed as "maladaptation" (Barnett & O'Neill, 2010; Magnan et al., 2016). A small but growing body of empirical work is emerging to assess maladaptive outcomes in planned adaptation initiatives (Barnett & O'Neill, 2010; Granberg & Glover, 2014; Magnan al., 2016; Neset, Wiréhn et al., 2018). This study aims to contribute to this growing area of research by assessing the risk (or potential) that existing planned adaptation initiatives in the study district may create maladaptive outcomes. This assessment would assist policymakers to carefully design adaptation strategies that have minimum risk of maladaptation.

Due to the limitation of global and regional climate models in providing place-based information about climate change, recent research highlights the need to document local observations and perceptions of climate change (Byg & Salick, 2009; Marin, 2010). This can be an alternative way to understand climate change and its impacts at the local level. Particularly in developing countries like Ethiopia where meteorological data are sparse in rural areas, local people's observations and perceptions of climate change have increasingly been recognized as an important source of information that can be used to track and understand the patterns of climate change (West et al., 2008; Alexander et al., 2011). Nevertheless, local peoples' perceptions of climate change are still poorly studied (Savo et al., 2016). In Ethiopia, some studies have assessed farmers' perceptions of climate change (e.g. see Bryan et al., 2009; Deressa et al., 2011; Debela et al., 2015; Kidane et al., 2018). However, none of these studies were conducted in Raya Azebo district of the Tigray region. Therefore, this study aims to examine smallholder farmers' observations and perceptions of climate change in order to document location-specific climate information about the study area.

This information is particularly useful for practitioners (e.g. for local government actors, NGOs), who strive to identify areas exposed to climate risks in Ethiopia and aim to implement suitable adaptation measures. The information can also be used in climate studies that aim to understand the history and pattern of climate change in Ethiopia in general and in Tigray region in particular.

To design effective climate change communication strategies, research underscores the need to assess individuals' understanding of climate change and the factors that influence their risk perceptions (Nursey-Bray et al., 2012; Chadwick, 2017; Markowitz & Guckian, 2018). There is a considerable research interest in the socio-psychological determinants of climate change risk perceptions (Weber, 2010). Most of the research on this topic has been conducted in the developed nations such as in the United Kingdom (Van der Linden, 2015) and the United States (Leiserowitz, 2006; Smith & Leiserowitz, 2012b). Across Africa, a number of studies have investigated how geographic locations, extension and credit services, climate information, and demographic factors influence smallholder farmers' climate change (risk) perceptions (Deressa et al., 2011; Fosu-Mensah et al., 2012; Bryan et al., 2013; Habtemariam et al., 2016; Badmos et al., 2017). However, none of these studies have examined how socio-psychological factors influence risk perceptions of smallholder farmers, except one study from Ghana (see Hitayezu et al., 2017). This study aims to make an empirical contribution to this field of climate change.

1.2 Research aims and objectives

The overall aim of this thesis is to investigate the perceptions, vulnerability and adaptation of farming households to climate change in the context of other multiple factors in the Tigray region of Ethiopia. To achieve this aim, the specific objectives of the study are:

- To examine farmers' perceptions of climate change and the factors that influence their risk perceptions
- To identify the climatic and non-climatic drivers of vulnerability and to examine how they influence the farmers' lives and livelihoods
- To identify the types of adaptation actions employed by smallholder farmers and to understand the importance of climatic and non-climatic forces in motivating those actions

- To assess the status of planned adaptation interventions that are in place to support smallholder farmers and to examine whether barriers exist that limit effective adaptation policy implementation at the local level

- To assess the risk of maladaptation that may arise from either the implementation of the existing planned adaptation initiatives in the study area or the farmers' adaptation strategies

1.3 Research questions

Based on the above objectives, the study seeks to answer the following research questions:

- How do smallholder farmers perceive climate change and what factors influence their risk perceptions?
- What are the climatic and non-climatic factors that contribute to vulnerability and how do they affect the farmers' lives and livelihoods?
- What are the different types of adaptation actions employed by smallholder farmers and what motivates those actions?
- What planned adaptation interventions exist to support farmers to adapt to climate change and what are the barriers (if any) that constrain effective adaptation policy implementation at the local level?
- Do the existing planned adaptation initiatives and farmers' adaptive strategies carry the risk of maladaptation? If yes, how can maladaptation be prevented?

1.4 Structure of the thesis

The overall structure of the thesis takes the form of 10 chapters including this introductory chapter. Chapter 2 reviews the theoretical literature on the topic of the study. The review covers three topics on vulnerability, adaptation and climate change risk perceptions. The chapter begins with an assessment of how vulnerability is defined, interpreted and assessed in climate change vulnerability research. This is followed by presentation of theoretical frameworks that have been developed to clarify the concept of climate change adaptation and maladaptation. It further reviews climate communication research and the various theoretical perspectives that explain the key determinants of climate change risk perceptions. Chapter 3 presents the methodology adopted for this thesis. Chapter4 provides background information about Ethiopia in relation to the country's geographical location, demography, political context, and

economy. It then looks at the country's core national policies with regards to climate change and smallholder agriculture.

The study findings are presented in 4 chapters. Chapter 5 examines farmers' perceptions of climate change and the determinants of climate change risk perceptions. This chapter also explores the climatic and non-climatic stressors that contribute to livelihood vulnerability in the study area, from the perspective of farmers and district-level officials. Chapter 6 examines the impact of the identified climatic and non-climatic stressors on farmers' lives and livelihoods. Chapter 7 explores how farmers adapt to those climatic and non-climatic stressors as well as opportunities and asses the risk of maladaptation from the implementation of the farmers' adaptation responses. Chapter 8 then assesses the status of planned adaptation interventions (government-led interventions) and the barriers to adaptation policy implementation at the local level. This chapter further examines the risk of maladaptation that may arise from either the implementation of the existing planned adaptation interventions. Chapter 9 discusses the key findings of the study. Chapter 10 concludes the thesis by summarising the key findings, providing recommendations and suggesting areas for further research.

Chapter 2: Literature review

2.1 Introduction

This chapter reviews the literature on vulnerability, adaptation, maladaptation, climate change communication research and practice, and the socio-psychological determinants of climate change risk perceptions. The purpose of this literature review is to define key terms and to establish the research area for this thesis and to develop the conceptual framework of the research. First, this chapter explores how various authors within the climate literature defined the term vulnerability and discusses the three conceptual approaches to vulnerability assessment. This is followed by an examination of how various scholars defined, characterized and categorized the adaptation and maladaptation concepts within the climate change literature. Lastly, the chapter reviews the field of climate communication research and practice and looks at factors that influence individuals' risk perceptions of climate change.

2.2 Concepts and definitions of Vulnerability

A wide range of research from different fields of studies provides terminologies and assessment approaches for conceptualizing and framing vulnerability (Brooks, 2003). The concept has been applied in various subject areas such as development studies, disaster risk management, public health and environmental changes and climate change (Brooks, 2003). In this respect, for example, researchers have applied the vulnerability concept to explore famine and food insecurity (Watts & Bohle, 1993), and to examine the sensitivity of livelihoods and rural poverty (Bebbington 1999, Dercon & Krishnan 2000; Prowse, 2003).

The diversity of disciplines in the use of vulnerability means that there are different interpretations and also varied perspectives and methodological assessment techniques (Birkmann, 2006). Indeed, the meaning of vulnerability is "contested" in the coupled human-environmental systems (Adger et al., 2006) and it is also "fuzzy" as it is interlinked with complex and dynamic social systems (Birkmann, 2006). Specifically, the emergence of different terminologies and treatment of the vulnerability concept has become challenging in the climate change literature (Füssel, 2007).

As can be seen in Table 2.1, there are various definitions proposed in climate change research as well as in other research traditions. This thesis follows the definition of vulnerability proposed by Adger (2006, p. 268) as "the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt." This definition offers an opportunity to examine the biophysical and the social dimensions of the vulnerability of farm households and it can also capture the constraints that limit their adaptive capacities.

Table 2.1: Some of the definitions of vulnerability

Author (s)	Vulnerability definitions
Bohle et al., (1994, p.37)	An aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of potential harmful perpetuations.
Kelly & Adger (2000, p.325)	The capacity of individuals and social groups to respond to, that is, to cope with, recover from or adapt to, any external stress placed on their livelihoods and well-being.
Cutter et al., (2003)	Vulnerability is defined as the potential for loss.
Turner et al., (2003, p.8074)	Vulnerability is 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.
UNDP (2004, p.98)	A human condition or process resulting from physical social, economic and environmental, factors, which determine the likelihood and scale of damage from the impact of a given hazard
Adger et al (2006, p.268)	Vulnerability is the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt.
IPCC (2014, p.5)	The propensity or predisposition to be adversely affected. The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

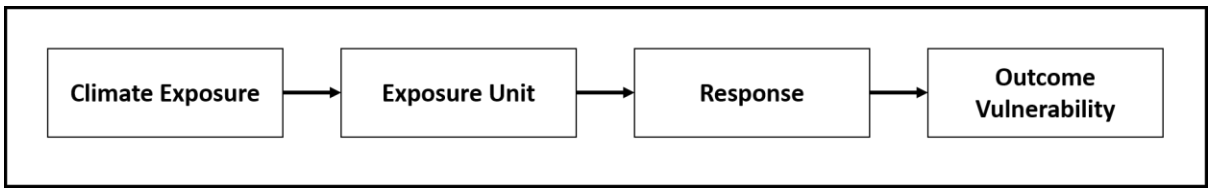
2.3 Interpretations of vulnerability to climate change

Vulnerability to climate change is commonly interpreted in two ways as "starting-point" and "end-point" (Kelly & Adger, 2000; O'Brien et al., 2007). In the "end-point" perspective, "the assessment of vulnerability is the *end point* of a sequence of analyses beginning with projections of future emissions trends moving on to the development of climate scenarios, thence to biophysical impact studies and the identification of adaptive options" (Kelly & Adger, 2000, p.327; emphasis is original).

Hence, in this interpretation vulnerability is characterised by the net impacts of climate change after viable adaptation measures have been undertaken (Füssel, 2005). In another expression, vulnerability represents climate change impacts minus adaptation (i.e., Vulnerability = Climate change impacts-Adaptation) (Gonsalves & Mohan, 2012). In this case, vulnerability can be measured in terms of monetary cost, reduced yield, human death and environmental degradation (O'Brien et al., 2007).

As can be seen in Figure 2.1, the "end-point" view of vulnerability can also be described as outcome vulnerability, where it is treated as a linear consequence of projected climate change impacts after considering adaptation options (O'Brien et al., 2007). According to Kelly & Adger (2000), this approach is relevant mainly in developing mitigation policies regarding greenhouse gas emissions and in international aid. Outcome vulnerability coincides with the scientific framing of climate change problem (O'Brien, 2007, p.76). In this framing, vulnerability is "an outcome that can be quantified and measured, and reduced through technical and sectoral adaptation measures, as well as by reducing greenhouse gas emissions'' (O'Brien, 2007, p. 76).

Figure 2.1: Outcome vulnerability



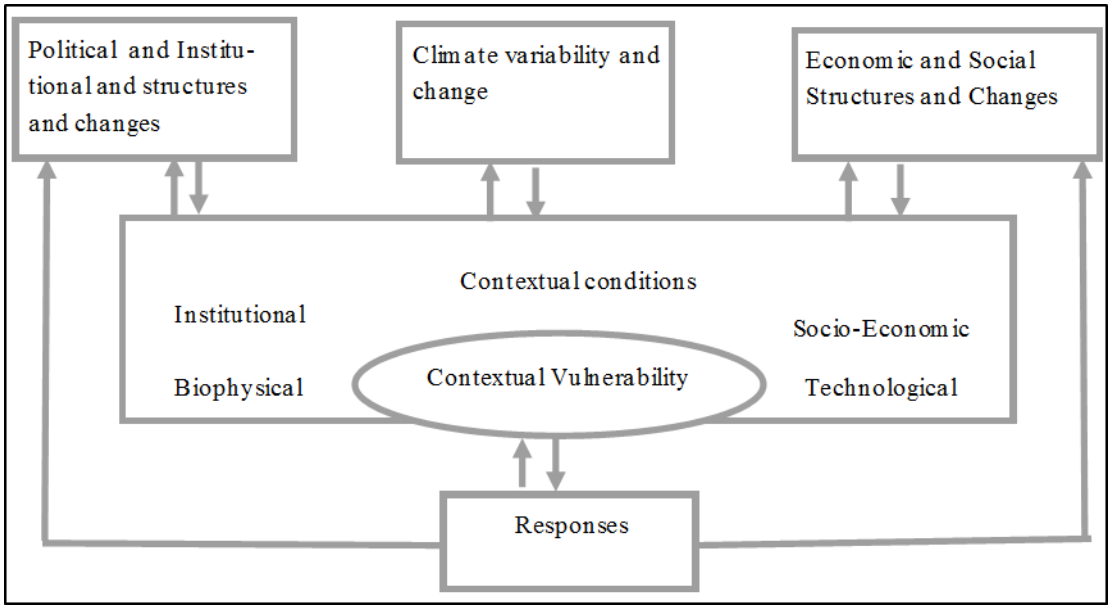
Source: O'Brien et al., 2007, p. 75

On the contrary, in the "starting- point" interpretation, vulnerability is viewed as a current state or pre-existing incapacity of people to cope with external stressors caused by climate change (O'Brien et al., 2007). In this perspective, vulnerability is not only the result of climate conditions but also a product of multidimensional contextual or socio-economic factors (O'Brien et al., 2007).

As Figure 2.2 indicates, a starting-point interpretation of vulnerability coincides with contextual vulnerability (O'Brien et al., 2007). Therefore, it is assumed that tackling present contextual vulnerability to climate change and variability helps to address future climate conditions (Burton et al., 2002; Füssel, 2005), and this is realized by examining the fundamental causes of vulnerability (O'Brien et al., 2004). Central to the starting-point interpretation is the consideration of vulnerability as a dynamic process, due to ongoing socio-economic and institutional changes (Leichenko and O'Brien, 2002; O'Brien, 2004). The vulnerability assessment under the "starting point" viewpoint seeks to explore relevant policies and strategies that address current vulnerability or to enhance the adaptive capacity of people to stresses (Kelly & Adger, 2002).

Contextual vulnerability is associated with human security framing of climate change, which views human-environmental interaction as inseparable components of the same setting (Forsyth, 2003). In this framing, adaptation measures are not only undertaken in response to changes in climate conditions, but they are viewed as adjustments to various stresses and transformations (Klein et al., 2007). Indeed, Eriksen et al., (2015) argue that adaptation must not be considered as a mere response to environmental changes but also as an element of societal change and processes.

Figure 2.2: Contextual vulnerability



Source: O'Brien et al., p.75

According to O'Brien et al., (2007), the two perspectives of vulnerability are not only about different interpretations of vulnerability, but also about the different framing of climate change problems, the type of questions prioritized and the methods followed. As a result, the authors provided a diagnostic tool to help distinguish whether a particular climate change research is addressing "end-point" or "starting-point" interpretations of the vulnerability based on the question raised and the methods adopted (see Table 2.2). The main distinction between the end-point and starting-point interpretation of vulnerability is their approach in terms of adaptation — the former conceives that adaptation and adaptive capacity determines vulnerability while the later assumes vulnerability determines adaptive capacity and hence adaptation options (O'Brien et al., 2004). In this thesis, the second-point interpretation of vulnerability is adopted.

Table 2.2: Diagnostic tool for identifying interpretations of vulnerability

	Outcome		Contextual
Prioritized questions	Are human activities contributing to dangerous climate change		Is climate change a relevant problem ?
	Which sector is likely to be negatively affected ?	Who is negatively affected by climate change	Why are some regions and social groups affected more than other ?
Focal points	Future climate change Sectoral sensitivities	Multiple stressors Institutions	Current climate variability Political economy (social Capital Livelihood and Coping Strategies
Methods	Dose-Response models Integrated assessment Models	Scenario-based Approaches Agent –based modelling Indicator approaches	Household Survey Cases studies
Identified Results	Measurable losses and gains Sectoral impacts Inappropriate Practice		Relative Winners and Losers Key interacting Processes Institutional and Socio-economic Constraints to local response
Policy Response	Reduced sectoral Sensitivities Technological Adaptations Reduced GHG Emissions	Capacity Building Adaptive management	Address local constraints to Responses Reduce inequalities Alternative Development Address Power Structures

Source: adapted from O'Brien et al., 2007

2.4 Approaches to vulnerability assessment

2.4.1 The Biophysical approach

The biophysical or hazards approach assesses " the vulnerability of a human system as determined by the nature of the physical hazard(s) to which it is exposed, the likelihood or frequency of occurrence of hazard(s), the extent of human exposure to hazard, and the system's sensitivity to the impact of the hazards" (Brooks, 2003, p.4). Studies that follow this approach typically concentrate on the extent of loss incurred (e.g. people at risk and property damage) due to climatic events such as flood, droughts and hurricane (Cutter, 1996; Dolan & Walker, 2006).

Hence, this approach aims to measure vulnerability by asking questions such as "what is the extent of climate change problem?" (O'Brien et al., 2004, p.3). For example, climate change impact studies use models to quantify the impacts of climate variables on crop yield and farm income (Deressa and Hassan 2009). This approach is in line with an "end-point" treatment of vulnerability (O'Brien et al., 2007). While useful in examining exposure to hazardous events and measuring the severity and magnitude of harm, a weakness of this approach is its failure to take account individuals' socio-economic factors that give rise to susceptibility to harm (Füssel, 2007).

2.4.2 The Socioeconomic (social vulnerability) approach

The second approach is known as socio-economic (social) vulnerability (Adger, 1999). In this formulation, vulnerability is considered as "a socially-constructed phenomenon influenced by institutional and economic dynamics" (Adger & Kelly, 1999, p.253). Hence, the focus is on the broader range of economic, sociocultural, historical and political factors that determine individual's and group's vulnerability and coping capacity to climate hazards (Cutter, 1996). Social vulnerability is influenced by poverty, inequality and political marginalization (Adger and Kelly, 1999). Some of the basic research questions asked by scholars in this approach are "who is vulnerable to climate change and why?" (O'Brien et al., 2004: p.3), "how do human conditions and process attenuate or amplify vulnerability?" (Ford et al., 2010: p.337). As Füssel and Klein (2006) emphasized, a pertinent future of this approach is its consideration of important "non-climate drivers" (e.g., economic, demographic, socio-political and biophysical drivers) which determine individuals' exposure and their responses in a wider context. This approach is consistent with a discourse where vulnerability is treated as a "starting point" rather than an "end-point" (Kelly and Adger, 2000). A limitation of this approach is the

marginalization of natural hazards and the actual damages caused by climate change as the analysis is more concentrated on the underlying social and political processes that generate vulnerability (Cardona, 2004).

2.4.3 Integrated approach

The limitations of biophysical and social vulnerability perspectives led to the development of integrated approaches to climate vulnerability research. This divergence of focus from the conventional approaches arises from the need to understand the complex interaction of both the biophysical and social system driving vulnerability. This third approach, also known as "hazard of place'', conceives vulnerability as a combination of hazard events and social processes that determine the exposure of people to harm and constrain their capacity to adapt in response to the adverse impacts (Cutter, 1996).

Several studies have integrated and extended both the biophysical and social vulnerability elements (Cutter et al., 2000; Turner et al., 2003; Dolan & Walker, 2006; Füssel & Klein, 2006). As Füssel (2007) highlights, the integration of 'internal' and 'external' factors is the central focus of integrated approaches. In the context of climate change vulnerability, for example, O'Brien et al (2004) in their study of "double exposure", have examined the influence of both natural hazard stressors and the underlying socio-economic factors.

However, some scholars are skeptical when it comes to integrating the two different approaches as they differ in their conceptualization of the character and causes of vulnerability (O'Brien et al., 2007). In fact, testing the usefulness of the integrated framework through three case studies, Turner et al., (2003b) observed the difficulty of examining the different factors and process in coupled human-environmental system empirically.

Overall, others continue to support the use of this approach as it provides a comprehensive understanding of both the biophysical and social elements of vulnerability assessment and their meaningful comparisons (O'Brien et al., 2004; Füssel & Klein, 2006; Dolan & Walker, 2006). Some studies urged the application of integrated approach through continues empirical investigation to overcome misunderstandings across disciplines and to test its practical applicability in a real context (Soares et al., 2012).

2.5 Components of Vulnerability

In the climate change literature, vulnerability generally encompasses elements of exposure, sensitivity and adaptive capacity (Turner et al., 2003; Smit & Wandel, 2006). Exposure is defined by the IPCC more broadly as "the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected." (IPCC, 2014, p.123). Sensitivity refers to "the susceptibility of an entity or system to the effects of an exposure" (Bennett et al., 2016, p. 908), while adaptive capacity is defined as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014, p.118).

More specifically in human systems, adaptive capacity refers to "the potential of the system to reduce its social vulnerability and thus to minimize the risk associated with a given hazard" (Brooks, 2003, p.13). In this view, vulnerability and adaptive capacity are negatively correlated (i.e., a community that has higher adaptive capacity will be less vulnerable and vice versa) (Füssel & Klein, 2006). According to Smit & Wandel (2006), environmental and social drivers determine the exposure-sensitivity of a system, and different socio-cultural, political and economic drivers also shape adaptive capacity.

Adaptations are a reflection of adaptive capacity, and they indicate measures of reducing vulnerability (Smit & Wandel, 2006). The adaptive capacity of the individual systems either facilitate or raises obstacles against the likelihood of adaptation or the nature of any adaptation measures to be taken (Smit et al., 2000). The factors that influence the capacity of the individuals to take adaptation responses are known as determinants of adaptive capacity (Adger et al., 2007). These determinants of adaptive capacity depend on the availability of economic resources, the existence of technological options, the level of access to information and skills, infrastructural services, institutions, equity and perceptions of climate change (Smit & Pilifosova, 2003; Yohe and Tol, 2002). For example, economic development is an important component of adaptive capacity, as it may offer an opportunity to access technology and thereby to invest in adaptation measures (Adger et al., 2007). Moreover, regions with well-established institutions are believed to have higher adaptive capacity as compared to those with less effective institutional structures (Smit & Pilifosova, 2003).

Risk perceptions and awareness of climate change are also critical elements that influence the adaptive capacity of individuals and communities (Dolan & Walker, 2006). According to Grothmann and Patt (2005), adaptation responses are taken if a person's risk perception is high (e.g perceived severity of drought). A section on the link between adaptation and climate change risk perceptions and observations is presented in section 2.8.

2.6 Differential and dynamic vulnerability

People in today's world are differentially vulnerable to current climate variability and change due to structural factors (Adger et al., 2003). The summary report of IPCC indicates with high confidence that differential vulnerability emanates from non-climate factors and unequal development processes (IPCC, 2014). For instance, the report documents that social discrimination based on gender, wealth, age and ethnicity amplify vulnerability rather than any single climate factor (IPCC, 2014).

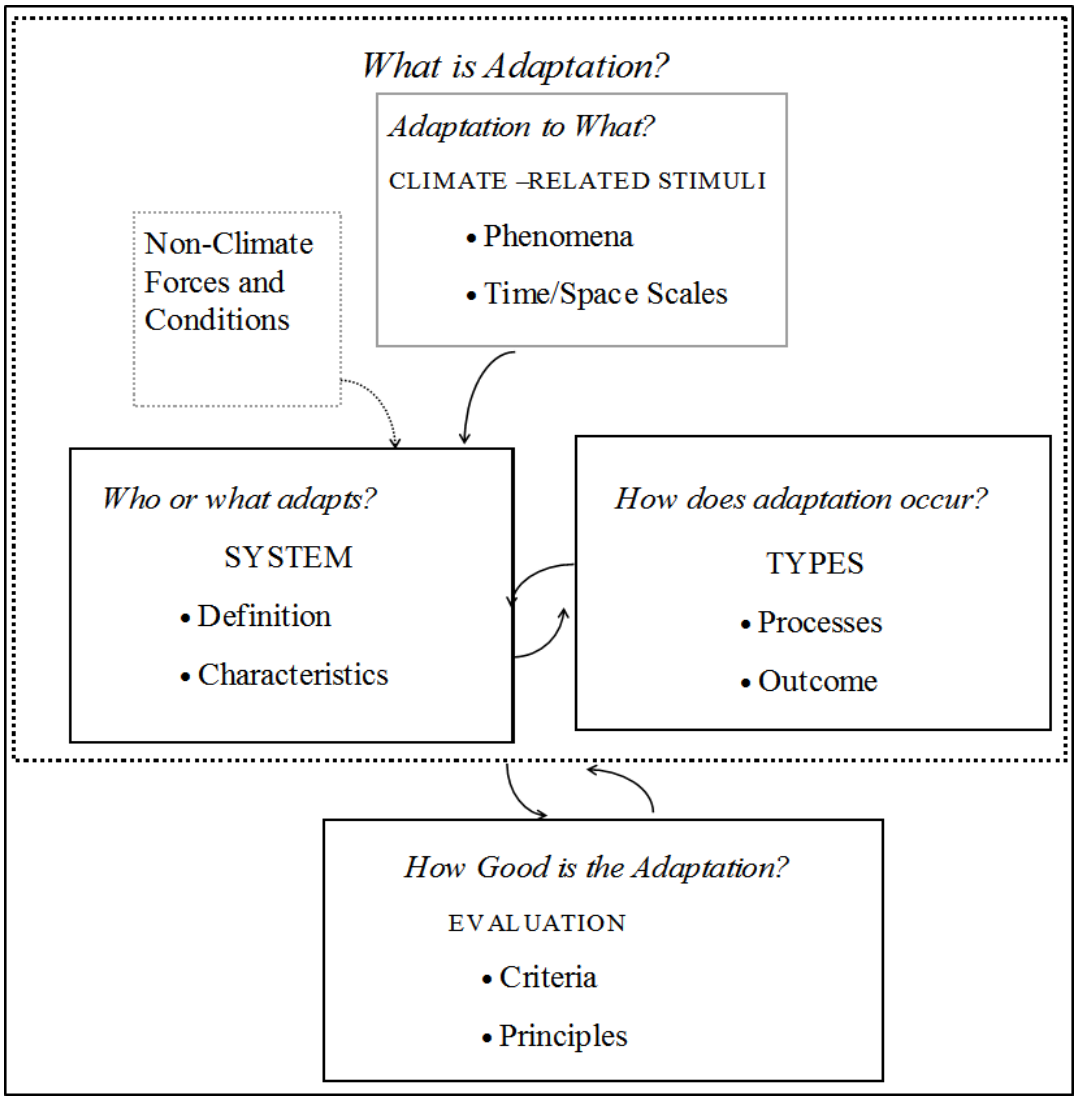
Climate conditions will interact with other stressors such as population growth, poverty and diseases to produce differential vulnerability particularly among the poorest segment of the world's population (Kasperson & Kasperson, 2001). In this respect, Africa is often cited as one of the most vulnerable regions in the world (Mertz et al., 2010; Busby, 2014; Niang & Ruppel, 2014). For this reason, vulnerability is regarded as context-specific and varies within countries (Adger et al., 2004 Brooks, 2005). Hence, to better understand climate change and its effects, recognizing differential vulnerability is vital (Kasperson & Kasperson, 2001).

One of the key characteristics of vulnerability which is recognized in the climate change field is its dynamic nature (Eriksen et al., 2005; Dilling et al., 2015). Vulnerability is viewed as a process in a continuous change both temporally and spatially (Adger & Kelly1999; Leichenko & O'Brien, 2002; Dilling et al., 2015). This dynamic characteristic of vulnerability is associated with rapidly changing technological, economic and institutional factors (Leichenko & O'Brien, 2002). According to Dilling et al., (2015, p.421), "the dynamics of vulnerability also remind us that climate change is one stressor in a complex suite of stressors and moving goals, and that efforts to reduce vulnerability in the system overall must consider how these stressors interact".

2.7 Adaptation

The concept of adaptation has a wider application by different users who work with global environmental change and hence there are different interpretations and use of its term in the literature (Smithers & Smit, 1997). Attempts have been made to synthesize concepts of adaptation through frameworks (e.g. Smithers & Smit, 1997; Bryant et al., 2000; Smit et al. 2000). As shown in Figure 2.3, Smit et al. (2000), developed a framework called the "anatomy of adaptation" which raises four basic questions to clarify the concept of adaptation. These questions include: (1) what is adaptation (i.e., adaptation to what)? (2) Who or what adapts? (3) How does adaptation occur? (4) How good is the adaptation?

Figure 2.3: Gross Anatomy of adaptation to climate change and variability



Source: Smit et al., 2000, p.230

2.7.1 Adaptation definitions

Various definitions of adaptation have been proposed in the literature based on different disciplinary and conceptual backgrounds (see Table 2.3). The word adaptation has its roots in the natural sciences (namely biology and evolutionary ecology), and it generally refers to the formation of genetic characteristics which creates a conducive environment for organisms to adapt and reproduce (Winterhalder, 1980; Kitano, 2002). In Anthropology, adaptation has been viewed as "one by which groups of people add new and improved methods of coping with the environment to their cultural repertoire" (O'Brien Holland, 1992, p.37). Clearly, the focus here is on human-environment interactions in a cultural context.

In the context of climate change, one of the earliest definitions of adaptation refers to "the process through which people reduce the adverse effects of climate on their health and well-being, and take the advantage of opportunities that their climatic environment provides" (Burton, 1992, cited in Smit et al., 2000, p. 227). With a focus on vulnerability, Pielke (1998, p.159) defined adaptation as "adjustments in individual groups and institutional behavior in order to reduce society's vulnerability to climate". Others emphasized the concept of resilience and referred to adaptation as "change in response to environmental conditions, which maintains, preserves or enhances viability of the system of interest" (Smithers & Smit 1997, p.139). Other definitions of adaptation have also been suggested, with a focus on responses to climate change or both climate change and variability, and with different units of analysis (i.e., individual, community or sector) (see Table 2.3). Therefore, the wider application and interpretation of the term adaptation meant that studies need to delineate the treatment of adaptation in that particular analysis (Smit et al., 2000).

For the purpose of this thesis, the definition of climate change adaptation by Moser & Ekstrom (2010, p. 22026) is adopted as follows:

> *Adaptation involves changes in social-ecological systems in response to actual and expected impacts of climate change in the context of interacting no climatic changes. 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.*

Table 2.3: Summary of adaptation definitions by different scholars

Author(s)	Definitions
Rennie & Sing (1996, p.18)	The ways in which local individuals, households and communities have changed their mix of productive activities, and modified their community rules and institutions, in response to vulnerabilities, in order to meet their livelihood needs.
Smithers & Smit (1997, p.139)	Adaptation involves change, in response to environmental conditions, which maintains, preserves or enhances viability of the system of interest.
Pielke (1998, p.159)	Adjustments in individual groups and institutional behavior in order to reduce society's vulnerability to climate.
Brooks (2003, p.8)	Adjustments in a system's behaviour and characteristics that enhance its ability to cope with external stresses.
Smit & Pilifosova (2001, p. 881)	Adaptation is adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts.
Smit & Wandel (2006, p.282)	A process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity.
Adger (2007, p. 720)	Adjustments to reduce vulnerability or enhance resilience in response to observed or expected changes in climate and associated extreme weather events.

2.7.2 Adaptation to what?

The first component in the framework by Smit et al (2000) attempts to make the definition of adaptation explicit by considering one basic question (i.e., adaptation to what?). This question in the framework deals with climate stimuli and the role of non-climate drivers and conditions. Climate stimuli have long been known by the term *stress* or *hazards (*Burton, 1997). The climate parameters in which adaptation responses are needed are commonly divided into three broad groups as: "(1) long-term changes in means or norms, (2) inter-annual or decadal variability, (3) isolated extreme events or catastrophic weather conditions, such as floods, droughts or storms" (Smit et al., 1999, p. 205). This implies that, climate stimuli in which adaptation takes place must be pointed out (Smit, 2000). This is because adaptation might be undertaken in response to climate change, climate variability or both (Smit et al., 1999).

Impact and adaptation studies tend to focus on adaptation to long-term climate change (Smit and Pilifosova, 2003). However, regarding consideration of adaptation to long-term climate change or adaptation to climate variability (extreme events), scholars argue that studies need to incorporate both (Burton, 1997; Smit et al., 1996). One rationale for this is that in different parts of the world (especially in developing countries), long-term climate change is not as testing an issue as that of the climate variability they face currently (Smit et al., 1996). Second, integrating climate change with climate variability helps to design better national and international strategies to manage future long-term climate-linked problems (Glantz, 1992). In this study adaptation refers to responses to both long-term climate change and climate variability (including droughts and floods).

In regard to non-climate forces, studies have noted that responses do not occur as a single measure to tackle climate change or variability regardless of its negative impacts (Smit & Skinner, 2002 Ford et al., 2014; Grüneis et al., 2016; Burnham & Ma, 2018). Adaptation can be measures taken to alleviate the negative influence of vulnerability and at the same time it could be undertaken because of some other opportunities (Smit et al., 1999). For example, market orientation could be a reason for changes in farming operations in agriculture, as equal as the climate factor (Smit & Skinner, 2002). Hence, "ascribing adaptation to climate change is not to simple process" (Adger et al., 2005, p.78). Adaptation response studies should systematically consider "adaptation to what?" for a better understanding of human responses and vulnerabilities (Smit et al., 1990).

2.7.3 What or who adapts?

The second element of the framework concentrates on defining the system of interest and its characteristics. Any analysis of adaptation requires specification of the boundaries and the system's subject (Smit et al., 2000). The systems subject relates to the unit of analysis in the adaptation. For example, adaptations are differentiated between "human systems" and "natural systems" (IPCC, 2014). Therefore, the focus is on the nature of the system as adaptation may occur in species, ecosystem or economic sector when facilitated by humans (Smit et al., 2000).

System definition in adaptation also relates to the scale of analysis (Smither & Smit, 1997). Adaptation may take place at individual-level, community, regional, national, or international levels (Smit et al., 1999; Smithers & Smit 1997; Kelly & Adger, 2000). Given spatial differences in adaptation, Vincent (2007) stresses the importance of scale and Brayan et al., (2009) suggest that national or international scale responses require local-level studies. Moreover, an adaptation study should consider the actors involved in the adaptation process (Füssel, 2007; Smit et al., 1999). For example, technological developments and government programs are facilitated by public agencies and organizations (Smit & Skinner, 2002) while farm management practices are conducted locally at an individual or farm level by farmers (Kandlikar & Risbey, 2000).

2.7.4 How does adaptation occur?

The third section of the framework relates to adaptation types based on different criteria. Various scholars have tried to classify adaptation into different categories. According to Smit and Skinner (2002), adaptation could be classified into four types based on: 1) Intent and purposefulness; 2) Timing and duration; 3) Scale and responsibilities, and 4) Forms. Adaptations maybe differentiated based on intent: as planned or autonomous (Carter et al., 1994). Planned adaptation strategies are conscious actions or policy measures most often implemented by public sectors in an effort to facilitate adaptation (e.g. infrastructural investment, or research project to enhance weather forecasting) (Fankhauser et al., 1999; Bryant et al., 2000). Planned adaptations are also called "purposeful" or "intentional" (Smit et al. 1999, p. 208).

Alternatively, actions undertaken mostly by individuals and private sectors maybe seen as autonomous, planned or a combination of both types (Smit 2000). Autonomous adaptations are also termed as "spontaneous" or "automatic" (Smit et al. 1999, p.208). The emphasis here is whether or not the actions are taken deliberately and who undertake the actions.

In terms of its "intentional" or "unintentional" nature, however, Fisher et al. (2010) note that there may not be a clear distinction between spontaneous and planned adaptation strategies. For example, a producer's choice of effective crop varieties that withstand harsh climate condition from the non-effective ones, based on long years of experience, maybe regarded as autonomous but it is also conscious effort, hence planned adaptation (Smit & Skinner, 2002).

Next, adaptation can be distinguished according to timing and duration. For instance, "reactive" or (responsive) adaptation takes place after the impacts of climate change and variability have been experienced (Glantz, 1992; Fankhauser et al., 1999). In contrast, "proactive" (anticipatory) adaptation involves prior preparation for the anticipated consequence of climate change in the future (Fisher et al., 2010). Therefore, the focus here relates to measures taken "before" or "after" the occurrence of climate change event. But again, the distinction maybe blurred in practice because "anticipation requires foresight and planning, whereas reaction does not require but may involve foresight and planning" (Fankhauser et al., 1999, p. 69). For example, a farmer who is affected by a recent drought, and anticipates that drought will continue or increase in the future, may change his farming practices or financial management to minimize the drought, and therefore this is a mixture of both reactive and proactive measure (Smit & Skinner, 2002).

Adaptations are also differentiated with respect to duration as short-term (tactical) or long-term (strategic) (Smit et al., 2000; Smit & Skinner, 2002). Some scholars also group short-term responses as "coping" and long-term as "adaptive" strategies, where coping mechanisms are emergency responses taken during livelihoods crisis while adaptive strategies are taken to sustain livelihood systems (Berkes &Jolly, 2001). For example, livestock selling is coping (i.e. tactical), while land use change could be regarded as long-term adaptation (or strategic) (Smit and Skinner, 2002). However, a coping strategy may change into adaptive responses through time as both are interlinked (Berkes &Jolly, 2001; Eriksen et al., 2005). Some authors argue that the effort to strengthen coping strategies is one way of facilitating adaptation to future long-term changes (Eriksen et al., 2005). However, an intervention aimed at addressing only short-term responses may fail to accommodate long-term adaptation needs (Weldegebriel & Prowse, 2013) or may amplify vulnerability to climate change in the long run (Ziervogel et al., 2008).

2.7.5 How good is the adaptation?

The last section of the "anatomy of adaptation" framework focuses on the evaluation of adaptation outcomes. Developing criteria to evaluate what makes adaptation successful is crucial in a situation where there is a resource constraint in dealing with the unknown climate change future (Doria et al., 2009). According to Smit et al. (2000), adaptation evaluations fall into two categories based on the adaptation types. The first evaluation mostly deals with autonomous (reactive) and the second relates mainly with planned (anticipatory) adaptations which are implemented by governments as part of policy interventions (Smit et al, 2000).

Attempts to evaluate adaptations may involve questions such as "how good is the adaptation?" (Smit et al., 2000), "what constitute a good adaptation policy?" (Megnan, 2014, p. 810), and how successful or effective are adaptation actions? (Adger et al., 2005, 2007). According to (Doria et al., 2009: p. 810), successful adaptation refers to "any adjustment that reduces the risks associated with climate change, or vulnerability to climate change impacts, to a predetermined level, without compromising economic, social, and environmental sustainability". The reverse of this definition may refer to maladaptation, since adjustment is considered maladaptive "if the action increases vulnerability or negatively affects actors' ability to deal with climate impacts or efforts to implement sustainable development goals (economic, environmental or social" (Juhola et al. 2016, p. 139). Indeed, the fact that there is a criterion to evaluate successful adaptations suggests that adaptations can also be unsuccessful, although a failed adaptation may not necessarily lead to maladaptation (Barnett and O'Neill, 2010).

There are several evaluation criteria to measure "successful" adaptations, for example, in relation to effectiveness, efficiency, equity and legitimacy (Adger, 2005). For example, in terms of equity, adaptation can be measured based on "winners" and "losers'" of adaptation policy outcomes (Adger, 2005). In parallel with this, there are certain principles to evaluate maladaptive outcomes. For instance, if adaptation measures "disproportionately burden the most vulnerable", then these actions are maladaptive (Barnett & O'Neill, 2010). In this thesis, the possibility of maladaptive outcomes that may arise both from autonomous and planned adaptation interventions will be assessed.

2.8 Maladaptation

As already stated above, the concept of maladaptation can help to evaluate the outcomes of adaptation practices that might be unsuccessful in reducing climate-linked risks or produce vulnerability instead. The term has been used in the late 1990s by Burton (1997) and Scheraga & Grambsch (1998). Burton (1997) used the concept to indicate how policies in different sectors could be maladaptive by exacerbating vulnerability. On the other hand, Scheraga and Grambsch (1998, p.87) considered maladaptation as one of the nine principles that need to be considered in adaptation policy since it can lead to "... negative effects that are as serious as the climate-induced effects being avoided."

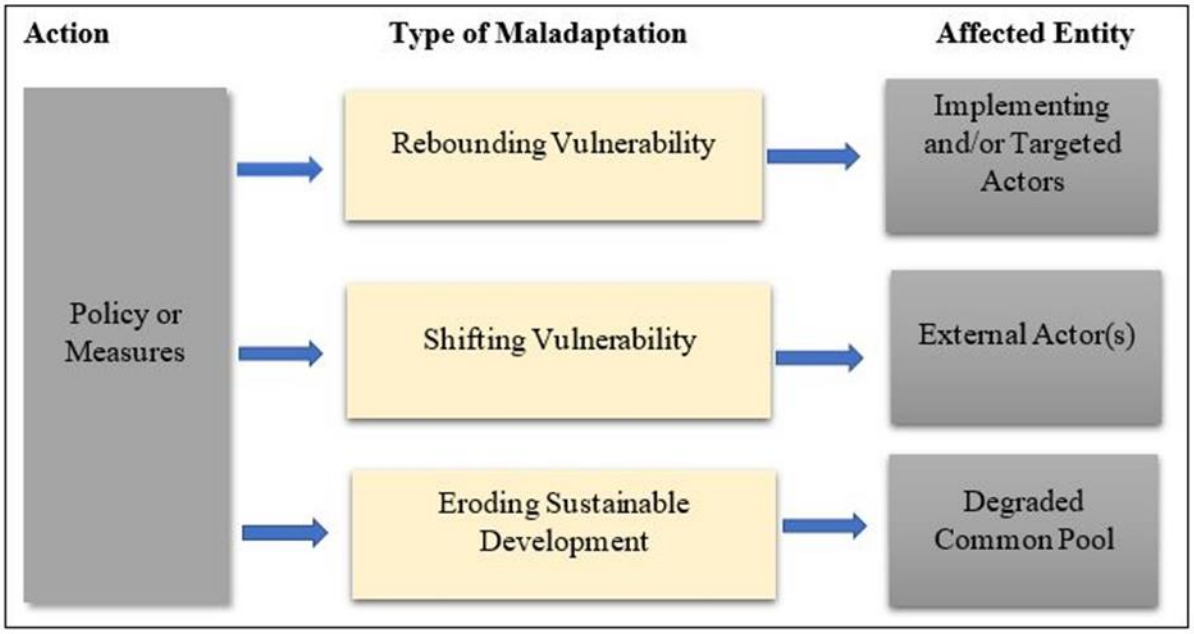
Barnett and O'Neill (2010; p. 211) defined maladaptation as "action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups". Following this definition, actions are considered maladaptive if they: (1) increase greenhouse gas emissions, (2) disproportionately burden the most vulnerable, (3) have high opportunity costs, (4) reduce incentives, (5) set paths that limit the choice of future generations (Barnett & O'Neill, 2010, p.211).

The definition of maladaptation also appeared in the glossary of the AR5-WGII report as: "actions that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future" (Agard et al., 2014, p.1769).

Despite the effort made to mainstream the maladaptation concept, some scholars argue that assessing maladaptation is difficult as there are no commonly agreed criteria or measurements and also due to the problems of subjective assessments (Granberg & Glover, 2014; Noble et al., 2014). This implies that one action that is perceived as maladaptive by one group or in a certain location might be recognized as a successful adaptation strategy by other groups or in different locations. This is exemplified by the case of migration where depending on the local condition or the individual characteristics, the strategy might be categorized as adaptive or maladaptive (Noble et al., 2014).

Against these drawbacks, Juhola et al. (2016, p.139) attempted redefining maladaptation as follows: "a result of an intentional adaptation policy or measure directly increasing vulnerability for the targeted and/or external actor(s), and/or eroding preconditions for sustainable development by indirectly increasing society's vulnerability".

Figure 2.4: Feedbacks in maladaptation



Source: Juhola et al., 2016

Accordingly, the authors identified three types of maladaptation outcomes based on various empirical findings of maladaptation cases as such:

1) Rebounding vulnerability (i.e. action that increases current or future climate change vulnerability of the implementing actor (or the targeted actor(s)).
2) Shifting vulnerability (an outcome that increases current or future vulnerability for one or several external actors). This type of maladaptation outcome emphasizes how large-scale adaptation action targeted to benefit one group in a specific location might cause an adverse impact on another location.
3) Eroding sustainable development (an outcome that increases greenhouse gas emissions and negatively impacts environmental conditions and/or social and economic value).

To facilitate its practical applicability, Juhola et al., (2016) argue that failed adaptation should not be considered as maladaptive outcome unless it leads to increased vulnerability or reduces the adaptive capacity of the society. In this thesis, the definition of maladaptation by Juhola et al., (2016) will be used to guide the analysis of maladaptive outcomes from autonomous and planned adaptation strategies.

2.9 Resilience and its link with the concepts of adaptation, adaptive capacity and vulnerability

The concept of resilience has been first used by ecologists to study ecosystem management (Holling, 1973). Since the late 1980s, however, it has been applied to study the interaction of social-ecological systems (SES) (Janssen & Ostrom, 2006). The term resilience is often interpreted as the ability of a system to absorb disturbances and shocks and still maintain the same structure and function after the occurrence of the events (Walker et al., 2004; Lei et al., 2014). The concepts of resilience, vulnerability, adaptation, and adaptive capacity are widely used across several fields such as in disaster risk reduction, ecology, and climate change (Berkes & Jolly 2002; Adger et al., 2005; Collier et al., 2009; Inaotombi & Mahanta, 2018). However, there is still little clarity or consensus on the relationship between resilience and the other three concepts (Cutter et al., 2008; Tyler & Moench, 2012; Lei et al., 2014).

Nelson (2011) argues that resilience and adaptation are related concepts as they both capture ways in which societies respond to disturbances. In his view, adaptation is a process of maintaining the resilience of a system (*i.e.*, adaptations are the steps and actions taken by humans to maintain resilience). Other scholars also consider adaptation as a component of the resilience system (Walker et al., 2009; Folke et al., 2010). However, there is a disagreement among scholars when it comes to the relationship between adaptive capacity and resilience. Some scholars treat them as similar concepts (Tompkins & Adger, 2004; Smit & Wandel 2006; Füssel, 2007; Stoddard & Cantor 2017). While others view adaptive capacity as a component of resilience ((Nelson 2011; Norris et al., 2008; Cohen et al., 2017). In this context, adaptive capacity is understood as the ability of a system to mobilize resources, knowledge, and skills, in order to influence and enhance resilience (Turner et al., 2003; Norris et al., 2008). This means that the higher the adaptive capacity within a system, the greater the chance that the system will be resilient in times of shocks (Engle, 2011, Nyamwanza, 2012).

There is a similar disagreement in the conceptualization of the relationship between vulnerability and resilience. Most scholars treat vulnerability and resilience as opposite sides of the same coin (Adger, 2000; Berkes, 2007; Lei et al., 2014; Wilson & Wilson, 2019). In a way, vulnerability is interpreted as a lack of resilience (Folke, 2006; Tyler & Moench, 2012). For example, when a social or ecological system lacks resilience, it becomes more vulnerable to shocks and disturbances (Kasperson & Kasperson, 2001;). Other scholars treat resilience as one component of vulnerability (Gallopín, 2006; Tyler & Moench, 2012). In this context,

vulnerability is interpreted as the exposure and sensitivity of a system to stresses and the ability or resilience of that system to adapt or recover from the effect those stresses (Smit & Wandel 2006).

This study acknowledges the importance of the resilience concept in studying how farmers interact with their environment and respond to shocks. However, due to the existence of conflicting understanding and interpretations on the relationship between resilience and the other three concepts (i.e., vulnerability, adaptation, and adaptive capacity), the main focus of this study will be limited to the later ones, to avoid confusions in the data collection, analysis and reporting of this study's findings.

2.10 The link between adaptation and climate change perceptions

Individuals and communities perceptions of changes in climate are important elements of the adaptation process (Adger et al., 2007). Earlier research asserted that perception is the first step in the adaptation phase and farmers need to detect the changes in their local climate before they take adaptation measures (Bryan et al., 2009; Maddsion, 2007). In this regard, an individual must be aware of the changes in the climate conditions before he/she perceives the changes as risk (Bohensky et al., 2013).

Risk perception of climate change is a critical motivating factor in adaptation action but so is perceived adaptive capacity (Grothmann & Patt, 2005). Indeed, "perception of risk or detection of changes in risk are not an end in themselves, but are signals to motivate proactive action" (Weber, 2014, p.3). Previous research emphasized the role of economic resource, infrastructure, technology and innovation, and governance in shaping adaptive capacity (Kelly & Adger 1999; Kates, 2000; Yohe & Tol, 2002; Jones et al., 2010). As important as socio-economic factors, cognitive factors such as risk perception of climate and awareness, are considered as key determinants of adaptive capacity (Dolan & Walker, 2006; Mercado, 2016).

Human judgements and climate change risk perceptions are complex and multidimensional (Weber, 2014; Van der Lidnen, 2015). This is because, public climate risk perceptions are driven and shaped by various socio-demographic, socio-cultural and psychological factors (Leiserowitz, 2006; Van der Lidnen, 2015). In this thesis, understanding the underlying socio-psychological factors influencing farmers' climate change risk perceptions is important to inform better strategies of communication climate change. The next section presents various theoretical viewpoints that explain climate change risk perceptions.

2.11 Climate change communication research and practice

Climate change communication is a growing field of study that explores individuals understanding of climate change and the factors that influence risk perceptions to provide better insights into communicating the issue of climate change to lay people (Chadwick, 2017). The field is highly interdisciplinary which covers a wide range of philosophical and research traditions (Moser, 2016; Chadwick, 2017). Hence, climate change communication is not merely a subfield of communication or climate research (Moser, 2016). One of the challenges of climate change communication as a research field is that there is no consensus among scholars on the meaning of communication, how it should be defined and used (Ballantyne, 2016). Another challenge identified by Moser (2016) is the disconnect that exists between climate change communication research and practice. Only a few researchers are engaged in sharing their social scientific insights with communication practitioners (Moser, 2016).

In terms of practice, much of the early climate change communication efforts focused on communicating the physical science of climate change in policy meetings and through conferences (Moser, 2010). However, climate change communication is now focused more on engaging the general public with the issue of climate change to motivate actions (Moser, 2010; Ballantyne, 2016). Despite great efforts, communication of climate change to lay people has been less effective and challenging (Chess & Johnson, 2007; Moser & Dilling 2011; Corner et al., 2014). This is largely because climate change is a slow-moving, invisible, and abstract phenomenon that is difficult for lay people to understand, perceive and relate to it (Nerlich et al., 2010; Moser, 2016). The complex and abstract nature of the climate change phenomena also poses a challenge to communicators to grab people's attention and engage them with the issue (Ballantyne, 2016; Markowitz & Guckian, 2018).

Another reason why communication of climate change is a very challenging issue is because of the existence of various social and psychological barriers to engaging people with the issue of climate change (Markowitz & Guckian, 2018). Peoples' understanding and perception of climate change is influenced by their pre-existing beliefs, culture, underlying values and worldviews (Leiserowitz et al., 2005; Goebbert et al., 2012; Howe & Leiserowitz, 2013; Corner et al., 2014). This poses a significant challenge for climate change communicators, as individuals tend to reject the information if it does not support their deeply held beliefs and values (Moser 2011; Markowitz & Guckian, 2018). Understanding the various socio-psychological factors that shape people's perceptions of climate change is important to improve communication efforts. The next section reviews the theoretical scholarship on factors that shape individuals' (risk) perceptions of climate change.

2.12 Climate change risk perceptions and determinants

2.12.1 Personal experience and the role of affect

Direct personal experience with extreme weather events shapes individuals' risk perception of climate change (Thomas et al., 2007; Lujala et al., 2015; Demski et al., 2017; Bergquist et al., 2019). For example, those who experienced flooding in the UK report more concern about climate change (Spence, 2011). Similarly, the frequent experience of drought events influenced farmers' risk perception in Thailand (Lebel et al., 2015).

Affect (emotion) is also an important element that influence individual's risk perceptions of climate change (Leiserowitz, 2006; Roeser, 2012; Smith & Leiserowitz, 2014). Leiserowitz, (2006, p, 48) defines affect as "a person's good or bad, positive or negative feelings about specific objects, ideas or images". Particularly negative affect is shown to increase perceptions of risks (Slovic et al., 2004). In the context of climate change, some research found that individuals who have negative feelings about climate change are more concerned about it (Leiserowitz 2006; Van der Linden 2015).

2.12.2 The role of knowledge and trust in information providers

Knowledge about climate change is considered as one dimension of risk perceptions (Sundblad et al., 2007). So far, numerous studies have attempted to address the cognitive understanding of climate change and how it shapes public risk perceptions (Siegrist & Cvetkovich, 2000; Malka, et al., 2009; Shi et al., 2016). Some studies show that knowledge of the causes and consequences of climate change significantly influence individuals risk perceptions of climate change (Hidalgo & Pisano, 2010; Van der Linden, 2015). In other words, individuals who possess greater knowledge of climate change tend to be more concerned about the issue of climate change (Milfont 2012; Tobler et al., 2012). Other studies indicate no significant relationship between climate change risk perceptions and knowledge (Brody et al., 2008).

Several studies have also explored the link between trust in information providers (e.g., scientists/ experts) and individuals' risk perceptions of climate change (Kellstedt et al., 2008; Malka et al., 2009; Buys et al., 2014; Arbuckle et al., 2015; Sullivan & White 2019). For example, Melka et al. (2009) found that people who trusted scientists as providers of credible information were more concerned about climate change. On the other hand, a study of Kellstedt et al., (2008) indicates that individuals who exhibited high trust in policy experts showed less concern about the issue of climate change.

2.12.3 The role of worldviews and human values

The cultural theory of risk focuses on the powerful role of worldviews in shaping individual's risk perception and behavior (Douglas & Wildavsky, 1982; Dake, 1991). According to Peter & Slovic (1996), four basic types of worldviews exist: hierarchical, fatalistic, individualistic and egalitarian. These four worldviews have been found to play key roles in determining risk perception of climate change and policy support (Leiserowitz, 2006; Kahan et al., 2011; Wang, 2017; Lacroix & Gifford, 2018). For example, some studies found that people with a more egalitarian worldview are more likely to be concerned about climate change than those whose worldviews are more individualistic (Shi et al., 2015; Xue et al., 2016).

Human values also play a key role in influencing risk perceptions (De Groot, 2013; Corner et al., 2014). Three human value orientations – (1) socio-altruistic values (more concerned for other humans); (2) biospheric values (more concerned for nature and environment) and (3) egoistic values (i.e., more oriented towards self-interest) – have been proposed to explain individual's risk perception (Stern et al., 1994; Schultz, 2001). These values have been tested empirically to explain individuals' risk perception about climate change (Van der Linden,

2015; Shi et al., 2016; De Dominicis et al., 2017). In particular, biospheric values were generally linked with increased climate change risk perception (Van der Linden, 2015).

2.12.4 Socio-demographic factors

Various socio-demographic factors have also been found to be linked with risk perceptions of climate change (Dang et al., 2012; Sundblad et al., 2007; Brody et al., 2008; Haq & Ahmed, 2017). In particular, gender is a key factor of climate change perception risk perception, where women tend to be more concerned about climate change than their male counterparts (McCright, 2010; Van der Linden, 2015). Equally important factors which are commonly associated with climate change risk perception are political affiliation, race, religion and educational attainment (see Smith & Leiserowitz, 2012). For instance, educational attainment was found to be the top-ranked predictor of climate change awareness and risk perceptions worldwide (Lee et al., 2015).

2.13 Conclusion

This chapter reviewed the academic scholarship on vulnerability, adaptation, maladaptation and climate change risk perceptions and its influencing factors. The review explored how various authors within the climate literature defined the term vulnerability and described the three conceptual approaches to vulnerability assessment. This review indicates that there is no generally agreed definition of the term 'vulnerability' but different scholars from various disciplinary backgrounds have defined it in various ways. This means the word vulnerability has wide interpretations and that there are different approaches to its assessment. This review found that within the climate change research, there are three dominant approaches to vulnerability assessment: (1) The biophysical approach, (2) The socio-economic (social approach), and (3) the integrated approach. This review also revealed that scholars have attempted to define and classify adaptation into four types based on: 1) Intent and purposefulness; 2) Timing and duration, 3) Scale and responsibilities, and 4) Forms. The review also revealed that scholars have developed several evaluation criteria to measure "successful" adaptations, for example, in relation to effectiveness, efficiency, equity and legitimacy. The concept of maladaptation has been suggested to evaluate the outcomes of adaptation practices that might be unsuccessful in reducing climate-linked risks and that may increase vulnerability instead. The chapter further reviewed climate communication research and the factors that shape individuals risk perception of climate change.

Chapter 3: Research methodology

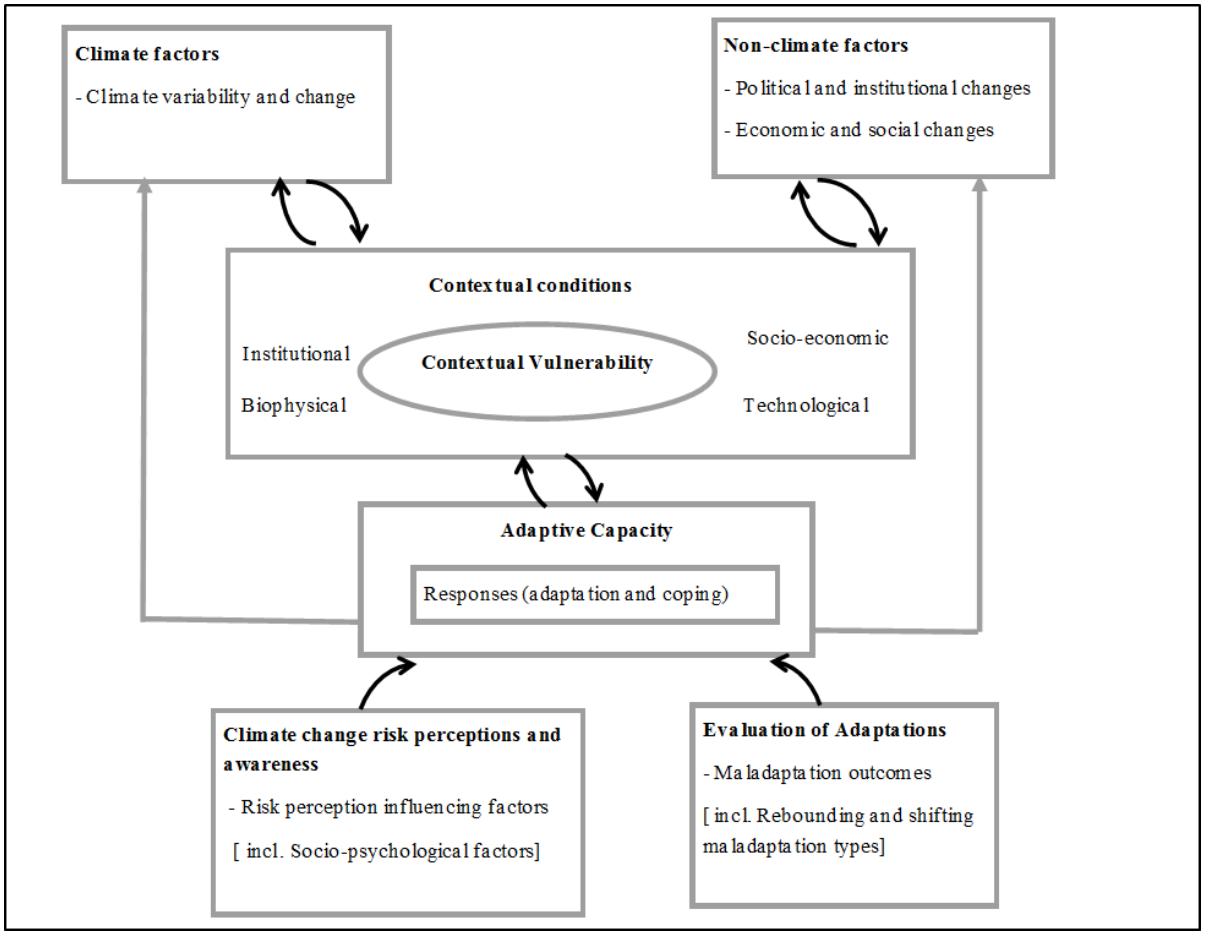
3.1 Introduction

This chapter presents the methodology of the study. It begins by introducing the conceptual framework of the study building on the literature review presented in the previous chapter. The chapter then presents the epistemological position of the study and the research approach adopted to fulfil the research objectives. This is followed by a description of the study region, the case study area and the specific study villages. The chapter then provides a detailed account of the various data collection methods employed to answer the research questions posed by the study and highlights the sampling techniques used to select research participants, the characteristics of the participants and research implementation process. The last section provides information about the data analysis techniques.

3.2 The conceptual framework of the study

This study introduces a conceptual framework that draws primarily from the contextual vulnerability framework by O'Brien et al. (2007) and is modified from the frameworks of Dolan & Walker (2006), Smit et al., (2000), Smit & Wandel, (2006), Juhola et al., (2016) and Van der Linden, 2015). The framework recognizes that climate variability and change occur in a state of ongoing political, institutional and socio-economic structure and changes which interact with inherent contextual conditions associated with a particular system to determine vulnerability. As Figure 3.1 shows, contextual conditions determine exposure to climate change and variability as well as the adaptive capacity of individuals or groups. Here, responses are "manifestations of adaptive capacity" (Smit &Wandel, 2006, p. 287). This framework explicitly considers that responses (adaptations) can be undertaken in response to climate factors (climate variability and change) and also due to non-climate drivers and conditions. Hence, it acknowledges the role of climate factors in conjunction with non-climate drivers in shaping adaptation responses (Smit, 1996).

Figure 3.1: Conceptual framework of the study



Adapted from O'Brien et al., 2007; Dolan & Walker, 2006; Smit & Wandel, 2006; Smit et al., 2000; Juhola et al., 2016; Van der Linden, 2015).

The model recognizes individual-level perceptions of climate risk and change that could enable and/or constrain adaptation responses. Risk perception and awareness are determinates of adaptive capacity as equal as other contextual factors (e.g., institutional arrangements, technology and resources) (Dolan & Walker, 2006). Adaptation evaluation is the last component which is added to the current framework to evaluate planned adaptations (Smit et al., 2000), that directly or indirectly increases individual's vulnerability to current or future climate change (Juhola et al., 2016).

3.3 The research philosophy

Philosophical positions shape the practice of research (Bryman, 2016; Creswell, 2011). Creswell (2011) suggests that researchers should explicitly communicate the philosophical position they adopt in their studies as it helps explain why they chose a particular research approach and data collection methods. Epistemology is a branch of philosophy which is particularly concerned with "the nature of knowledge and how it can be acquired"(Ormston et al., 2014).

The two dominant epistemological positions that shaped the development of social science research are that of "positivism" and interpretivism (Bryman, 2016). Positivism advocates that methods and principles of the natural sciences are suitable for social research investigation (Bryman, 1984; Tuli, 2010). Positivists hold the view that knowledge is acquired through the careful measure of the external or observable behaviour of individuals (Neuman, 2006). Thus, social science researchers who support positivism often use surveys to generate quantitative data that could be analysed using statistical techniques (Travers, 2001; Neuman, 2006). Interpretivism on the other hand, asserts that the natural science methods are not suitable for studying the social world. Interpretive researchers often use qualitative methods to understand the social world from the research participants' perspectives and their lived experiences (Neuman, 2006; Ormston et al., 2014).

A third philosophical position comes from the pragmatists who encourage social science researchers to be flexible and choose research methods that best suits the objective and the specific research questions of their studies (Morgan, 2007; Feilzer, 2010). In other words, pragmatism "is not committed to any one system of philosophy" (Creswell, 2011: p.10). It appreciates the value of both qualitative and quantitative techniques and the knowledge produced by such techniques (Denscombe, 2008; Onwuegbuzie & Leech, 2005). This study adopted a pragmatic position in order to understand farmers' perceptions of climate change, the climatic and non-climatic drivers of vulnerability and farmers adaptation responses to those drivers. Accordingly, a combination of both qualitative and quantitative methods was utilized to produce adequate knowledge from this research.

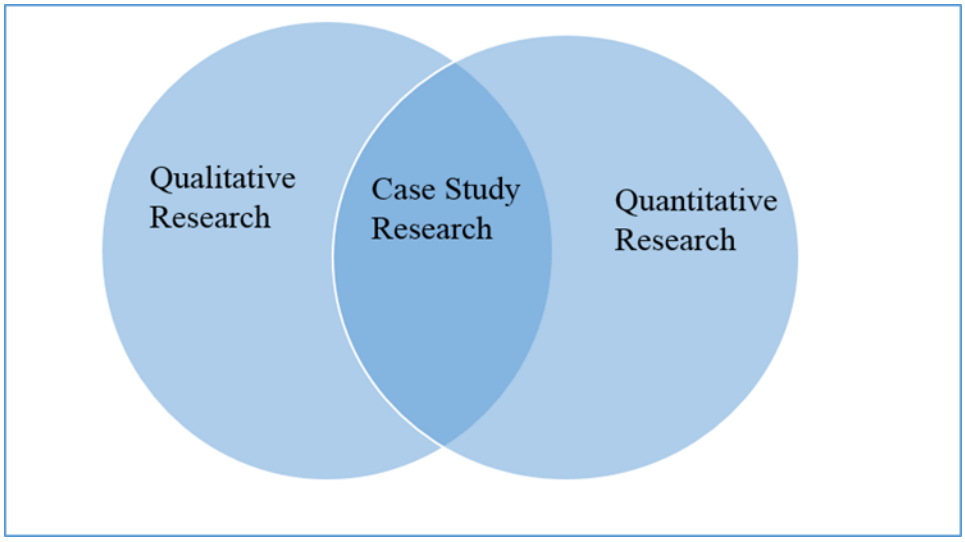
3.4 A case study approach

Case study as a research approach or methodology involves "a systematic gathering of enough information about a particular person, social setting, event, or group to permit the researcher to effectively understand how it operates or functions"(Berg, 2001, p. 225). The approach allows in-depth, multi-faceted investigation of complex phenomena in their natural settings (Baxter & Jack, 2008; Yin, 2009; Crowe et al., 2011). A case study approach was adopted in this study, given the fact that vulnerability is a complex research issue that requires a detailed investigation of the various factors that produce it.

Case studies are often characterized by their holistic approach in research investigation rather than studying isolated factors (Denscombe, 2010; Zainal, 2007). Since this study sought to fully understand how multiple factors (i.e. climatic and non-climatic factors) shape vulnerability and farmers' adaptation responses it was considered important to use a case study approach. In this regard, the approach allowed the researcher to examine the concepts of vulnerability and adaptation in a broader context.

One of the key advantages of a case study approach is that it invites researchers to use multiple-data collection methods from a variety of sources (Yin, 2009; Denscombe, 2010). Although a case study approach is more regularly used in qualitative studies, it is also used by quantitative researchers (Gray, 2009). As shown in Figure 3.2 below, a case study research can be qualitative, quantitative or a combination of the two (i.e., mixed method case study) (Baxter, 2016).

Figure 3.2: Intersecting domains of inquiry



Source: Baxter, 2016, p.132

Thus in a mixed-method case study, the researcher can use a variety of data collection tools such as observation, structured questionnaire, semi-structured and open-ended interviews and document analysis (Gray, 2009; Denscombe, 2010). This study adopted a mixed-method case study approach in order to understand the complex interaction of climatic and non-climate factors that make smallholder farmers vulnerable and how these farmers respond to these factors.

In case studies, researchers can follow one of the two main designs: a single-case design where a single topic is explored in-depth or a multiple-case design where several cases or subjects are studied in one study (Campbell & Ahrens, 1998; Gustafsson, 2017). Although a multiple-case design can be time consuming and expensive, it is preferred over a single-case design (Zach, 2006; Yin, 2009). This is because a multiple-case design allows a wider exploration of several research topics and thus the evidence generated through such a design tend to be more robust and reliable (Baxter & Jack, 2008; Gustafsson, 2017). This study adopted multiple-case design by examining several cases (subjects) to address the research questions posed in the previous chapter (Chapter 1).

In both single and multiple-case designs, researchers can either consider using just one unit of analysis (i.e. a holistic case study), or they can adopt multiple-units of analysis (i.e., an embedded case study) (Yin, 2003; 2009). Initially during the data collection phase, this study followed a holistic multiple-case design. This means, the researcher explored several research topics (cases) by taking one peasant association (*kebele)* as the unit of analysis. However, as the study progress, the design shifted from a *holistic* to an *embedded* multiple-case design. In other words, the researcher examined the various cases (research subjects) across four different villages, district and region (multiple units) rather than focusing on just one peasant association. Yin (2009) recommends researchers to be flexible in their case study design whenever required. In this study, a modification to the original case study design was necessary because some important findings could have been ignored, if the researcher did not pay attention to embedded units (e.g. villages).

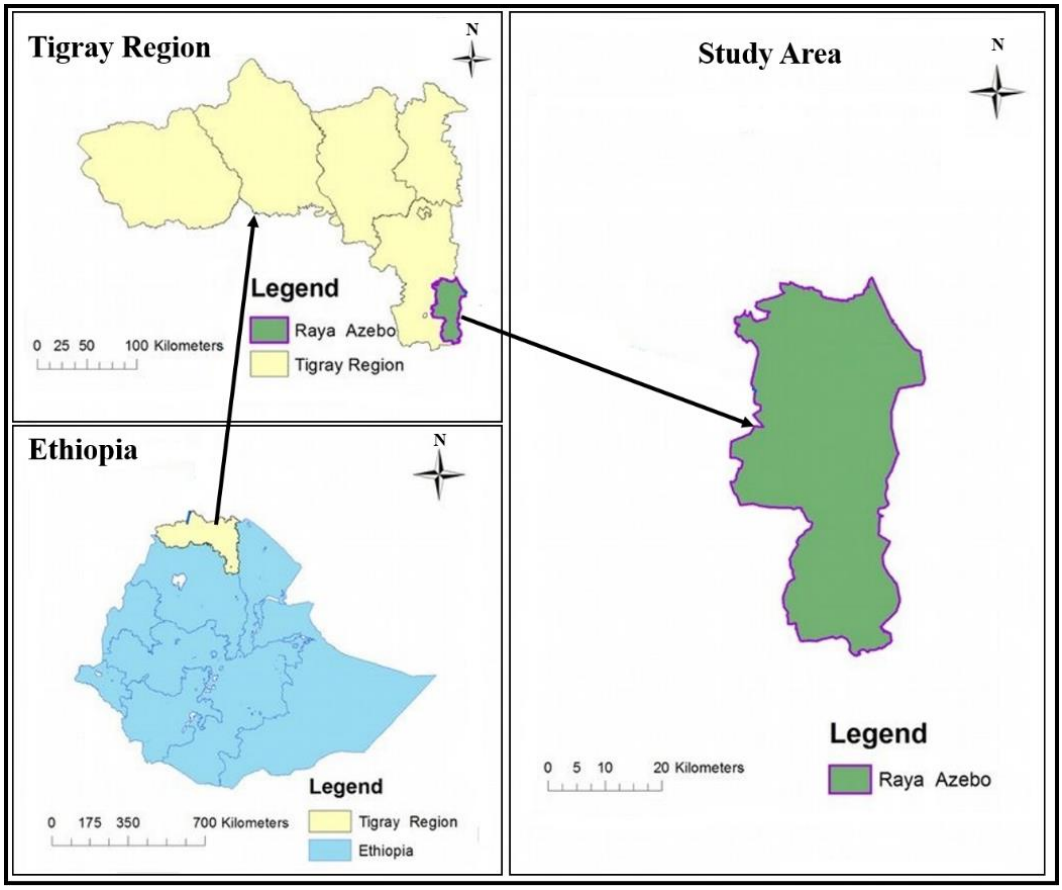
3.5 Description of the case study region, area, and villages

The Tigray national regional state is located at the Northern tip of Ethiopia. Geographically, it is situated between 12° 15' N and 14° 57' N latitude and 36° 27' E and 39° 59' E longitude. The regional state is made up of 7 administrative zones and 35 rural districts. The region covers approximately a total land area of 53,000 Km^2. The capital city of Tigray, Mekelle, is located about 783 km North of Addis Ababa. The total population of the region is 4.3 million out of which 83% live in rural areas (CCA, 2007). The altitude of the Tigray region ranges from 1500 – 3000 meters above sea level (ma.s.l.) The region has predominately a semi-arid tropical climate (van der Veen & Gebrehiwot, 2011). The mean annual rainfall across the region varies from less than 600mm in the east to an excess of 1200mm in the west (NMA, 2017).

The study was conducted in Raya Azebo district, which is one of the 35 districts in the Tigray region. The district lies between 12°47'50.22'' N latitude and 39°38' 36.44'' E longitude in the Southern part of Tigray region. It is located at a distance of 665 Km from Addis Ababa and 150 Km from Mekelle. The altitude of the district ranges from 1470 ma.s.l to 2370 ma.s.l. The administrative town of the district is *Mekoni.* Based on the national census conducted in 2007, the district has a total population of 135,870 (CCA, 2007). According to the data obtained from the district Bureau of Agricultural and Rural Development (BOARD), the total area of the district is 1343 Km^2, of which cultivable land is 35.15% and grazing land is 29.32%. The majority (96.9%) of the cultivable land in the district is rain-fed and only 3.1% is irrigated land.

The district has three agro-climatic zones, 47% of the area is *Kolla* (lowland), 50% *weynadega* (Midland) and 3% *Dega* (Highland) (NMA, 2017). Average annual rainfall ranges between 400-700mm, while average annual temperature for the area is between 15 ˚C and 30 ˚C (Bewket, al., 2015). The rainfall in Raya Azebo district is bimodal with two rainy seasons. The main rainy season – *meher* (summer) starts in June and ends in September, while the short rainy season *belg* (spring) begins around January and ends in March. In this district, the agricultural production system is mixed crop-livestock farming. The main crops produced in this area are Teff, Sorghum and Maize.

Figure 3.3: Location map of the study area



Source: Tembo, 2018

The Raya Azebo district has 18 *kebeles. Kebele* is the smallest administrative unit in Ethiopia (it is similar to a ward). Each *kebele* consists of either 3 or 4 villages. In total, the district has 68 villages. Out of the 18 *kebeles*, the specific *kebele* selected for this study was Hade Alega. Hade Alga *kebele* has four villages, namely Hade Alaga, Ade Tela, Dalata and Keyeh Tekely. These four villages were part of this study and they are described as follows.

Village 1 – Hade Alega

Hade Alega village has a total population of 3200 with 634 households, of which 359 are male headed and 275 are female-headed. This village is 20 km away from Raya Azebo district. It has a total land size of 3,176 ha, out of which 790 ha is cultivable land, 536 ha is grazing land and 1850 ha is forest land. The average annual rainfall ranges between 400mm and 600mm, while the mean annual temperature is between 18˚C and 28˚C. Households in this village follow mixed crop-livestock farming system. The dominant crops produced in this village are Sorghum, Teff, and Maize. The village has 3,215 cattle, 3,165 small ruminants, 437 draft animals.

In terms of rural infrastructure, Hade Alega village has better road access, transport facilities, pipe water and electricity service. In this village, there is one primary school (grade 1-8), one health post, two Orthodox churches and three mosques. There is also one local market centre where farmers sell and buy agricultural products. To access the main market centre, farmers had to travel to the *Mekoni* town of Raya Azebo district.

Village 2 - Ade Tela

Ade Tela village has a total population of 3,321 with 725 households, of which 400 are male headed and 325 are female-headed. This village is approximately 37km away from Raya Azebo district. It has a total land size of 705.25 ha, out of which 399.25 ha is cultivable land, 230ha is grazing land and 76 ha is forest land. The average annual rainfall ranges between 400mm and 600mm, while the mean annual temperature is between 16˚C and 27˚C. Households in this village follow mixed crop-livestock farming system. The dominant crops produced in this village are Sorghum, Teff, and Maize. There are 3,542 cattle, 4,340 small ruminants, 348 draft animals in this village.

Village 3 – Dalata

Dalata village has a total population of 1728 with 550 households, of which 350 are male headed and 200 are female-headed. This village is approximately 35 km away from Raya Azebo district. It has a total land size of 2,887.75 ha, out of which 885.75 ha is cultivable land, 1042 ha is grazing land and 960 ha is forestland. The mean annual rainfall ranges between 450mm and 700mm, while the mean annual temperature is between 18˚C and 28˚C. Households in this village follow mixed crop-livestock farming system. The dominant crops produced in this village are Sorghum, Teff, and Maize. The village has 1,823 cattle, 4,340 small ruminants, 348 draft animals.

Village 4 - Keyeh Tekely

Keyeh Tekely village has a total population of 1521 with 476 households, of which 275 are male headed and 201 are female-headed. This village is approximately 25 km away from Raya Azebo district. It has a total land size of 2,498 ha, out of which 490 ha is cultivable land, 620 ha is grazing land and 1388 ha is forestland. The mean annual rainfall ranges between 400mm and 650mm, while the mean annual temperature is between 17˚C and 28˚C. Households in this village follow mixed crop-livestock farming system. Similar to the other three villages, the dominant crops produced in this village are Sorghum, Teff, and Maize. The village has 1,823 cattle, 4,340 small ruminants, 348 draft animals.

Critera for the selction of the case study region, area, villages

This study selected Tigray as a case study region because the region is one of the most vulnerable regions in Ethiopia to the impacts of climate change (Deressa et al., 2008). Out of the 54 districts in the Tigray region, Raya Azebo was chosen, as the district has experienced very severe and recurrent droughts over the past few decades (Meze-Hausken, 2004; Gebrehiwot & van der Veen, 2013). Although the researcher used climate change exposure as the main criteria to select the case study region (district), the researcher understanding of the language spoken in the Tigray region was also taken as an additional criteria. The four villages were purposely chosen for two reasons. The first reason was that these villages are remotely located from the town of Raya Azebo district, and as a result, they have been rarely researched. The second reason was because of the availability of the required cases (e.g. the issue of land grabbing) in Ade Tela and Dalata villages and the presence of NGO-led adaptation program (Weather index insurance) in all the four villages.

3.6 Data collection methods

This study used both qualitative and quantitative methods to collect primary data. The qualitative methods used in this study included focus groups, historical timeline, pairwise ranking and semi-structured and unstructured interviews. The quantitative method employed in this study was survey questionnaire. The study also used document review to collect secondary data. The section below presents a description of each method.

3.6.1 Focus groups

The focus group is the most popular qualitative data collection method in social science research (Bryman, 2016). It is a method of interviewing a group of individuals to gain in-depth information on a specific topic or theme (Barbour, 2007; Bryman, 2016). Unlike group interview, focus group method promotes group interaction (Finch et al., 2014). In other words, the way focus group participants discuss a particular topic among themselves is important rather than simply interacting with the researcher (or moderator) (Barbour, 2007; Bryman, 2016). Focus groups are commonly used in the initial exploratory stage of a research project (e.g. to obtain quick background information and to develop (refine) the survey questionnaires or they can be used to obtain rich information from the participants (Rea & Parker, 2005). In this study, focus groups were used for both purposes.

During this study, five focus group discussions were conducted. The first two focus groups were held during the initial stage of the data collection period (8/11/2016). These two focus groups were conducted separately for men (n = 15) and women (n = 10). The purpose of these two initial focus groups was to identify the vulnerability factors (both climatic and non-climatic), and to understand their impacts on farmers' lives and livelihoods. One important advantage of the focus group method is that, it allows the individuals to raise core issues that are relevant and important to them (Bryman, 2016). In this study, the first question was unprompted (open-ended), to enable focus group participants to identify challenges (concerns) which are pertinent and significant to them and the community as a whole. Hence, the first question asked focus group participants to identify the various challenges they had experienced in their community without referring to climate change. After the open-ended question, participants were asked to discuss how the identified challenges affected their lives and livelihoods (see Appendix B).

Following the two initial focus groups discussions, a third one was conducted on 20 November, 2016. This focus group involved both women (n = 4) and men (n = 7) who participated from each village. The aim of this particular focus group was twofold: (a) to identify locally relevant farm and non-farm related adaptation strategies which are commonly practiced by farmers in the study area; (b) to elicit information about the key motivating factors (climatic and non-climatic conditions) that induce the locally identified farm and non-farm adaptation strategies. The fourth focus group was conducted with a group of 10 farmers (6 men and 4 women), who participated in a weather index crop insurance (WII) program. The objective of this focus group was to investigate the risk of maladaptive outcomes from the implementation of the WII program. The last focus group was carried out towards the end of the data collection period. The purpose of this focus group was to gather information regarding the effectiveness of the government-led watershed development program. A total of 10 farmers (5 women and 5 men) participated in this focus group discussion.

Criteria for the selection of focus group participants

In all the focus groups, participants were selected purposely based on the criteria that they: (1) have lived at least for 10 years in the case study area; (2) have a better knowledge of the local conditions and the research topic under investigation; (3) can express the views and concerns of the village they represent. To recruit focus group participants, convenience and purposive sampling techniques were used. To discuss the watershed-development program, participants were selected using convenience sampling technique (i.e., they were invited to participate in the discussion when they were undertaking watershed development activities). Participants who took part in all the other focus groups were selected purposively. Three development agents (DAs) who work in the study area and four village leaders assisted the researcher with the recruitment of focus group participants. During the selection process, efforts were made to include participants from both genders and different socio-economic and age groups. The participants involved in all the five focus group discussions were household heads. However, all the FGD participants were different from those who participated in the survey

The focus groups were conducted in a place where all farmers from the four villages gather for a meeting. Each focus group meeting started with an introduction of the research goal. Participants were made aware that their participation in the focus groups was voluntary, that they would not receive any monetary compensation, and that all the information they provided will be treated confidentially. All the focus groups were audio recorded based on the consent obtained from the participants.

All the discussions were conducted in Tigrinya, the official language used in the Tigray region. The researcher's knowledge of Tigrinya was very helpful in various ways. Most importantly, it avoided interpretation bias, which could have been a problem if the focus groups were conducted with the help of translators (Peña, 2007). The absence of a language barrier also facilitated the communication process and it built trust between the researcher and the focus group participants. Two other research assistants helped the researcher in facilitating the discussions and taking notes. Since everyone's viewpoint was important, the research encouraged each participant to speak in turn. Focus group meetings varied in duration from 1.5 to 4 hours.

3.6.2 Historical timeline

Historical timeline is one of the most important Participatory Rural Appraisal (PRA) techniques, which is used to identify and understand past events (e.g. environmental, economic social, political events), that have occurred in a particular community (Chambers, 1994; Uddin & Anjuman, 2013).

In this study, a historical timeline technique was used to collect information about major drought events that have occurred in the case study area over the last 45 years. From each village, four farmers who lived in their respective villages at least for 70 years (older community members) were selected purposely to participate in the timeline exercise. A timeline was drawn on a flip chart with a 10-year period intervals starting from the 1950s to 2015 and it was displayed on a whiteboard. Participants were then asked to recall major drought events that have occurred between those years (1950 – 2015). The major drought years that were recalled by the participants were written down on a flip chart (this is illustrated in chapter 6, Figure 6.2). This method was very useful in understanding the history of past and recent drought incidents that have affected the study area.

3.6.3 Pairwise ranking and scoring

Pairwise ranking is a PRA technique that allows communities to prioritize or rank various problems by comparing the problems in a systematic way (Russell, 1997). In this study, the pairwise ranking method was used to identify and understand the most important factors that contribute to livelihood vulnerability in the study villages, as perceived by the participants. In total, five pairwise ranking exercises (one in each village and one with district officials) were conducted. Each exercise was conducted with a group of 10 – 12 participants, which included both men and women. In the first stage of the exercise, participants were asked to identify factors that contribute to vulnerability. A list of all vulnerability factors which were identified by the participants were placed in a matrix table, which was constructed by the researcher and displayed on a whiteboard. Participants were then asked to compare each vulnerability factor with each of the other vulnerability factors until the matrix was completed. As the participants made the comparisons, the results were recorded in the matrix table. The final result was obtained by counting the number of times each vulnerability factor appeared in the matrix. (see Chapter 5, Table 5.6 -5.9).

3.6.4 Interviews

Gray (2009, p. 369) defines the interview as "a conversation between people in which one person has the role of researcher". Interview is a suitable research technique when the researcher wants to obtain insights into individual's opinions, experiences and attitudes (Gray, 2009; May, 1997). In this study, the two main types of qualitative interviews, namely semi-structured and unstructured interviews (Bryman, 2016), were used to collect information from key informants. The unstructured interviews were mainly used to triangulate and/or to clarify issues raised by farmers during focus groups and survey questionnaires. In unstructured interview, "there may be just a single question that maybe asked, and the interviewee is then allowed to respond freely" (Bryman 2016, p.468). In this study, during unstructured interviews, the researcher primarily asked a single question or introduced a theme and key informants were allowed to speak freely around the topic. In total, 25 unstructured interviews were conducted with key informants at regional and district levels. These key informants included land administration officers, drought early warning experts, agricultural experts, natural resource management coordinators, developments agent and crop insurance program coordinators.

A total of 15 semi-structured interviews were conducted with national, regional and district level government officials to elicit information on the factors that constrain climate change adaptation policy implementation at the local level. The key informants interviewed included individuals from the following government institutions:

1) Ministry of Environment, Forest and Climate Change
2) Tigray Environmental Protection and Land Use Administration agency
3) Tigray Regional State Bureau of Agriculture and Rural Development
4) Raya Azebo District Bureau of Agriculture and Rural Development
5) Raya Azebo District Finance and Economic Development Office

The key informants that were interviewed at national and regional levels were those who are directly involved in climate change adaptation policy formulation, planning and implementation. Lists of questions were developed to guide the interviews (see Appendix C). However, the interview guides were more flexible in order to accommodate the specific information needed from each key informant, and also to enable the key informants to share their views more freely and widely. Interviews with national level key informants were held in Addis Ababa, while regional level key informants were interviewed in, Mekele. All the

interviews were conducted face-to-face in the office of the key informants. The interviews lasted between 30 minutes and 1hour.

3.6.5 Household survey

A survey involves obtaining self-reported information from individuals about themselves (Rea & Parker, 2005). The technique is particularly useful when the researcher is interested in generalizing findings to a wider population by studying a small section of that population (Kelley et al., 2003; Rea & Parker, 2005). This study used a survey to investigate perceptions, vulnerability and adaptation of farming households to climate change in the context of non-climatic factors. In this study, the household is the basic unit of analysis, which is locally defined as a group of biologically related individuals who reside in the same dwelling house and which also include those living outside of the household but who make a contribution to the household income.

The respondents who were chosen for the face-to-face interview were the household heads due to their primary role in farm and non-farm related decision making within the household. Culturally in rural Ethiopia and in this particular case study area, the man is usually the head of the household. A woman becomes the head of the household if she divorces her husband or if he dies. The participants in this survey included both male-headed and female-headed households.

To administer the household survey, a structured questionnaire was developed (see Appendix D). Initially, the survey questions were developed based on an extensive literature review on climate change perception, vulnerability and adaptation. However, some of the research questions were later modified based on the insights gained from focus groups. In this regard, the information gathered through focus groups was helpful in informing the development of the structured questionnaire before the implementation of the final household survey. The modified questionnaire was categorized into themes which incorporated household socio-demographic characteristics, farmers' climate change (risk) perceptions and the influencing factors, the climatic and non-climatic drivers of livelihood vulnerability and farmers' adaptation responses to those drivers. Almost all the questions in the questionnaire had close-ended response categories to increase the chance of response rate and to compare respondents' answers more easily (Rea & Parker, 2005). However, some of the close-ended questions had an open-ended question in the form of "others, please specify" to allow respondents to provide answers which may not have been included in the fixed list of response options.

Prior to the implementation of the actual household survey, a pre-test was conducted with 20 farm households. A sample size of 20 farmers for pre-testing the survey was determined based on the recommendation of Rea & Parker (2005). The pre-test was conducted to ensure that that questionnaire was easy to complete (e.g., in terms of the length of the questionnaire) and that the questions were unambiguous (Chadwick & Albrecht, 1984; Gray, 2009). After the pre-testing, the researcher realized that the questionnaire took a long time to complete, which consequently affected the response rate. Therefore, some detailed questions that were less important in answering the study's main research questions were removed.

After the pre-tests were conducted, the next step was to train enumerators who would assist the researcher with the data collection. Five enumerators who had a college degree and previous data collection experience in the study area were recruited for the administration of the questionnaires. A two-day training session was organized for the enumerators to familiarize them with the objectives of the research, the contents of the questionnaires, and ethical considerations of the study. The training was held in the town of Raya Azebo district.

Sample size and sampling strategy

The intended sample size for the household survey was 400. To reach this sample size, first proportionate sample was assigned to each of the four villages based on their total household population size obtained from the local administrative office (Table 3.1). Then from each village, the desired sample households were selected using a systematic random sampling technique (Bryman, 2016; Rea & Parker, 2005). The sampling procedure was as follows: First, a sampling interval was calculated using this equation k= N/n, where k is the sampling interval, *N* is the total household number in Had Alega and *n* is the sample size required. Hence, in this case, the sampling interval was 634/101= 6.2, which was rounded to 6. Then the next step was to choose a random starting number between 1 and 6 (i.e. the sampling interval). The number that was selected was 3. Based on these results, the 3^{rd}, 9^{th}, 15^{th}, 21^{st} houses were selected to administer the household survey. This procedure continued until the desired sample size of 400 was achieved. However, in some cases when the researcher or enumerators were unable to reach the selected household head or if he/she refused to participate in the survey, the neighbouring household head was chosen as a substitute.

To increase the likelihood of meeting household heads at home, the surveys were administered during weekends and holidays[1]. Each interview took between 1hr and 1:30hrs to complete. The surveys were administered between December 2016 and February 2017. The researcher and enumerators each completed a maximum of five questionnaires a day. Each survey took between 1hr and 1:30hrs to complete. Some of the interviews were audio recorded with the consent of the survey respondents. This was done to capture individual stories in relation to challenges experienced because of climatic and non-climatic factors.

Table 3.1: Total household population size and number of sampled households in each study village

	Total number of households	Sampled households
Ade Tela	725	135
Hade Alega	634	101
Dalata	550	95
Keyeh Tekely	476	69
Total	2,385	400

Data source (household population size): *kebele* administrative office

Socio-demographic characteristics of survey respondents

Table 3.2, shows the socio-demographic characteristics of the survey respondents. From the table, it is clear that the majority of the survey respondents (69.8%) were male and the remaining 30.2% female. In terms of age structure, most of the respondents (46%) were between 36-45 of age. Relatively, few respondents belonged to the young (18-25) and old age (65+) groups. Of the total 400 survey respondents, almost two-thirds of the respondents were married, 22.3% are widowed, 12.3% were divorced, and the rest 1.8% were single. It is important to note that most female-headed households in rural Ethiopia are either widowed or divorced. Indeed, the survey results show that, out of the total 122 female respondents, 63 are widowed and 42 are divorced. Table 3.2 indicates that the majority (46%) of the survey respondents had a large family size (between 5 - 8 children).

[1] In the study area those farmers who follow Orthodox religion do not engage in farming activities during saints' days.

Table 3.2: Socio-demographic characteristics of survey respondents

Socio-demographic variables		Total number (Frequency)	Percent (%)
Gender of the head of the household	Female	121	30.3
	Male	279	69.5
Age of the head of the household	18-25	24	6
	26-35	54	13.5
	36-45	184	46
	46-55	81	20.3
	56-65	43	10.8
	65+	14	3.5
Marital status	Married	254	63.8
	Widowed	89	22.3
	Divorced	49	12.3
	Single	8	1.8
Number of children within the household	No children	30	7.5
	1- 2	58	14.5
	3 - 4	119	29.8
	5-8	184	46
	8+	9	2.3
Religion	Orthodox Christian	334	83.5
	Muslim	66	16.5
Education	Don't read and write	343	85.7
	Read and write	42	10.5
	Primary education	9	2.3
	Secondary education	4	1.0
	Higher education	2	0.5
Annual income from November 2015 - October 2016 in Ethiopian Birr (ETB)	500 - 5,000	86	21.5
	6,000 -10,000	139	34.8
	11,000 - 25,000	86	21.5
	26, 000 - 40,000	52	13
	40,000 +	37	9.2

Source: Household survey (n = 400)

In relation to religion, all the survey participants are believers. The majority (83.5%) are Orthodox Christians, while a small minority (16.5%) are Muslims. As can be seen in Table 3.2, the status of education in the study area is very low. A large number of the survey respondents (85.6%) are uneducated. Few respondents (10.5%) can read and write without attending formal education. The remaining respondents have attended formal education up to primary (2.3%), secondary (1%) and tertiary level (0.5%). Annual household income level between November

2015 and October 2016 ranged from 500ETB to 40,000ETB. The majority of the survey respondents (35%) earned between 6,0000 to 10,000 ETB.

3.6.6 Document review

Documents can be an important data source in both qualitative and quantitative studies (Bryman, 2016). They contain "text (words) and images that have been recorded without a researcher's intervention" (Bowen, 2009: p.27). Documents can provide important background information and supplementary data that are needed for the research (Bowen, 2009). They can also be used to verify or support findings collected through other research methods (e.g. interviews) (Yin, 2009).

Hence, documents from various sources were used for this study in addition to the primary data collected through the qualitative and quantitative research methods. Three types of documents were analysed and used for the purpose of this study. The first types of documents were various published journal articles such as on climate change risk perception, vulnerability and adaptation. The second types of documents were published government policy documents related to climate change adaptation, agricultural and rural development in Ethiopia, which included:

- Ethiopia's National Adaptation Program of Action (NAPA)
- Ethiopia's Climate-Resilient Green Economy strategy (CRGE)
- Ethiopia's Programme of Adaptation to Climate Change (EPACC)
- Ethiopia's Growth and Transformation Plan (GTP)
- Sustainable Development and Poverty Reduction Program (SDPRP)

The third types of documents were mainly published and unpublished government reports which were used to collected demographic data, background information about Ethiopia and the case study area (villages).

3.6.7 Data analysis techniques

Both qualitative and quantitative data analysis techniques were employed to analyse the data gathered through the various methods described in previous sections. Qualitative data were analysed using a thematic analysis, which is one of the most common techniques to qualitative data analysis (Bryman, 2016). First, all the audio-records were transcribed from Tigrigna language into English by the researcher. Then all the transcripts were read through multiple times "to obtain a general sense of the information" (Carswell, 2009, p.185). Following that, the researcher used open coding strategy. This type of coding strategy *involves applying codes that are derived from the text* (Blair, 2015 p. 17). This means, the research did not use pre-set codes from the literature prior to the data collection, but rather generated the codes directly from the data. The different themes that emerged from the texts were noted down and later triangulated with the results of quantitative analysis. Direct quotes from farmers and key informants were used in the result and discussion chapters to "give readers a flavour of the original texts" (Nowell et al., 2017, p .11). All the qualitative data coding were done manually

Following the completion of the household surveys, the questionnaire data were coded and entered into the Statistical Package for Social Sciences (SPSS) version 22. The survey achieved high response rates (100%) and there was no missing data. To analyse the quantitative survey data both descriptive and inferential statistical techniques were employed. Descriptive statistical techniques made use of frequencies, percentages and means. These techniques were used mainly to describe the quantitative data related with farm households' socio-demographic characteristics, the climatic and non-climatic drivers of vulnerability and adaptation responses. The two inferential statistical techniques which are used in this study included Pearson's *r* correlation and ordered logistic regression.

3.7 Conclusion

This chapter has presented a description of the methodology applied to investigate perceptions, vulnerability and adaptation of farming households to climate change in the context of other multiple factors in the Tigray region of Ethiopia. It provided the conceptual framework guiding this study. The chapter also outlined the philosophical position of the study and the research approach followed to meet the research aim. It also presented a description of the study region, the case study area and villages. Further, this study has outlined the data collection methods and the techniques followed to analyse the data.

Chapter 4: Background to Ethiopia and the climate change policy context

4.1 Introduction

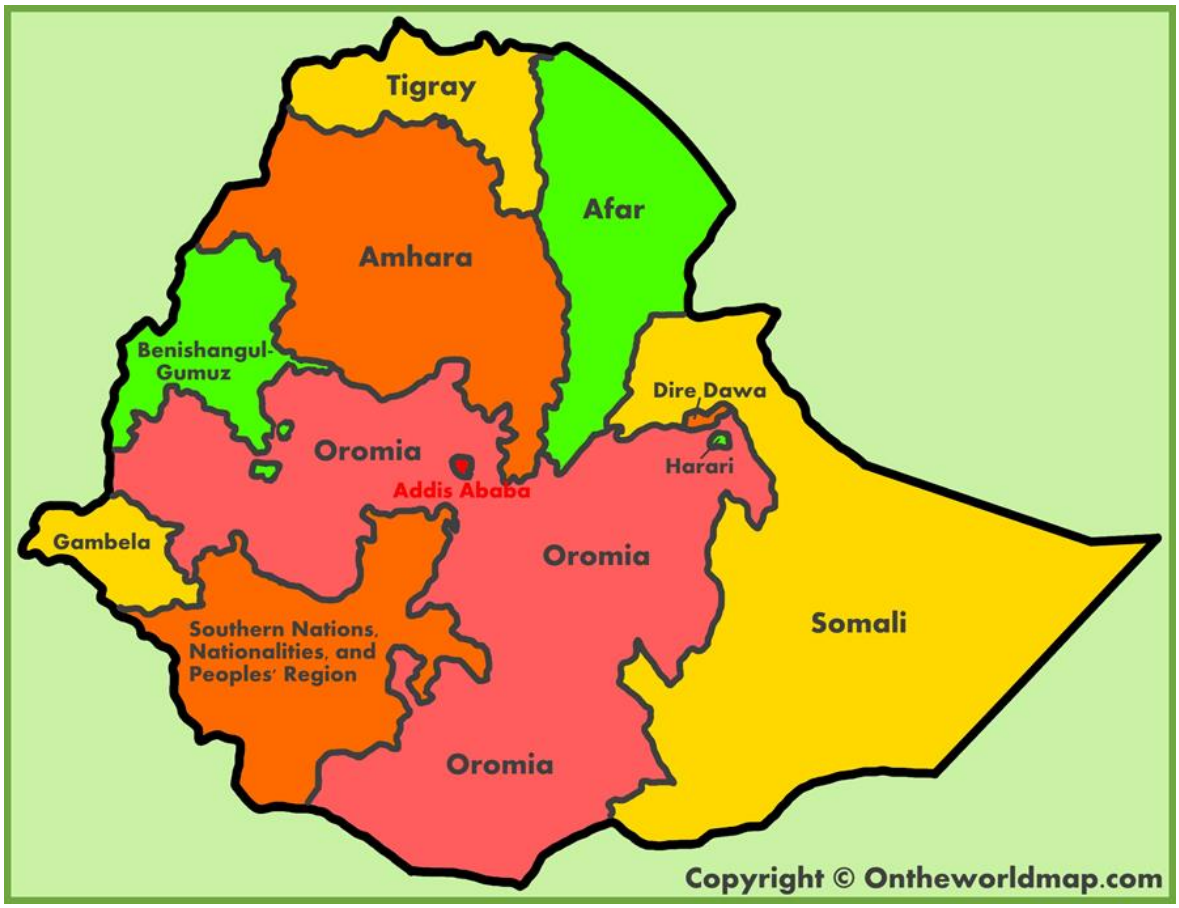
This chapter presents background information about Ethiopia in relation to the country's geographical location, demography, political context, and economy. Following this, the land tenure system, the broad development approach and the related agricultural policy context of Ethiopia will be presented. The chapter then presents a description of Ethiopia's institutional framework and policies to address the issue of climate change in the country. The last section assesses the content of the existing national climate change adaptation policies in order to understand how policymakers in their formulation of the policy documents conceptualized and interpreted vulnerability and prioritized adaptation measures.

4.2 Contextual background to Ethiopia

Ethiopia is situated in Eastern Africa. It is located between 9°8'42" N latitude and 40°29'22.8" E longitude. The country shares its border with Eritrea, Somalia, Djibouti, South Sudan, Sudan, and Kenya. In terms of land coverage, the country occupies an area of 1,096,570 sq. km. (CIA, 2018). With a total population of 108.3 million in 2018, Ethiopia is the second most populous country in Africa, and it is expected that the population will reach 191 million by 2025 (CIA, 2018; UN, 2017). Ethiopia has a very young age structure, as more than 63 per cent of the country's total population is under age 25 (CIA, 2018).

The country's population is diverse, comprising more than 80 ethnic groups. The major ethnic groups are the Oromo, Amhara, Somali and Tigrayan making more than 70% of the population (CSA, 2008). The official working language is Amharic but Oromigna and Tigrigna are also widely spoken. The major religion in Ethiopia is dominated by Orthodox Christianity which constitute 43.5% followed by Muslim 33.9%, Protestant 18.5%, traditional 2.7%, Catholic 0.7% and other 0.6% (CSA, 2008).

Figure 4.1: Location map of Ethiopia



Politically, Ethiopian societies had autocratic government for a long period. After long years of highly centralized monarchic rule, the last monarch Emperor Haile Selassie who accessed to the throne in 1931, was overthrown after a popular uprising in 1974. However, the popular uprising against the Emperor was followed by a repressive military dictator, Mengistu Hailemariam known locally as the Derg. In 1991, the dictatorial government was in turn expelled by a coalition of four ethnically defined rebels named the Ethiopian Peoples' Revolutionary Democratic Front (EPRDF). Since 1991, Ethiopia has transformed from a no party monarchic rule from (1931-1974) to one party-military dictatorship (1974-1991), to multiparty system with an elected government (1991- until present).

The country today is officially known as the Federal Democratic Republic of Ethiopia and has a parliamentary form of government wherein the Prime Minister is the head of government and the President is the head of the state. In 1995 a new constitution was adopted which introduced a federal system of government. This decentralized system devolves power to nine regional states along ethnic lines and two self-governing city administrations. Even though Ethiopia has a multiparty system, since 1991 one-dominant party that is (EPRDF) is ruling the country until the present.

In terms of its economy, according to a World Bank (2018) report, Ethiopia is the fastest growing economy in Africa with strong, broad-based growth averaging 10.3% a year from 2006/07 to 2016/17 (World Bank, 2018). The service sector has exceeded agriculture as the principal source of GDP at 39.3% in 2016/17 (African Development Bank group, 2018). Agriculture's share of GDP is stagnant at 36%, in 2016/17 and industry contributed 25.6% share of GDP in 2016/17 (Ibid). Although its employment share declined from 80.2 to 77.3 % between 2005 and 2013, the agricultural sector continues to dominate employment (CIA, 2018; World Bank, n.d.).

Ethiopia's foreign exchange originates from the services sector mainly from the aviation industry followed by export of several commodities such as coffee, oilseeds, and edible vegetables including khat, gold, flowers, live animals, raw leather and meat products. Major imports of the economy constitute aircraft and machinery, metal and metal products, motor vehicles, electrical materials, petroleum, fertilizers and chemicals. Ethiopia's export sector is small and accounts for less than 10% of the GDP leading to persistent foreign exchange shortages and trade deficits (World Bank, 2014; African Development Bank group, 2018). In 2017, Foreign Direct Investment (FDI) grew strongly by 27.6 percent and Ethiopia ranked the second largest recipient of FDI in Africa with $3.6 billion inflow (World Investment Report, 2018; IMF, 2018).

Under the current leadership, Ethiopia has registered a considerable strengthening of performance in Human Development, notably as the second largest improver in Africa over the past decade (Ibrahim Index of African Governance, 2016). The poverty rate has decreased from 44 % in 2000 to 23.5% in 2015/16 surpassing the Millennium Development Goals (MDGs) target of 24% (IMF, 2018; AEO, 2018). Despite the fact that progress has been made toward eradication of extreme poverty, Ethiopia is still among the poorest countries in the world with a per capita income of $783 (World Bank, 2018).

4.3 Land tenure system in Ethiopia

The purpose of this section is to provide a brief historical overview of the land tenure system in Ethiopia during the past two regimes and under the contemporary government of Ethiopia. Understanding the context of land tenure arrangements, particularly under the current government, is critical as it defines the nature of the existing land ownership rights. This understanding is relevant as it will be discussed in the forthcoming chapter of this dissertation on the issue of land tenure security.

4.3.1 Imperial Era (Prior to 1975)

Under the imperial regime (i.e., during Emperor Haile Sellassie time) land tenure rights were classified into communal or kinship tenure *(rist),* grant land (*gult*), church tenure, private (*gebare),* and government tenure *(maderia or mengist)*(Tenaw et al., 2009**).** It is recognized that the land tenure system during the imperial period has been very complex (Brietzke, 1976). The existence of political control and class structures, geographical variations, and the cultural and ethnic diversities of the nation have contributed to the complexity of the historical land tenure classification system (Adal, 2002; Deininger et al., 2008). Prior to 1975, land was largely conquered by a few landlords and the church (USAID, 2004). During this period, greater than 70% of productive fertile land was controlled and owned by 1% of the ruling elites ((Tenaw et al., 2009). Emperor Haile Sellassie and his family were proprietors of massive tracts of land (Ambaye, 2012). Hence, many peasants were involved in sharecropping by working for landed classes (Bruce & Rahmato, 1994). This suggests that social power and status played key roles in accessing land ownership and enjoying all its benefits. The concentration of land by a few royal family members and the ruling class elites resulted in inequality in land ownership which led to political objections by ordinary peasants (Deininger et al., 2008). The peasants rebellion was followed by students' movements with the slogan of "Land to the Tiller" which finally led to the defeat of the Emperor in 1974 (Ambaye, 2012; Kebede, 2002).

4.3.2 Derg era (Post-1975)

After the 1974-1975 rebellion, a military government (*Derg*) took over power by overthrowing Emperor Haile Sellassie. The Marxist government swiftly passed land reform which was called "Public Ownership of Rural Lands Proclamation" (Kebede, 2002). Then Derg nationalized all rural land by transferring ownership of land to the state and hence land became the "collective property" of the people of Ethiopia (Proclamation No.31/1975). The proclamation declared that "…. any person who is willing to personally cultivate land shall be allotted rural land sufficient for his maintenance and that of his family" (Proclamation No.31/1975). However, in the Constitution's provision, peasants were given only land use rights and the sale, mortgage and/or lease of land was strictly forbidden. Derg's land reform has brought some positive outcomes, especially by eliminating manipulation of tenants by landlords and balancing inequalities in landholding that was notable during the previous imperial time (Bruce et al., 1994; Kebede, 2002).

However, this land reform had some negative consequences as well. Following the land reform, the government promoted villageization (i.e., locating all farmers at a specific location even though they opposed the displacement), and encouraged state market quotas instead of free market and imposed heavy taxes (Deininger et al., 2008; Kebede, 2002). The frequent land redistributions as part of the reform (i.e., resettlement and villageization) together with other factors created land tenure insecurity (Bruce et al., 1994; Crewett & Korf, 2008). The polices did not bring the desired economic and agricultural growth either (Tenaw et al., 2009).

4.3.3 The current government (Ethiopian People's Revolutionary Democratic Front)

After the downfall of the Derg, the Transitional Government of Ethiopia (EPRDF) designed an economic policy which declared that land ownership would remain under the state control until a new federal constitution was developed (Belay & Manig, 2004). Given that the transitional government overthrew the Marxist government (Derg), and adopted a free market policy, it was expected that private ownership of land would be enacted (Ambaye, 2012). However, the government didn't make any substantial changes regarding private land ownership, as it maintained public ownership of land under the new Constitution (Proclamation No.1/1995).

Under Article 40(3), it is declared that:

> *The right to ownership of rural and urban land, as well as all of the natural resources, is exclusively vested in the State and in the people of Ethiopia. Land is a common property of the Nations, Nationalities and Peoples of Ethiopia and shall not be subject to sale or to other means of exchange.*

Even though state ownership of land was clearly declared in the new Constitution of Ethiopia, debate over state versus private ownership of land became a big issue (Adal, 2002). Obviously, the government of Ethiopia advocated state ownership of land, as declared in the constitution. On the other hand, western donor agencies, international organizations, and many scholars supported private ownership of land (Ambaye, 2013; Crewett & Korf, 2008).

Social equity and tenure security were the two main positions that the government maintained as to why land should belong to the state (Ambaye, 2012). The argument is that private ownership of land would lead to the concentration of land in few wealthy and influential urban dwellers and that poor peasants, who don't have alternative livelihood options, would be in a disadvantageous position (Adal, 2002). This argument seems to suggest that social equity (fairness) would be ensured through public or state ownership of land. Additionally, public/state ownership of land is seen as a viable means to protect farmers from negative market shocks, as private ownership of land might encourage farmers to sell their farmland to "urban bourgeoisie" during hardship time (Crewett & Korf, 2008). The government claims that tenure security can be ensured through land registration and certification (Rahmato, 2008).

Those favouring pro-private ownership argue that state ownership of land withholds the development of land markets and hence decreases productivity (Ethiopian Economic Association, 2002). The argument made by the people who are against state-ownership of land mainly focuses on the problem of tenure insecurity (Adal, 2002). For example, some critics of state ownership would argue that state ownership of land reduces incentives to invest in suitable land use management and to adopt new farm technologies as a result of tenure insecurity (Rahmato, 2004 cited in Crewett et al., 2008). However, the government dismisses the critique by arguing that the issue of tenure insecurity is resolved through land registration and certification which has been implemented in the Tigray and Amhara regions already (Ambaye, 2013). Even though the process of land certification and registration began decades ago,

expropriation of land and natural resource from landholders did not stop public officials from expropriating land from smallholders and exploiting the natural resources (Rahmato, 2011).

Following the enactment of the national land policy (i.e., Federal democratic republic of Ethiopia Constitution in 1995), the government endorsed a Rural Land Administration and Use Proclamation (RLAUP) (Proc.87/1997) and later cancelled and replaced another rural land law policy (Proc. 456/2005). Regarding access to and use of rural land, the proclamation specifies that "Peasant farmers/ pastoralists engaged in agriculture for a living shall be given a rural land free of charge" and "any citizen who is 18 years of age or above and who wants to engage in agriculture for a living shall have the right to use rural land" (Proc.456/2005). As for the nature of the land use, peasants/pastoralists have holding rights. Meaning they have rights to:

> *Use rural land for purposes of agriculture and natural resource development, lease and bequeath to members of his family or other lawful heirs, and includes the right to acquire property produced on his land thereon by his labour or capital and to sale, exchange and bequeath same"(Proc.456/2005).*

In other words, except for sale and mortgage (similar to the Derg regime), donation and inheritance right of land are allowed, which is one crucial improvement that EPRDF government did over that of Derg. In contrast to the military government Derg, farmers now have full ownership to their produce and they can sell it at a market price. The current government also differs from the Derg regime, in that it allows landholders to transfer land in the form of inheritance and renting Another important declaration of RLAUP is the duration of rural land use rights, whereby by "the rural land use right of peasant farmers, semi-pastoralists and pastoralists shall have no time limit (Proc.456/2005).

RLAUP also permits land use rights to private investors who want to engage in farming investment according to the federal and regional investment policies and laws, on the condition that farmers' and pastoralists' land use rights is of primary importance (Proc.456/2005). Unlike peasant farmers and pastoralists who can possess land use rights free of charge, the government permits land use rights to investors on the condition of payment arrangements specified by the law (Proc.1/1995).

The federal Constitution under Article 40(7) guarantees every Ethiopian citizen "the full right to the immovable property he builds and to the permanent improvements he brings about on the land by his labour or capital" (Proc.1/1995). Further, in case of expropriation, Article 40(8) entitles its citizens appropriate payment of compensation for the private property built on the land in advance (Proc. 1/1995). If it is rural land, user of the land who is dispossessed for public work activities "shall be given the compensation proportional to the development he, has made on the land and the property acquired, or shall be given a substitute land thereon" (Proc. 456/2005). In principle, the compensation that should be paid for the loss of agricultural land has to be 10 times the market value of what farmers can produce on their land (Harris, 2015) In other words, small-scale farmers should be compensated the equivalent of what they can produce in ten years, in case of arbitrary eviction (Ambaye, 2012).

4.4 Large scale-agricultural investment: The policy context

In the following section, the broad development approach of Ethiopia and the related agricultural policy environment will be presented. Understanding the agricultural policy context is imperative as it explains how the government's development agenda has evolved through time and how that influenced the nexus between smallholders versus large-scale agricultural investment and issues related with farmers' land insecurity concerns. Particularly, the understanding of the development policy surrounding the large-scale agricultural investment is critical, as it has contributed to land grabbing in the study area, which will be described and discussed in the in the forthcoming chapters.

4.4.1 The Agricultural-Led Industrialisation Strategy (ADLI)

The EPRDF's development strategy since the downfall of the Derg regime was centred on agriculture and smallholder farming. The government's decision to adopt the agriculture sector as the main development strategy was based on the premises that 85 % of the Ethiopian population depends on farming and agriculture contributes to 45% of the GDP, hence development needs fast agricultural growth (MOFED, 2003). Through its Sustainable Development and Poverty Reduction Program (SDPRP), the government also stated it provides "….overriding primacy to the welfare of the rural populace" (MOFED, 2002, p. 41).

To this end, the government adopted the Agricultural-Led Industrialisation (ADLI) strategy. The strategy's focus was highly rural-centred and tend to favour smallholder farmers, as they represent the majority of the Ethiopian population (Rahmato, 2011). The ADLI strategy stresses that, although capital is a limited resource, through the use of the country's labour-rich and "bulk land" resources, rural development and agricultural production that improve the livelihoods of the rural poor can be achieved (MOFED, 2003). The document proposes key targets such as supporting farmers through capacity development, disseminating improved farming technologies, and provision of credit services were proposed so as to realize agricultural development and thereby to improve rural livelihoods (MOFED, 2003). Large-scale farming was envisaged as a long term-plan to strengthen agricultural development, but clearly, smallholder-agriculture was key to the ADLI strategy until that shift occurs (MOFED, 2003).

Although the ADLI approach narrowed class differentiation among rural dwellers, the agricultural sector did not bring the required economic growth and change (Lavers, 2012a). Food insecurity and increased poverty have been major issues both in the 1990s and 2000s (Rahmato, 2008). The World Bank also acknowledged that"… the rates of growth remain below those needed to reach Ethiopia's development goals, and below potential" (World Bank, 2007, p.33).

4.4.2 Post-ADLI

The lack of development progress observed through small-scale agriculture coupled with the global push towards agricultural commercialization and large scale-farming must have led the government to make a policy shift (Lavers, 2012a). This was evidenced in the second poverty reduction document, the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP), where the government strategically focussed on the commercialization of agriculture and the promotion of private sector development (MoFED, 2006). Amongst the eight pillars of the government's five-year plan during PASDEP (2005/06-2009/10) was "a massive push towards accelerated growth" through these two policy trusts (i.e., commercialization of smallholder agriculture and private sector development). The major difference between the first SDPRP and the second PASDEP development approach is the fact that the first focuses on the subsistence smallholder sector while the latter was on commercialization (Teshome, 2006).

In a similar fashion, the five-year (2010/11-2014/15) Growth and Transformation Plan (GTP) that builds on the design and implementation of PASDEP, further consolidated the idea of agricultural commercialization by smallholder farmers and private investors with the aim of selling farm outputs to domestic and export markets (MOFED, 2010), suggesting a pure shift towards a trade-based development approach. The GTP underscored that the main source of agricultural growth will depend on the commercialization of smallholder cultivation but a joint support for private investment and large-scale farming will be given, as it is one among the fundamentals of the strategy (MOFED, 2010). This growth and transformation plan recommends a dual strategy that aimed at creating a synergy between smallholder agriculture and large scale farming.

The government's motivation to support large-scale agricultural investment is based on the expected benefits that it will produce higher value agricultural commodities and thereby increase foreign earnings; create job opportunities for local farmers; improve national food security of the country and reduce vulnerability to climate risks through irrigation agriculture; and benefit rural communities through better infrastructural and telecommunication facilities (MOFED, 2010).

As a result of the increased strategic focus towards agricultural commercialization and large-scale farming in the design created by PASDEP in 2005/2006, federal and regional authorities were highly involved in attracting large farm companies and foreign investors through promotions from 2007 onwards (Rahmato, 2011). This resulted in a rush by foreign investors to gain access to large tracts of land since 2008 (Rahmato, 2011). It is also clear from the GTP document that the trend of attracting investors continued, as it was envisaged to transfer 3.3 million hectares of land to commercial farming investors by the end of 2015 (MOFED, 2010). In the second Growth and Transformation Plan (GTP II), which is to run from 2016 to 2020, it was reported that participation in agricultural development by private investors during the first GTP was minimal despite "the natural resources endowment and suitable land available for agriculture" (National Planning Commission (NPC), 2016, p.126). Hence, the land transfer to investors will increase from 2.4 million hectares in 2014/2015 to 3.1 million by 2019/20 (NPC, 2016). This increasing trend in the figures suggests the ambition of the government to keep large-scale investment on the development agenda. Often, the government claims that these large-scale land transfers to investors are "unused" or underutilized lands (MOFED, 2010).

4.4.3 The outcome of large-scale agricultural investment

Although the Government of Ethiopia is ambitiously promoting large-scale investment as documented in its policy document, concerns have been raised from various academicians and researchers who are critics of the large -scale farming. The main issues raised regarding the implication of land transfers to investors are related to food security, displacement and loss of farm land, environmental impacts, and rural employment.

The argument by Rahmato (2011) is that large-scale land transfer to foreign investors by the Ethiopian government is not contributing to the improvement of national food security. This is because there is lack of formal or informal legislation that binds investors to supply agricultural products to local markets and hence foreign investors are solely focused on export markets and towards fulfilling their own country's food security needs. According to Lavers (2012), such agricultural investment strategy indeed resulted in the emergence of domestic and foreign investors in Ethiopia and encouraged what he called a "trade-based food security strategy'' by compromising on domestic food production.

Loss of farmland and displacements as a result of ongoing investment projects were observed in parts of the country which ultimately resulted in loss of livelihoods and food insecurity situations among the affected communities (Shete & Rutten, 2015). It has been noted that the loss of farmland for large-scale investment purposes not only has serious negative consequences on the food security status of local communities, but also on their cultural identity (Horne & Mousseau, 2011). Others also pinpoint the negative impacts of large-scale investment to the environment. For example, evidence from the Gambella region in Ethiopia shows that large tracts of land given to investors were actually covered with forest and woodlands that have now contributed to deforestation in the area (Horne & Mousseau, 2011).

The government's promise to smallholder farmers that large-scale investment will facilitate technology transfer and creates jobs for local farmers has not yet been fully realized. For example, it has been argued that the technology transfer is very negligible, as large scale agriculture is operated with sophisticated technology that cannot be transferable or easily accessible to subsistence farmers (Rahmato, 2011). Regarding the job creation possibilities, the low wage rates paid to employees who work for commercial investors were raised as a concern, which is partly because of the government's failure to amend the minimum pay standard (Horne & Mousseau, 2011).

At the time of the study, the land ownership status of the survey participants was mixed. The survey participants from Hade Alega and Dalata villages all had land-holding rights. This means they had the rights to:

> *Use rural land for purposes of agriculture and natural resource development, lease and bequeath to members of his family or other lawful heirs, and includes the right to acquire property produced on his land thereon by his labour or capital and to sale, exchange and bequeath same"(Proc.456/2005).*

However, the majority of the villagers from Ade Tela and Dalata had lost their land for large-scale agricultural investment purpose. Hence, out of the 400 farmers who participated in the survey, 177 (43%) were landless at the time of the study.

4.5 The institutional framework in relation to climate change

Ethiopia ratified the United Nations Framework Convention on Climate Change (UNFCC) in 1994 and the Kyoto Protocol in 2005 (Environmental Protection Authority (EPA), 2012). In fact, some studies document that the country started participating in various international efforts which aimed at reducing climate change impacts since the late1970s (Eshetu et al., 2014).

The first institutional arrangement that has been put in place in 1974 following the famine in the northern region of Ethiopia is the Relief and Rehabilitation Commission (RCC) and later renamed as Disaster Prevention and Preparedness Commission (DPPC) under the Ministry of Agriculture (Nachmany et al., 2015). Although climate change is not directly stated, the DPPC was established with three main objectives: (1) preventing natural or human-made disasters (Prevention), (2) building capacity to reduce the impacts of disasters before their occurrence (preparedness), (3) and ensuring timely emergency response to affected communities. (Response) (Proclamation 10/1995). This effort exemplifies the country's first step commitment to take notice of natural and human-made disasters seriously as early as the 1970s. However, in this early stage climate-related efforts were not mainstreamed across the different sectors of the economy and there was no coordinated institutional arrangement (Eshetu et al., 2014).

The National Meteorological Agency (NMA) under the Ministry of Water and Energy (MOWE) represented Ethiopia at the UNFCCC conference in Kyoto in 1997 and at the Copenhagen climate change conference (COP15) in 2009 (Eshetu et al., 2014). Following the 2009 Copenhagen negotiation, the Environmental Protection Authority (EPA) within the Ministry of Environment and Forest (MOEF) became the leading institution to oversee climate change issues **(**Eshetu & Bird, 2015**)**. The EPA developed the Climate Resilient Green Economy (CRGE) strategy in 2011, which deals with climate change mitigation and adaptation efforts. Currently, the NMA is responsible for climate data recording, monitoring and projections, which is purely a technical task (Oates et al., 2011). There is no clear justification for the change of NMA's leading institutional role on the issue of climate change in the country, but the NMA was criticized for not mainstreaming climate change matters into the country's overall development plans effectively (Eshetu et al., 2014). Perhaps it was believed that the EPA has more capacity to deal with the wider political, socio-economic and environmental issues related to climate change than the NMA (Oates et al., 2011).

The EPA has transformed into the Ministry of Environment and Forest in 2014, and again in 2015, it evolved into the Ministry of Environment, Forest and Climate Change (MEFCC)(Eshetu & Bird, 2015). The incorporation a climate change component at ministerial level shows the country's ambitious plan to take climate change as a serious matter. This rapid institutional reform is encouraging, but the performance of the MEFCC in implementing the Climate Resilient Green Economy (CRGE) strategy effectively is yet to be seen in the coming future. In addition to the MEFCC, the government of Ethiopia has formed a second institution called the CRGE Facility under the Ministry of Finance and Economic Cooperation (MoFEC), that facilitates the administration of national and international climate funds in order to implement the CRGE strategy (Eshetu & Bird, 2015). The development of the CRGE Facility and the MEFCC institutions at the national level is promising. However, this is not taking place at a district and local level. Studies from LDCs show that there are limited capacity and knowledge on how to institutionalize the NAPA and other climate-related adaptation policies into regional and local development plans (Regmi et al., 2016). In the Ethiopian context, understanding of climate change problems among regional and district level CRGE Facility Committees is still weak (Eshetu et al., 2014).

4.6 Climate-Related National Polices in Ethiopia

4.6.1 The Environmental Policy

The Ethiopian government has designed various policies and strategies with the aim of reducing the vulnerability of the country to climate-linked risks. One of the prominent programmes is The Environmental Policy of Ethiopia which was issued in 1997 (EPCC, 2015). The Environmental Policy of Ethiopia provides an overarching policy framework for numerous environmental problems generally and climate change particularly. For example, section 3.9 of the policy element particularly focuses on the challenges of atmospheric pollution and climate change. In this section, the policy aims to addresses the issue of climate change through: (1) promotion of climate monitoring programs; (2) active involvement in protecting the ozone layer; (3) focus on enhancing the country's hydro, geothermal and solar energy potentials as a means of reducing greenhouse gas emissions; and (4) maximize the country's biomass by implementing agroforestry programs, and through reforestation and rehabilitation of degraded area (Environmental Policy of Ethiopia (EPE), n.d.). It is clear that the Environmental Policy of Ethiopia acknowledges the issue of climate change. However, apart from suggesting the promotion of a climate monitoring program it does not specify or prioritized alternative adaptation strategies needed to reduce the vulnerability of the country to climate change variability. This limitation might be because the policy was designed when the issues of climate change and the need for adaptation were not hot topics on the political agenda (Adem, 2011). In fact, the environmental policy in Ethiopia was designed not because of the Ethiopian government's own political will but because of a push from donor agencies (Ruffeis et al., 2010). The policy document dedicates a section where it sets out the mechanisms to ensure the impacts of the of climate change through monitoring, evaluation and reporting at village, district, regional and federal level. However, there is no well-established reporting requirements that records the impact of the policy implementation in practice (Adem, 2011).

4.6.2 Ethiopia's Growth and Transformation Plan (GTP I and II)

The Government of Ethiopia has articulated two consecutive Growth and Transformation Plans, where the first was implemented during the period 2010/11-2014/15 and the new five-year development plan is for the period 2015/16-2019/20. The first GTP document considers that climate change presents both a risk and opportunity for Ethiopia. Despite the low contribution of the country to global greenhouse gas emission, Ethiopia is hard hit by the impacts of climate change (MOFED, 2010). The GTP recognizes that specific economic sector

and agro-ecological zones are highly vulnerable to the effects of climate change, and as a result the country loses 2% to 6 % of its total production. Because of this reason, the government gives attention to the need for adaptation during the GTP implementation period. As one of the objectives of the environment and climate change programs is to build a "climate resistance green economy", the document highlights that appropriate adaptation and mitigation efforts are priority actions that need to be taken during the GTP implementation period, this will be realized through policies, strategies and action plans. As compared to the previous national climate policies, the GTP moves one step forward regarding environment and climate change issues, at least in theory, as evidenced in its clear objectives and targets outlined in the policy document. However, doubts were raised whether these ambitious objectives and targets will be realized in practice (Adem, 2011). Indeed, the second Growth and Transformation Plan acknowledges that during the GTP I period "limited implementation capacity as well as inadequate adaptation and promotion of Green Technology Packages have remained challenges in the course of implementation, which need to be taken and addressed in GTP II" (NPC, 2016, p.62).

4.7 National plans and strategies related to climate change

4.7.1 National Adaptation Program of Action (NAPA)

Ethiopia actively engages in the global climate change process of the UN Framework Convention On Climate Change (UNFCCC) (Irish Aid, 2016). As a member of the UNFCC, the country is required to tackle climate change issues by producing a National Adaptation Plan of Action (NAPA) and by mainstreaming of climate change into sectoral development policy plans (Adem, 2011). As a result, Ethiopia has produced and submitted the first National Adaptation Program of Action (NAPA) in 2007 (NMA, 2007). The rationale for developing the NAPA document is based on the fact that the country's adaptive capacity is low, hence urgent and immediate adaptation is required. In the preparation of the NAPA documents, thirty-seven adaptation options were identified of which eleven were prioritized using a multi-criteria analysis.

Some of the prioritized strategies include: (1) promoting drought/crop insurance program; (2) strengthening drought and flood early warning systems in Ethiopia; and (3) development of small scale irrigation and water harvesting schemes (NMA, 2007, p.11). The NAPA document was an initial step towards organizing adaptation activities across different government sectors, but it was not envisaged to be a long-term plan on its own (Oates et al., 2011). In fact, there was a drawback in the preparation process of the document, as some important stakeholders (e.g., from Ministry of Health) and community members at a local level were not represented and consulted (Adem., 2011).

4.7.2 Ethiopia's Program of Adaptation to Climate Change

The National Adaptation Program of Action was updated and replaced in 2010 by Ethiopia's Program of Adaptation to Climate Change (EPACC) with the aim of adopting a more participatory approach in designing adaptation options from federal, regional and local levels (Eshetu et al., 2014). The EPACC document identifies that impacts of climate change will continue to threaten Ethiopia, hence the designing and implementation of adaptation activities play a key role to protect the country (Environmental Protection Authority of Ethiopia (EPA), 2010).

The program identified about 20 problems associated with the effect of climate change, for example, in the areas of health, agriculture, forestry, water, and land management, along with 7 responses to tackle these problems. These priority measures to be taken for implementing adaptation to climate change are:

- Identifying and mapping the areas prone to climate-linked risks
- Making information accessible for all
- Strengthening drought and flood early warning systems
- Mainstreaming adaptation into development activities
- Including adaptation to climate change into educational curricula
- Enhancing research capacity on adaptation to climate change
- Seeking financial sources and new technologies from domestic and international donor agencies for the effective implementation of adaptation

Unlike the NAPA document**,** the EPACC is more holistic in terms of identifying and recognizing the likely impact of climate change on various sectors such as human and animal health, agriculture and biodiversity, and land resources. Moreover, the preparation of EPACC documents involved various experts, and more importantly, farmers and pastoralists who bear the brunt of climate change.

4.7.3 Climate Resilient Green Economy Strategy (CRGE)

Ethiopia is among the few nations to have integrated its objective of developing a green economy and building resilience to climate change in one policy framework entitled: *Climate Resilient Green Economy* (CRGE) strategy in 2011 (Eshetu et al., 2014). The main vision of CRGE's strategy for Ethiopia is to become a middle-income country by 2025, which entirely depends on a carbon-neutral growth (Federal Democratic Republic Of Ethiopia (FDRE), 2011). The CRGE has two components to realize this vision: the first one is the Green Economy Strategy (GES) which largely aims to address mitigation through reducing greenhouse gas emission (GHG) and the second one is the Climate Resilience Strategy (CRS) that focuses on the adaptation to climate change mainly in agriculture, forestry, and water and energy sectors.

4.8 Vulnerability interpretation in adaptation policies of Ethiopia

This section will analyse the content of the national climate change adaptation policies of Ethiopia in order to understand how policy makers in their formulation of the policy documents conceptualized and interpreted vulnerability and proposed adaptation policies options. The adaptation policy documents chosen for the purpose of this analysis are the National Adaptation Program of Action (NAPA), Ethiopia's Program of Adaptation to Climate (EPACC) and the Climate Resilient Green Economy Strategy (CRGE).

The NAPA document recognizes the complexity of the vulnerability concept. Climate related factors are largely documented as the main causes of the country's vulnerability. Other non-climatic factors such as a lack of health service, population pressure, and weak institutions are noted. But there is no focus on how these non-climatic factors contribute to vulnerability. A clear definition of vulnerability is not given. In contrast, there is no mention of even the word vulnerability in the EPACC adaptation policy document. The CRS seems to adopt the 2012 IPCC's definition of vulnerability as: "the propensity or predisposition to be adversely affected" (FDRE, 2011, p.12). The policy document acknowledges that non-climatic or "exogenous" factors also drive vulnerability even though they are not addressed in the document. As compared to the NAPA and EPACC, the CRS document gives recognition to the role of non-climatic factors hence there is some understanding of the contextual nature of vulnerability. The document highlights that among other things, institutional and governance issues influence vulnerability and hence measures that aim at reducing vulnerability must address both climatic and non-climatic drivers of vulnerability.

The main concern emphasized in all three documents is the issue of climate change and the associated impacts. For example, the NAPA and CRS documents identified the current and future temperature and rainfall trends for Ethiopia and the extreme weather events (e.g., drought and flood events) associated with the changes. After identifying the trends and the specific climate-related hazards, the NAPA/EPACC/CRS documents concentrated on the potential impacts on different sensitive sectors such as on agricultural, water, livestock, and wildlife.

In regards to the proposed climate change adaptation responses, the NAPA prioritized eleven adaptation options but almost all of them are technical solutions in nature (e.g., promoting drought/crop insurance, building small-scale irrigation, developing multi-purpose large scale

water development). However, "adaptation must be seen as part of the dynamics *of* societies rather than simply being a technical adjustment to biophysical change by society" (Eriksen et al., 2015, p.524). This framing recognizes the social construct of vulnerability, and when adaptation policy responses are understood this way, they can address the root causes of vulnerability. The EPACC policy responses go beyond physical and technical adaptation solutions by incorporating other components, such as research on climate change adaptation and mainstreaming adaptation into education curricula. The CRS also shares the same view of strengthening institutional capacity as that of the EPACC document. However, most of the adaptation options proposed in the document tend to be technical solutions (e.g. soil and water conservation work, drought resistance crops). The policy options proposed in the NAPA/EPACC/CRS tend to address outcome vulnerability rather than contextual vulnerability, as "climate factor" is the centre of analysis. Addressing outcome vulnerability in CCA policies and suggesting technical solutions such as irrigation, drought resistance crops, does not mean it's the wrong pathway. The argument is that it should be integrated with an approach that addresses the inherent drivers of vulnerability so as to reduce vulnerability more effectively now and in the future. None of the policy documents question how social and political processes shape vulnerability and thus they do not propose any adaptation mechanisms that address contextual vulnerability.

Adaptation options designed by national climate policies in Ethiopia must recognize and acknowledge the multiple stressors that causes vulnerability at all stages. Ascribing climate related problems as the only (main) source of the country's vulnerability and masking other possible drivers of vulnerability will not bring the intended positive outcome. Similarly blaming the western world for their higher contribution to GHGs emission and seeking climate finance or compensation for it should not be the only solution to effectively reduce vulnerability and enhance the adaptive capacity of vulnerable households. The government authorities who are working in the development sector as well as those who are designing and implementing climate adaptation policies need to be aware of the vulnerabilities created by the social and political system in the country.

4.9 Conclusion

The current government of Ethiopia generally maintained the land tenure policy of the Derge regime by declaring state ownership of land. This land tenure system suggests that the state, through its full land ownership rights, can actually exercise its power to use the land for any purpose without any limitation. This means that in case of expropriation, farmers' livelihoods might be threatened, as there is no room for objection. Farmers have usufruct rights to the land but they cannot sell exchange or mortgage their land. These limited rights might have implications whenever farmers want to make long-term investments on their land.

The slow development progress observed during the implementation of the ADLI strategy meant that a single focus on subsistence (small-scale) agriculture is not the right strategy anymore. This has led to a shift towards a dual agricultural development approach that attempted to integrate the commercialization of small-scale agriculture and the promotion of large-scale agricultural investment. The evaluation of the government's policy documents indicates that more and more focus is being given to large-scale farming with the aim of transforming the country's economic engine which is agriculture. Big hopes and expectations are laid on foreign investments and investors. However, these big expectations and hopes will not always bring the desired positive outcomes without the associated cost. The issues of food insecurity, land disposition and displacements and negative environmental impacts are being observed as a result of land-related investments in the country.

In Ethiopia, the issue of climate change is well recognized, particularly at the national level. The country has made rapid institutional reform to incorporate the climate change unit at the ministerial level. Also, the country has formulated at least five major climate-related national policies, such as that of the National Adaptation Program of Action (NAPA), to reduce the impacts of climate change. The formulation of climate policy documents is encouraging, and demonstrates the importance given to the issue of climate change in Ethiopia. However, one major gap that emerged from the analysis of the content of the policy documents is that there is a high tendency to view climate change as the single most important driver of vulnerability for smallholder agriculture and livelihood systems. Due to these, the role of non-climatic factors (e.g., policies and institutional challenges) in contributing to these vulnerabilities seems to be largely neglected and the climate change adaptation responses proposed are mainly technical solutions.

Chapter 5: Farmers' perceptions of climate change and the drivers of livelihood vulnerability

5.1 Introduction

This chapter presents the findings of the study on farmers' perceptions of climate change and the climatic and non-climatic drivers of livelihood vulnerability in Raya Azebo district. The chapter first examines whether farmers perceive climate change as *psychologically distant* – i.e., whether farmers perceive climate change to be an event that will happen in the future, affecting societies dissimilar to themselves in other geographical locations. The chapter then explores the type of changes farmers perceive in their local climate and their perceptions regarding the causes of climate change. This is followed by an examination of the various socio-psychological factors that influence farmers' risk perceptions of climate change. The last section in this chapter presents the analysis of farmers' perceptions of the climatic and non-climatic stressors that produce livelihood vulnerability in the study area.

5.2 Is climate change a psychologically distant problem?

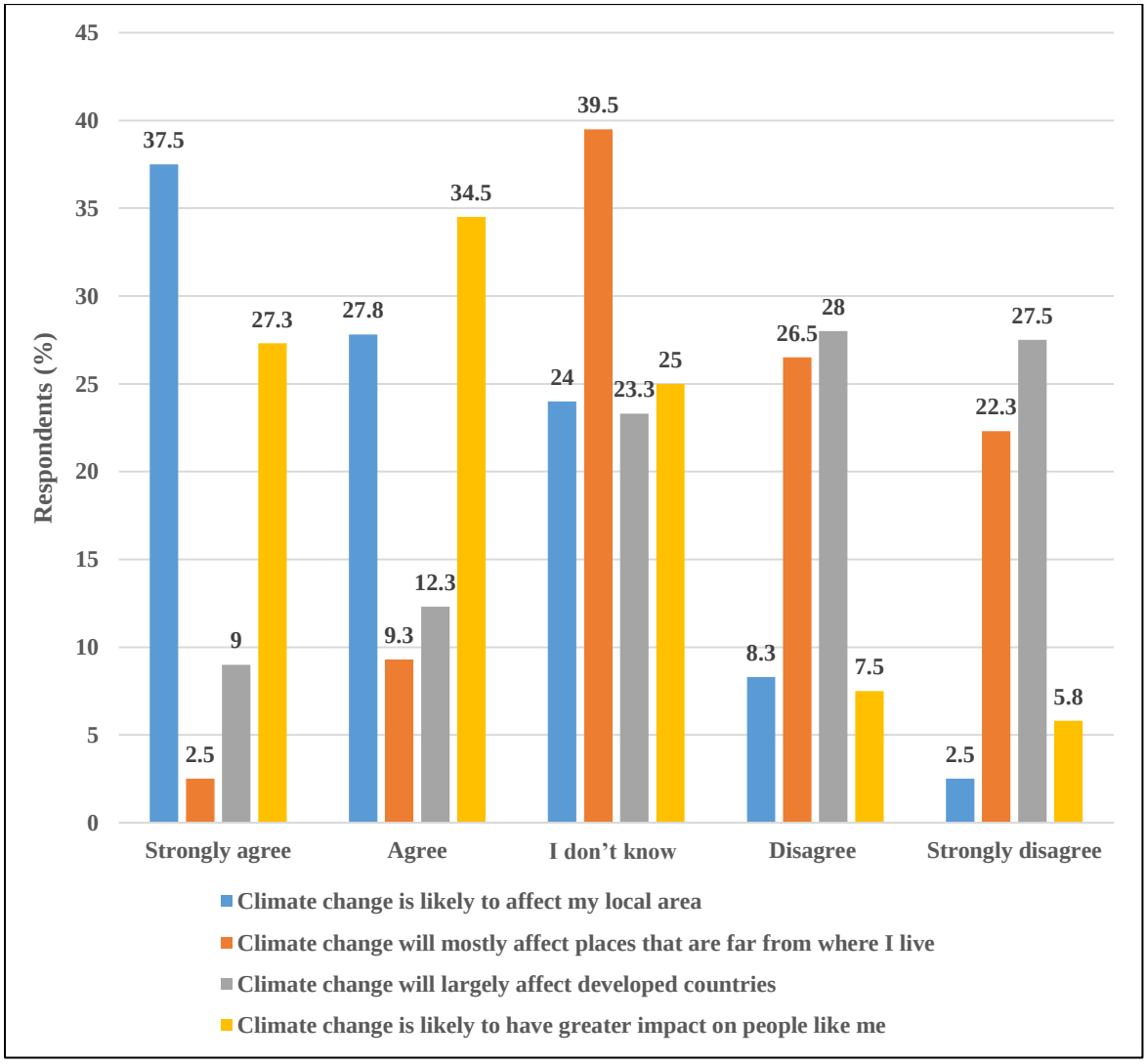
Despite the reality of climate change, scholars observe that climate change is still perceived by many as a psychologically distant issue – meaning, it is perceived as an event that will happen in the future, which will impact other people in other far places (McDonald, 2015). This somehow raises a concern, because it has been demonstrated that psychological distance leads to disengagement with climate change issue or it acts as a barrier to climate change adaptation and mitigation (Singh et al., 2017).

This section explores how farmers in the case study area perceive the psychological distance of climate change based on the survey data. Farmers' perceptions of the psychological distance of climate change were assessed using eight questions, which included the four domains of psychological distance – i.e., geographical, social, temporal and hypothetical distance dimensions. The questions to measure the perceived psychological dimensions were adopted from Spence et al. (2012), and they were slightly modified to suit this study's context.

5.2.1 Geographical and social distance dimension of climate change

To assess the geographic distance dimension, farmers were asked to indicate their level of agreement to the following questions: (1) climate change is likely to affect my local area; (2) climate change will mostly affect places that are far from where I live. As can be seen in Figure 5.1, the majority of farmers agreed with the statement that their local area will likely be affected by climate change, with 37.5% of the respondents who strongly agreed and another 27.8% who agreed with this statement (i.e., 65.3% of the total sample). However, only a few farm households agreed with the statement that climate change would impact places that are far from their local area, with only 2.5% who strongly agreed and 9.3% who agreed with this idea. Thus, nearly half (48.8%) of the respondents disagreed with the statement that climate change will affect other places. Therefore, these results suggest that climate change is not regarded as a geographically distant problem by farmers of the study area.

Figure 5.1: Farmers' perceived geographic and social distance of climate change

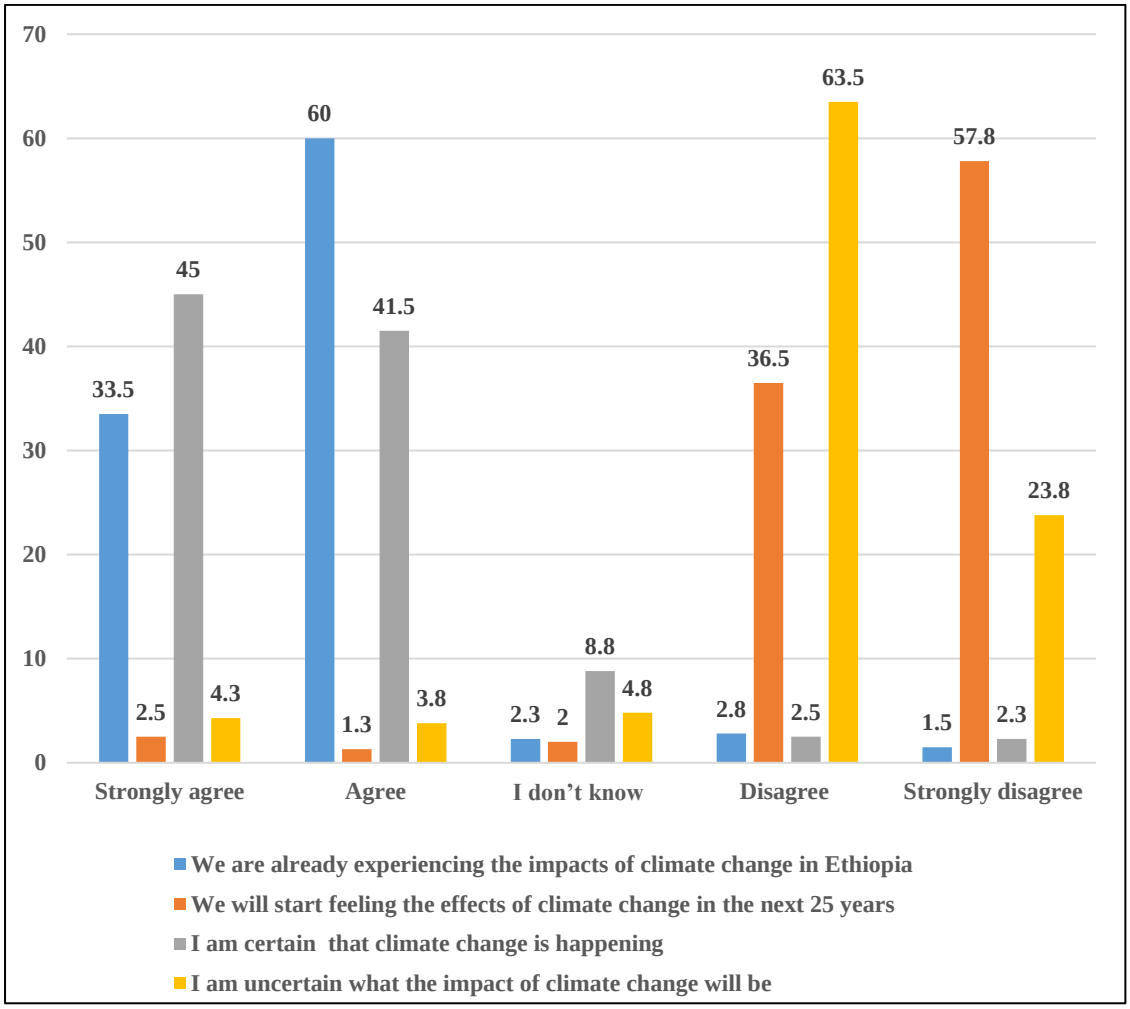


To explore the social distance dimension, farmers were asked to indicate their level of agreement to these questions: (1) climate change will largely affect developed countries; and (2) climate change is likely to have a greater impact on people like me. In Figure 5.1 above, it can be seen that few respondents agreed with the statement that climate change would largely affect developed nations, with only 9% who strongly agreed and another 12.3% who agreed with this question. Further, Figure 5.1 shows that the majority of the households tend to believe that climate change would likely have a bigger impact on people like themselves, with 27.3% of the sample who strongly agreed and an additional 34.5% who agreed with this statement. These results indicate that most farmers in the study area do not perceive climate change as a socially distant phenomenon. Instead, it appears that climate change is perceived as a socially proximal event, given that farmers believe climate change to have a larger impact on people similar to themselves than other people.

5.2.2 Temporal and hypothetical distance of climate change

The temporal dimensions of climate change were also assessed by asking farmers whether they think climate change is already happening in Ethiopia or whether it will start happening in the next 25 years. As Figure 5.2 shows, the majority believe that climate change is happening in Ethiopia now, with 33.5% of the farmers who strongly agreed and 60% who agreed with this statement. On the other hand, the majority disagreed with the statement that climate change is something that will happen in the future (after 25 years), in which 36.5% disagreed with the statement and 57.8% strongly disagreed (Figure 5.2). In regards to climate change certainty, the majority of farmers are certain about climate change reality (45% strongly agreed and 41% strongly disagreed with the statement) (see Figure 5.2 below). Relatively, few farmers are uncertain about future impacts of climate change, with 4.3% who strongly agreed and 3.8% who agreed about their uncertainty about the long-term impacts of climate change. These findings confirm that farmers seem to perceive climate change to be temporally close.

Figure 5.2: Farmers' perceived temporal distance of climate change



5.2.3 Links between climate change concern and psychological distance dimensions

The psychological distance that individuals perceive about climate change might influence their concern about climate change and consequently their willingness to address the issue of climate change. In this study, a Spearman's correlation was used to see if there is a relationship between perceived psychological distance domains and concern about climate change. Table 5.1 shows that there is a strong positive correlation between the perceived impact of climate change on the local area and concern about climate change, which was statistically significant, $r_s = 0.823$; $p < 0.01$). This means that as farmers' level of agreement regarding climate change impact on their local area increases, their level of concern about climate change also increases. This finding suggests a greater belief that climate change is a geographically proximate phenomenon is associated with higher concern about climate change. In another interpretation, when the perceived geographical distance of climate change is lower, concern about climate change is higher.

As can be seen in Table 5.1, the belief that climate change will have a greater impact on oneself (or similar people), is strongly and positively correlated with concern about climate change, which was statistically significant $r_s = 0.864$, $p < 0.01$). As farmers' level of agreement with the statement: "climate change would largely affect people like me" increases, their concern about climate change also increases. This indicates that climate change concern increases with perceived social proximity of its impacts (i.e., when farmers perceive climate change is psychological nearer).

In regards to the temporal dimension, there is a strong positive correlation between farmers' belief that climate change impacts are being experienced in Ethiopia and concern about climate change, which was statistically significant ($r_s = 0.763$, $p < 0.01$). This result reveals that the more temporally close climate change impacts are perceived to be, the more concerned farmers are about climate change. Strong belief about climate change certainty (happening now) is also moderately correlated with concern about climate change, which was statistically significant ($r_s = 0.464$, $p < 0.01$). The more farmers perceive climate change as something that is happening now (i.e., psychologically close), as opposed to in the future (psychologically distant time), the higher their concern level. Strong belief about climate change certainty is also moderately correlated with concern about climate change, which was statistically significant ($r_s = 0.464$, $p < 0.01$).

Table 5.1: Spearman's Correlation between concern about climate change and psychological distance dimensions

Psychological distance domain	Concern about climate change
Climate change is likely to affect my local area	0.823**
Climate change is likely to have a greater impact on people like me	0.864**
We are already experiencing the impacts of climate change in Ethiopia	0.763**
I am certain that climate change is happening now	0.464**

Note: ** Correlation is significant at the 0.01 level

Overall, the findings in the previous section revealed that smallholder farmers in the study area do not see climate change as a distant issue. The majority of the surveyed farmers perceive that climate change is already occurring in their local area as well as in Ethiopia more broadly. The next section will specifically examine farmers' perceptions of the changes they observed in their local climate.

5.3 Farmers' perceptions of climate variability and change

During focus group discussions, farmers were asked to identify changes they have observed in local climate conditions. Participants detected changes in rainfall patterns (e.g., late and early cessation of rainfall, unusual rains, decreasing trends of rainfall amount); high temperatures, and frequent droughts and sometimes unusual flooding. Focus group participants' local observations were included in the survey to understand how many of the sampled respondents noticed similar changes.

As seen in Figure 5.3, 86.5% and 79.8% of survey respondents perceive that rains are coming late and ending early. During focus group discussion, participants noted that *Belg* rains used to start in February but now it is common to observe the rains coming late (i.e., March/April). Participants also added that in previous years *Belg* rains used to stay longer (at least for three months), but now they stop quickly before the normal rainy season ends. As a result, the number of rainy days are declining over time. For example, as one old farmer recalled during the focus group:

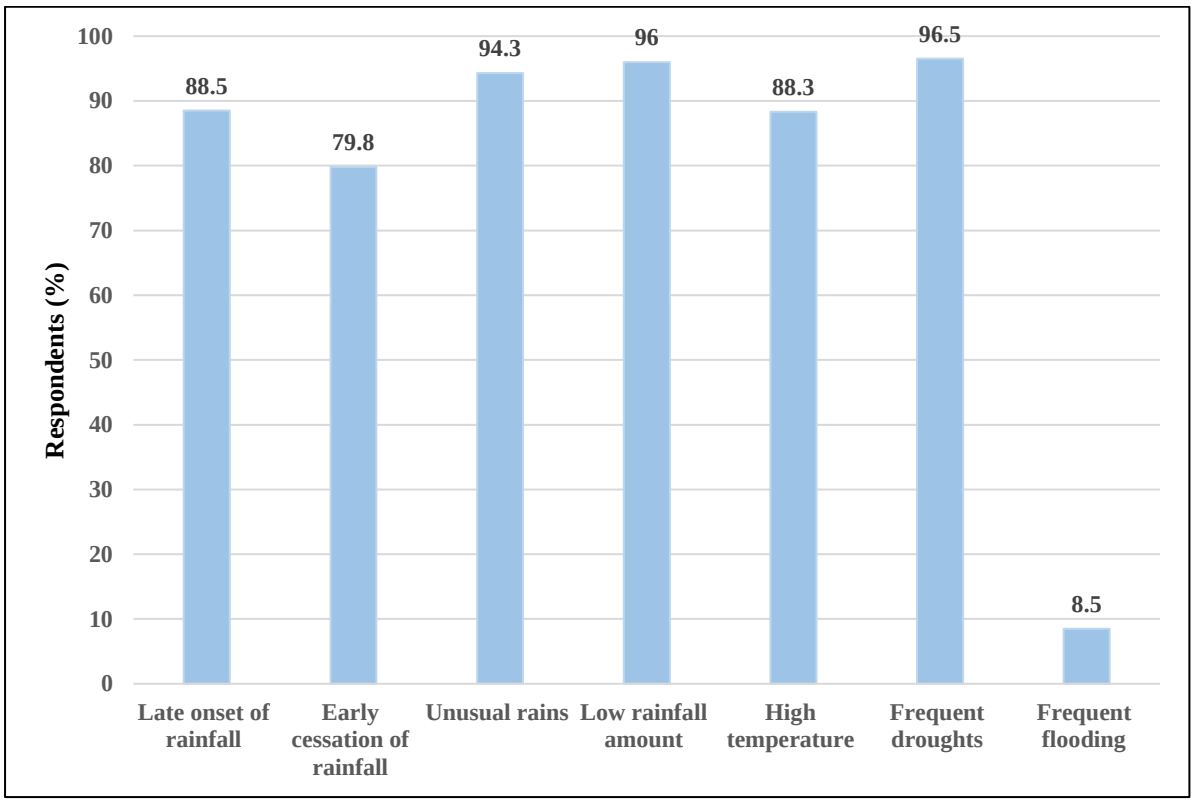
> *In the past, I remember it used to rain day and night the whole season without any interruption. Nowadays, we are lucky if it rains even once every four days". (Participant ≠ 2, FGD 1 2016/17).*

Most farmers (94.3%) also observed unusual rains in agricultural off seasons (in December and January). Nearly all of the respondents (96%) perceived that the quantity of rainfall they receive is decreasing from year to year. This perception is broadly consistent with results of long-term meteorological data analyses that show a downward trend in rainfall amount in the Tigray region (Gebrehiwot & Veen, 2013). For example, one of the participants during the focus group commented:

> *Back then, when it rains, it was sufficient for the crops, for the animals, and also for us [domestic purposes]. Now it rains very little".*

Farmers also perceived that due to low rainfall and/or lack of rains, droughts are occurring more frequently (which was reported by 96.5% of the sampled respondents). Indeed, meteorological drought analysis for Tigray region, which also included the study area, indicates that moderate-to-severe drought occurs once every 2-3 years (Gidey et al., 2018).

Figure 5.3: Farmers' perceptions of local climate variability and change



A significant number of farmers observed higher temperatures, especially during the summer season, which was indicated by 88.3% of the respondents. Temperature trends for the period between 1981-2014 in Tigray region show hotter temperatures, particularly between October-December (USIAD, 2015). During the focus group, it was emphasized that flooding is not a recurring event in their local area. Only 8.5% of the surveyed household perceived that floods are occurring more and more frequently.

A chi-square test was performed to see if there is a difference in farmers' perceptions of local climate variability and change across the four studied villages. As shown in Table 5.2 below, there is no statistically significant difference in farmers' perceptions of climate change between the four villages. The survey results suggest that changes in local climate conditions are detected by the majority of the households regardless of their geographical locations.

Table 5.2: Farmers' perception of changes in local climate variability and change by geographic location (villages)

Changes observed in local climate conditions	Village locations	Respondents (%)		X^2 value
		Yes	No	
Late onset of rainfall	Hade Alega	87.1	12.9	X^2 (3, N = 400) = 2.13, p = 0.5
	Keyeh Tekely	88.4	11.6	
	Ade Tela	88.1	11.9	
	Dalata	82.1	17.9	
	Total	86.5	13.5	
Early cessation of rainfall	Hade Alega	80.2	19.8	X^2 (3, N = 400) = 0.3, p = 0.9
	Keyeh Tekely	81.2	18.8	
	Ade Tela	80	20	
	Dalata	77.9	22.1	
	Total	79.8	20.3	
Unusual rains	Hade Alega	97	3	X^2 (3, N = 400) = 2.7, p= 0.4
	Keyeh Tekely	94.2	5.4	
	Ade tela	93.3	6.7	
	Dalata	91.6	8.4	
	Total	94.3	5.7	
Low rainfall amount	Hade Alega	97	3	X^2 (3, N =4 00) = 0.9, p = 0.8
	Keyeh Tekely	94.2	5.8	
	Ade Tela	96.3	3.7	
	Dalata	95.8	4.2	
	Total	96	94	
High temperature	Hade Alega	88.1	11.9	X^2 (3, N = 4 00) = 4.9, p = 0.2
	Keyeh Tekely	82.6	17.4	
	Ade Tela	87.4	12.6	
	Dalata	93.7	6.3	
	Total	88.3	11.7	
Frequent droughts	Hade Alega	98	2	X^2 (3, N = 4 00) = 3.7, p = 0.29
	Keyeh Tekely	95.7	4.3	
	Ade Telela	97.8	2.2	
	Dalata	93.7	6.3	
	Total	96.5	3.5	
Frequent flooding	Hade Alega	5.9	94.1	X^2 (3, N = 4 00) = 2.4, p = 0.49
	Keyeh Tekely	11.6	88.4	
	Ade Tela	7.4	92.6	
	Dalata	10.5	89.5	
	Total	81.	91.5	

Source: Household survey

5.4 Farmers' perceptions regarding the causes of climate change

To assess farmers' perception of the causes of climate change, survey respondents were asked three correct and three incorrect statements about the causes of climate change. The correct statements are based on the general scientific consensus about the causes of climate change such as the (IPCC, 2014). As shown in Table 5.3, respondents were asked to respond to each statement as "correct", "incorrect" or "I don't know" options.

Table 5.3: List of correct and incorrect questions about the causes of climate change

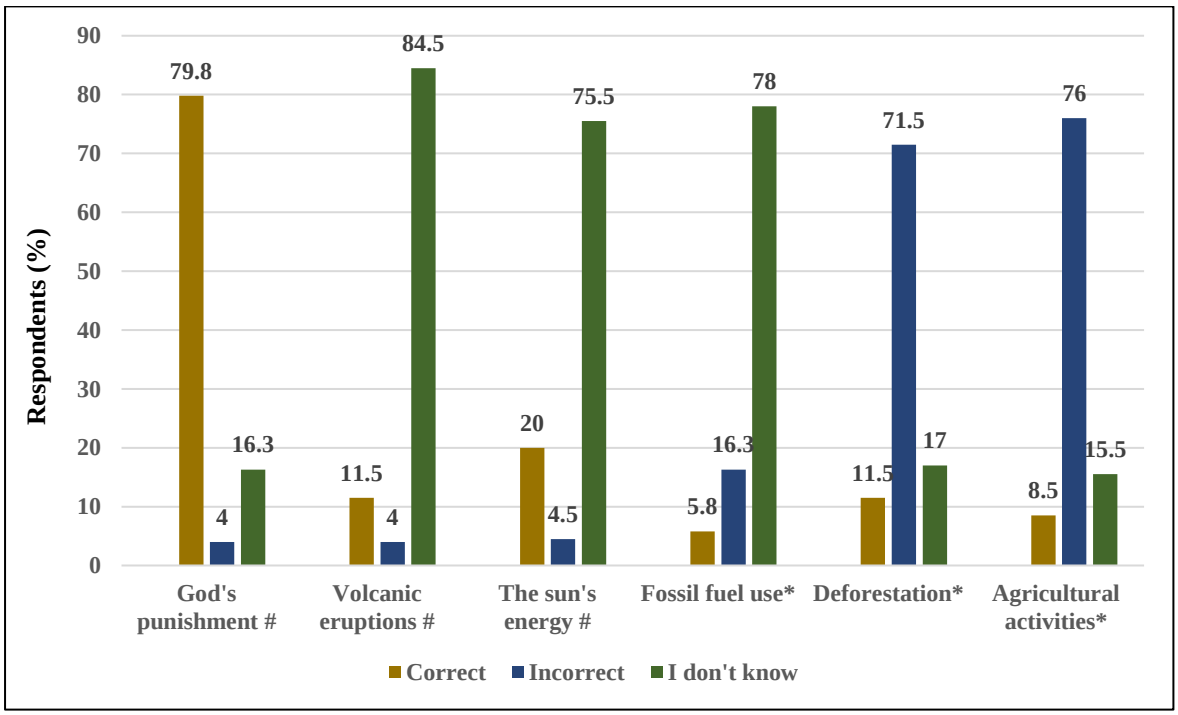
Cause of climate change	Please indicate whether the following statements about the cause of climate change is correct or incorrect		
	Correct	Incorrect	I don't know
God's punishment			
Deforestation			
Agricultural activities (e.g. excessive use fertilizer use, cattle breeding)			
Fossil fuel use (contribute to $C0_2$)			
The sun's energy			
Volcanic eruptions			

Source: Household survey questionnaire

Scientifically, it is believed that climate change is mainly caused by greenhouse gas emissions (GHGs) that lead to warming of the atmosphere. It is also recognised that burning of fossil fuels, deforestation and agricultural activities (e.g., fertilizer use and breeding livestock) contribute to GHG emissions, which suggest the contribution of humans to climate change (IPCC, 2014b). As opposed to the scientific understanding, however, farmers' perceptions about the cause of climate change centred mainly around religious reasons. As Figure 9.3 shows, the majority of the farmers cited supernatural force ("God's punishment"), as a reason for the changes observed in climate change, which was reported by 79.8% as a correct statement. Most farmers in this case study area believe that climate change is a result of people's disobedience to God's commands. Examining survey results by geographic locations, a greater number of Keyeh Tekely villagers (84%) perceived climate change to be the result of God's punishment, compared with Ade Tela (79.3%), Hade Alega (79%) and Dalata villagers (78.9%) (although this was not statistically significant).

In line with the scientific view, few farmers perceived that climate change is caused by fossil fuel use (5.8%), deforestation (11.5%) and agricultural activities (8.5%) (Figure 5.4). Nevertheless, the majority do not think that deforestation and agricultural activities contribute to climate change (as indicated by 71.5% and 76% of the respondents respectively) (Figure 5.4).

Figure 5.4: Farmers' perceptions about the causes of climate change



Note: # indicates incorrect and * correct statements about the causes of climate change

In sum, results indicate that perceptions of climate variability and change are detected by most of the farmers regardless of their geographic locations and it is widely believed that "God" caused climate change. The following section will examine the various socio-psychological factors that shape farmers' risk perception of climate change.

5.5 Determinants of farmers' risk perception of climate change

This section presents a description of the dependent and independent variables used for the analysis of the factors that determine farmers' risk perception of climate change.

5.5.1 Dependent variable

In this study, the dependent variable is climate change risk perception. Following Van der Linden (2015), farmers' climate change risk perception was measured on a five-point Likert scale. Survey respondents were asked to indicate their level of concern about climate change, where the value of 5 is given for the highest level of concern about climate change and 1 for the lowest (only a single item question was used).

5.5.2 Independent variables

Socio-demographic factors

The study considered four socio-demographic factors as independent variables, which included age, gender, education and income. Education and income were both treated as a continuous variable, where the former was measured through years of schooling and the latter through the total annual income of the household. Age of the household head was also treated as a continuous variable. Gender was coded as a dummy variable where "1'' represent female and "0" represent the male.

Experience with extreme weather events (drought)

To assess drought experience, farmers were asked to indicate how many times they had personally experienced drought in their lifetime. Thus, if a farmer indicates a higher number that represents more drought experience.

Affect

Following Peters & Slovic (2007), holistic affect was measured by asking farmers their overall feeling associated with climate change, using a 7-point Likert-scale, which ranged from 1("very pleasant") to 7 (very unpleasant). A higher score represents a negative affect.

General value orientations

Farmers' value orientations (i.e., egoistic, altruistic and biospheric values), were captured by adopting 12 questions from De Groot & Steg (2008). To measure each value (for example, egoistic values), farmers were asked to rate material possession on a 5-point Likert scale ranging from 1 (opposed to my values), 3 (important), 5 (extremely important). The scores were added for each value orientation.

Knowledge about the causes of climate change

Farmers' knowledge level about the causes of climate change was assessed by posing 3 correct and 3 incorrect statements – scholars have used a similar approach to measure public knowledge about climate change in previous studies (Shi, & Siegrist, 2015; Tobler et al., 2012). The correct statements are based on the general scientific consensus about the causes of climate change. One of the knowledge statements asked was "the cause of climate change is God's punishment". Farmers answered the statement with "correct", "incorrect" or "I don't know". "I don't know" responses were treated as wrong answers. The correct responses provided by the farmers were then added together to represent knowledge score (i.e., if the farmer responds to the six questions correctly he/she has better knowledge than a farmer who scores 3). To measure the farmers' practice of using local media sources (i.e., TV/Radio), the farmers were asked to indicate how often they follow TV/Radio programs within a week.

5.5.3 Model results of ordered logistic regression on climate change risk perceptions

The results from ordered logistic regression on the determinants of climate change risk perceptions are presented in Table 5.4 below. The model explored the influence of sociodemographic factors, drought experience, affect, value orientations, local media use and knowledge about the cause of climate change on climate change risk perception.

The results in Table 5.4 show that age is a significant predictor of climate change risk perception (OR = 1.23, $p < 0.001$). As the age of a farmer increases by one year, the odds of reporting higher levels of concern about climate change increases by 1.23 times. This means that older farmers tend to show higher concern about climate change than younger farmers do. Table 5.4, also shows that education has a significant but inverse relationship with climate change risk perception (OR=-0.114, $p < 0.05$). Farmers who have higher educational attainments are less likely to report a higher concern about climate change than farmers who

have lower education. Of the four demographic factors explored in the model, gender and income were not significant predictors of climate change risk perception.

As seen in Table 5.4, frequent drought experience is a positive and significant predictor of climate change risk perception (OR = 2.21, $p < 0.001$). This means that the likelihood of reporting higher levels of concern about climate change increases when farmers experience more droughts. As farmers' drought experience increases by one-unit, the odds of reporting higher levels of climate change concern increases by 2.21.

Table 5.4: Ordered logistic regression on climate change on climate change risk perception

Independent variables	Climate change risk perception		
	Coefficient	Odds ratio	*P*-value
Gender	-0.125	0.881	0.596
Age	0.213	1.23	0.000***
Education	-0.114	0.891	0.025*
Income	2.74e-06	1.00	0.545
Drought experience	.794	2.21	0.000***
Affect	0.947	2.57	0.000***
Biospheric value	0.02	1.02	0.098
Altruistic value	-0.019	.980	0.148
Egoistic value	0.853	2.34	0.000***
Knowledge	-0.092	0.912	0.335
Local media	0.174	1.19	0.004**
N = 400			
Note: Dependent variable is climate change risk perception; *p<0.005, **p<0.01,***p<0.001; Source: Household survey			

Table 5.4 also shows that affect is a significant predictor of climate change risk perception (OR = 2.57, $p < 0.001$). This means that farmers who have strong negative feelings about climate change are more likely to report higher categories of climate change concern. As farmers' negative affect about climate change increases by one-unit, the odds of reporting higher categories of climate change concern increases by 2.5.

The model also tested the influence of three human value orientations on climate change risk perceptions. These value orientations are: (1) egoistic (i.e. people who are self-focused); (2) altruistic (i.e., people who are concerned about other people, society in general); (3) biospheric (people who are concerned about the environment or nature).

As can be seen in Table 5.4 above, egoistic values are significantly and positively related to climate change risk perception (OR = 2.34, $p < 0.001$). In other words, farmers who have strong egoistic value orientations are more likely to report higher levels of concern about climate change. As farmers' egoistic value score increases by one-unit, the odds of reporting higher levels of climate change concern increases by 2.34. The other two value orientations (biospheric and altruistic values), were not significant predictors of climate change risk perception.

In regards to local media use, the result suggests that media has a significant effect on climate change risk perception (OR = 1.19, $p < 0.005$). The positive regression coefficient suggests that the more farmers use local media (i.e., TV and Radio), the greater their level of concern about climate change. Farmers who attend to local media regularly have higher odds of falling into the higher categories of climate change concern (1.19 times greater chance), compared to those who are low users of local media.

As can be seen in Table 5.4, knowledge about the causes of climate change has no significant effect on climate change risk perception. In other words, increased knowledge about the causes of climate change is not associated with high concern about climate change. In sum, results of the ordered logistic regression model suggest that farmers' climate change risk perceptions are influenced by age, education, drought experience, negative holistic affect, egoistic value orientations and local media use.

The previous sections in this chapter specifically dealt with farmers' perceptions regarding climate variability and change, their perceptions of the causes of climate change and the factors that influence their risk perceptions. It was important to investigate whether farmers are aware of climate change in the first place before moving to the examination of farmers' perceptions of the climatic and non-climatic drivers of livelihood vulnerability - the subject of the next section.

5.6 Farmers' perceptions regarding the climatic and non-climatic drivers of livelihood vulnerability

The first part in this section presents the qualitative findings of the various climatic and non-climatic drivers of vulnerability which were identified by participants during focus group discussions and participatory ranking and scoring exercises. The second and the third parts of this section deal with the analysis of survey and participatory ranking and scoring results, to demonstrate where climate-related factors fit among the various non-climatic factors that produce livelihood vulnerability.

5.6.1 Identifying the type of climatic and non-climatic stressors that contribute to livelihood vulnerability in the study villages

To identify the various climatic and non-climatic stressors that are confronting farmers of the study area, two separate focus groups were conducted with male and female participants. This was followed by four participatory ranking and scoring exercises, which were conducted one in each village. Overall, 24 stressors relating to climatic and non-climatic conditions emerged from the results of the focus group discussions and PRA exercises (See Table 5.5). The type of stressors identified in the focus groups and during the pairwise ranking and scoring exercises can fall under biophysical, socio-economic, institutional and policy related challenges (Table 5.5).

Table 5.5: Types of the climatic and non-climatic stressors that contribute to livelihood vulnerability in the study villages

Type of stressors category	Sub-category	Overall stressor types identified during focus groups and PRA exercises across four villages
Biophysical	Climate change	Drought, erratic rains, flooding
	Environmental	Deforestation
	Other	Crop pest and diseases, low soil fertility
Socio-economic	Economic	Agricultural market uncertainties and limited market access, the high cost of seeds, unemployment
	Social	Population rise, illness
	Infrastructure and technology	Poor roads, lack of electricity, water shortages, lack of modern farm implements
Institutional	National policies	Forced fertilizer adoption, land-grabbing
	Other	Ineffective extension system, weak early warning, destruction of the cactus plant by a human-made factor, corruption, discrimination of minority groups

Source: Results from the qualitative focus group discussions and PRA exercises

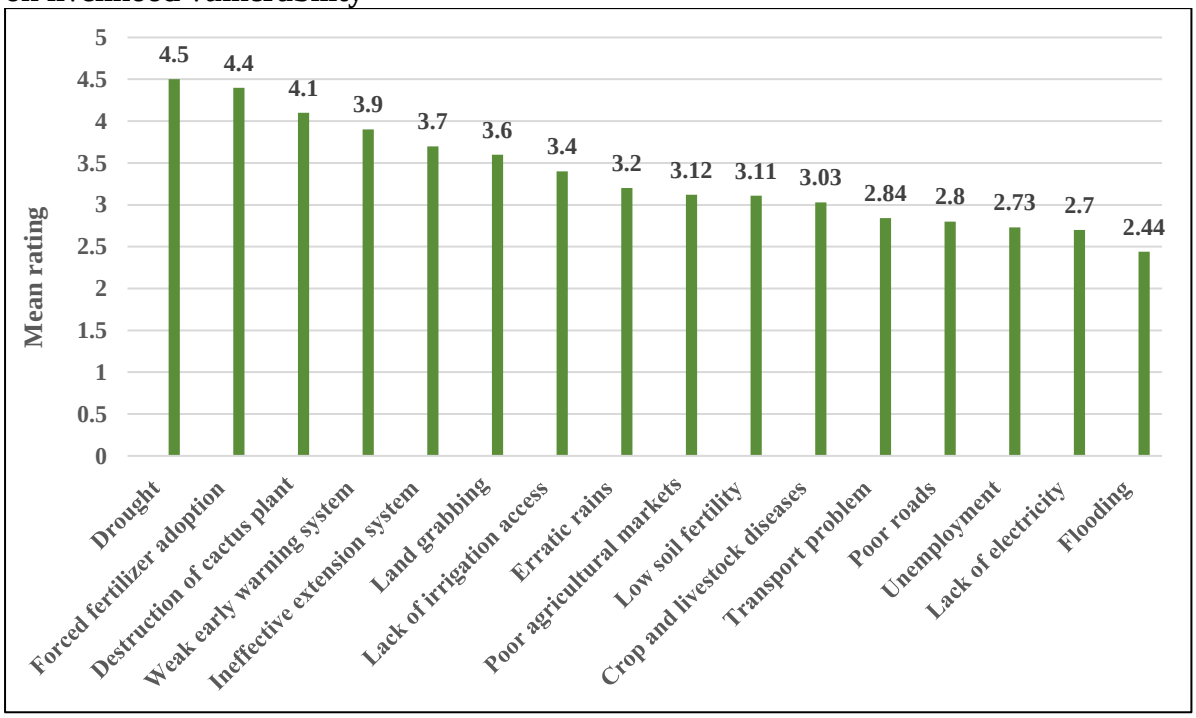
5.6.2 Comparing the significance of climatic and non-climatic stressors in contributing to livelihood vulnerability at the household level: where do climatic factors fit?

After the various climatic and non-climatic stressors pertinent to the farmers of the study area were identified through focus groups and PRA methods, they were included in the household questionnaire. Survey respondents were then asked to rate the significance of each stressor in contributing to livelihood vulnerability on a Likert scale ranging from 1 to 5 (1 = not at all significant, 2 = least significant, 3 = fairly significant, 4 = significant, 5 = very significant).

Figure 5.5 shows the mean scores of the significance of each stressor in contributing to livelihood vulnerability as perceived by farmers at the household level. The highest rated stressor is related to climate factor (particularly drought), with a mean score of 4.5. Whilst drought was the highest rated stressor, the other climate-linked stressors (i.e. erratic rains and flooding) were not rated in the top six list. Instead, non-climatic stressors such as forced

fertilizer adoption (4.4), destruction of the cactus plant by a human-made factor (4.1), weak early warning (3.9), poor extension system (3.7), and land-grabbing (3.6) were identified among the top six most significant stressors (Figure 5.5). Yet, given that drought was rated first as compared to other non-climate stressors, it remains the most significant stressor that contributes to livelihood vulnerability at the household level.

Figure 5.5: Farmers' perceptions of the significance of climate and non-climatic stressors on livelihood vulnerability



Bar graph showing the mean ratings of the significance of stressors on livelihood vulnerability (Likert scale of 1-5: 1 = not at all significant, 2 = Least significant, 3= fairly significant, 4 = significant, 5= very significant

5.6.3 Comparing the significance of climatic and non-climatic stressors in contributing to livelihood vulnerability across villages

Pairwise ranking and scoring exercises were carried out in each of the four villages and one at the district level, to enable participants to identify and rank the various climatic and non-climatic stressors that contribute to livelihood vulnerability (see Table 5.6 -5.10). The analysis of pairwise ranking involves counting the number of times each stressor is chosen as the most significant problem in order to arrive at an overall ranking. Each matrix table below (Table 5.6 -5.10) has identical lists of stressors, one across the top (x-axis) and the other down the left side (y-axis). Each cell in the matrix represents a paired comparison of two stressors. For example, in Table 5.6, "corruption" (stressor number 1) was compared first with "destruction of cactus plant" (stressor number 2). The participants perceived that "destruction of cactus plant" is the most significant problem than "corruption" and so "2" was placed in the cell in the "Corruption" row under stressor number 2 ("destruction of cactus plant"). This was repeated with the next problem "limited local employment opportunities" (stressor number 3). In this case, the participants still prioritized "limited local employment opportunities" as the most significant problem than "corruption" so "3" was placed in in the cell in the "Corruption" row under stressor number 3 ("limited local employment opportunities"). This was repeated until all the stressors had been compared with stressor No. 1 ("Corruption"). The ranking was obtained by counting the number of times each stressor appeared in the matrix.

Similar to the result found at the household level, drought was the first most significant problem in Hade Alga and Keyeh Tekely villages; followed by forced fertilizer adoption and destruction of cactus plant, which were ranked second and third respectively (see Table 5.6 - 5.7). These problems will be described in more detail in the next result chapter (Chapter 6). Other stressors that were commonly identified in Hade Alga and Keyeh Tekely were limited local employment opportunities, ineffective early warning systems, erratic rainfall, scarcity of farmland available for the youth (land shortages), and the high cost of agricultural inputs. Stressors distinct to Hade Alga villagers were corruption and discrimination of minority groups. While human illness and soil fertility problems were only mentioned in Keyeh Tekley.

Table 5.6: Ranking and scoring of stressors that contribute to livelihood vulnerability as perceived by Hade Alga villagers

Stressor types	Stressors number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	Score	Rank
1. Corruption		2	3	4	5	1	1	8	9	10	1	1	1	5	8
2. Destruction of cactus plant			2	4	2	2	2	2	9	2	2	2	2	10	3
3. Limited local employment opportunities				4	5	3	3	8	9	3	3	3	3	7	6
4. Drought					4	4	4	4	4	4	4	4	4	12	1
5. Weak early warning systems						5	5	5	9	5	5	5	5	9	4
6. Discrimination of minority groups							7	8	9	10	6	6	6	3	10
7. Market access challenges								8	9	10	7	7	7	4	9
8. Poor extension system									9	8	8	8	8	8	5
9. Forced fertilizer adoption										9	9	9	9	11	2
10. Land shortages											10	10	10	6	7
11. Erratic rainfall												11	12	2	11
12. The high cost of seeds													13	1	12
13. Population rise														1	12

Source: Pairwise ranking and scoring exercise with Hade Alga Villagers (N=11)

Table 5.7: Ranking and scoring of stressors that contribute to livelihood vulnerability as perceived by Keyeh Tekely villagers

Stressor type	Stressors number															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Score	Rank
1. Weak early warning		2	1	1	5	1	1	8	1	1	1	12	13	14	7	7
2. Erratic rainfall			2	2	5	2	2	8	2	2	2	12	2	2	10	4
3. High seed costs and poor seeds				3	5	3	6	8	3	3	3	12	13	14	5	9
4. Health issues					5	4	6	8	1	10	11	12	13	14	1	12
5. Drought						5	5	5	5	5	5	5	5	5	13	1
6. Market issue							6	8	6	6	6	12	13	14	6	8
7. Poor extension system								8	7	7	7	12	13	14	3	10
8. Destruction of cactus plant									8	8	8	12	8	8	11	3
9. Flooding										10	11	12	13	14	1	12
10. Lack of farm implements											11	12	13	14	2	11
11. Crop pest and diseases												12	13	14	3	10
12. Forced fertilizer adoption													12	12	12	2
13. Land shortage														13	9	5
14. Limited local employment opportunities															8	6

Source: Pairwise ranking and scoring exercise with Keyeh Tekely Villagers (N=13)

Looking at the most significant stressor identified in Ade Tela and Dalata villages, the study revealed an interesting finding. As can be seen in Table 5.8 and 5.9 below, land grabbing was perceived as the number one stressor that contributes to livelihood vulnerability. Indeed, this survey result also confirmed that villagers from Ade Tela (84%) and Dalata (75%) are more likely to perceive land grabbing as a very significant factor, compared to Hade Alga (7.9%) and Keyeh Tekely (2.9%) villagers. A chi-square test of independence confirmed that there is a statistically significant difference between villager's geographic location and their perception of land grabbing as a source of vulnerability ($X2$ (12, N=400) = 330.9, $P < .01$).

Table 5.8: Ranking and scoring of stressors that contribute to livelihood vulnerability as perceived by Ade Tela villagers

Stressor type	Stressors number												
	1	2	3	4	5	6	7	8	9	10	11	Score	Rank
1. Deforestation		1	3	1	1	6	7	8	1	1	1	6	5
2. Lack of market access			3	4	5	6	7	8	9	10	1	1	9
3. Land grabbing				3	3	3	3	3	3	3	3	10	1
4. The ineffectiveness of the agricultural extension system					5	6	7	8	9	10	11	1	9
5. Poor roads and transportation problem						6	7	8	9	5	5	4	7
6. Forced transport adoption							6	8	6	6	6	8	3
7. Destruction of cactus by human-made factors								8	7	7	7	7	4
8. Drought									8	8	8	9	2
9. Shrinkage of grazing land										9	9	5	6
10. Water shortages											10	3	8
11. No electricity												1	9

Source: Pairwise ranking and scoring exercise with Ade Tela villagers (N=15)

Table 5.9: Ranking and scoring of stressors that contribute to livelihood vulnerability as perceived by Dalata villagers

Stressor type	Stressors number												
	1	2	3	4	5	6	7	8	9	10	11	Score	Rank
1. The ineffectiveness agricultural extension system		2	3	4	5	6	7	8	9	1	1	1	9
2. Destruction of cactus by human-made factors			2	4	2	2	7	2	2	2	2	8	3
3. Deforestation				4	5	3	7	3	3	3	3	6	5
4. Land-grabbing					4	4	4	4	4	4	4	10	1
5. Forced fertilizer adoption						5	7	5	5	5	5	7	4
6. Poor roads and transport problems							7	6	6	6	6	5	6
7. Drought								7	7	7	7	9	2
8. Water shortages									9	10	11	1	9
9. Shrinking of grazing land										9	9	4	7
10. Lack of electricity											10	1	9
11. Limited market access												2	8

Source: Pairwise ranking and scoring exercise with Dalata Villagers (N =10)

Table 5.8 and 5.9 above revealed that drought was the second most important concern, followed by forced fertilizer adoption and destruction of the cactus plant. Other stressors that were more emphasized in Adetela and Dalata were the issue of deforestation and shrinking of grazing land, poor roads and transport problem, water shortages and lack of electricity.

5.6.4 Comparing the significance of climatic and non-climatic stressors in contributing to livelihood vulnerability at the district level

At the district level, officials identified 15 stressors that they perceive are contributing to livelihood vulnerability in the four villages studied (Table 5.10). Similar to results found at the household level and in two villages (Hade Alga and Keyeh Tekely), district officials identified drought as the most significant stressors that contributes to livelihood vulnerability. Next to drought, district officials ranked farmers' lack of farming knowledge and their poor saving habits, as the second and third most significant stressors that contribute to livelihood vulnerability. What is most surprising is that stressors (e.g. forced fertilizer adoption, the destruction of cactus plant, weak early warning, poor extension system, and land grabbing), that were considered by farmers as a significant problem – were not even identified as a concern by district-level officials.

Table 5.10: Ranking and soring of stressors that contribute to livelihood vulnerability as perceived by district-level officials

Stressor type	Stressor number															Score	Rank
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
1. Drought		1	1	1	1	1	1	1	1	1	1	1	1	1	1	14	1
2. Erratic rains			3	2	5	6	4	8	2	2	11	2	2	14	2	6	9
3. Farmer's lack of farming knowledge				3	3	3	3	3	3	3	3	3	3	3	3	13	2
4. Poor post-harvest handling technique					5	6	4	8	4	4	11	4	4	14	4	7	8
5. Lack of agricultural equipment						6	5	8	5	5	11	5	5	14	5	8	7
6. Poor family planning							6	8	6	6	11	6	6	14	6	9	6
7. Illness								8	9	7	11	7	7	14	7	4	11
8. Farmers' poor saving habits									8	8	8	8	8	8	8	12	3
9. Poor land condition										9	11	9	9	14	9	5	10
10. Animals diseases											11	10	10	14	10	3	12
11. Agricultural market uncertainties												11	11	14	11	10	5
12. Flood													12	14	15	1	13
13. Frost														14	13	1	13
14. Poor rural infrastructure															14	11	4
15. Crop pest and diseases																1	13

Source: Ranking and scoring exercise with Raya Azebo districts officials (N = 10)

In this study, what is most surprising is that stressors (e.g. forced fertilizer adoption, the destruction of cactus plant, weak early warning, poor extension system, and land grabbing), that were considered by farmers as a significant problem were not even identified as a concern by district-level officials. Given that there is a potential mismatch between farmers' perception of key stressors and that of district-level officials' view, this may suggest that efforts aimed at reducing livelihood vulnerability at the local level may not be successful. This is likely because,

district officials have close contact with authorities at the regional and federal level, and thus what they communicate to higher officials may not reflect what farmers truly perceive as a problem (as demonstrated in this case). The design and implementation of national and regional policies maybe highly influenced by the information that federal and regional authorities receive from district level officials rather local farmers. This is not to say that district level officials' perceptions of stressors that contribute to livelihood vulnerability in Hade Alga are irrelevant. Rather it is to highlight that the root causes of vulnerability may not be solved if the farmers' perceptions of significant stressors are overlooked or given less attention by policymakers.

5.7 Conclusion

This chapter presented the findings of the research on farmers' perceptions of climate change and the various socio-psychological factors that influence their risk perceptions. The chapter also presented findings relating to farmers' and district officials' perceptions of the climatic and non-climatic drivers of livelihood vulnerability in the study area. The results showed that smallholder farmers in the study area do not perceive climate change as a distant phenomenon on a number of psychological dimensions. Farmers tend to perceive the impacts of climate change to be geographically, socially, temporally and hypothetically close (or proximal). Results also revealed a positive correlation between psychological proximity and increased concern towards climate change.

Findings revealed that farmers' understanding of the causes of climate change widely differs from the scientific explanation of climate change causes. The majority of the study participants had a strong belief that climate change is a result of humans' disobedience to God's commandments. Although the farmers' view of the cause of climate change widely differs from the scientific view, they are well aware of the changes that are occurring in their local climate. Farmers have noticed that rainfall has become more erratic and its quantity is decreasing, and drought is becoming more frequent. Overall, these perceptions are similar across the four villages – i.e., climate change has been perceived by the majority of the farmers regardless of their geographic location. Results further indicate that various socio-psychological factors shape farmers' risk perceptions of climate change including age, education, drought experience, negative affect, value orientations and local media.

Concerning the drivers of livelihood vulnerability, farmers' identified twenty-four stressors that are linked to climatic and non-climatic factors. Drought imposed fertilizer adoption, destruction of the cactus plant by a human-made factor, land grabbing, ineffective agricultural extension and early warning systems, inadequate rural infrastructure, poor agricultural markets, unemployment and the prevalence of crop pests and diseases were among the frequently cited drivers of livelihood vulnerability by farmers.

The results regarding the most significant driver of livelihood vulnerability are mixed. At the household level, farmers perceived drought as the first most significant stressor compared to other non-climatic stressors. This perception was similar among officials at the district level. At the village level, community participants from *Hadealga* and *Dalata* perceived that drought is the most important vulnerability factor that is affecting their community as a whole. Yet, villagers from Ade Tela and Dalata identified that land grabbing (a non-climatic factor) is the most significant challenge in their villages (this issues will be discussed in the next chapters (chapter 6 and 8).

The next chapter will explore how climatic and non-climatic factors affect farmers' lives and livelihoods in various forms. The chapter will also look at how some of the non-climatic stressors directly or indirectly increase farmers' vulnerability to climate change and reduces their capacity to cope with and adapt to climate-linked factors (e.g. drought).

Chapter 6: The impacts of climatic and non-climatic stressors on farmers' lives and livelihoods

6.1 Introduction

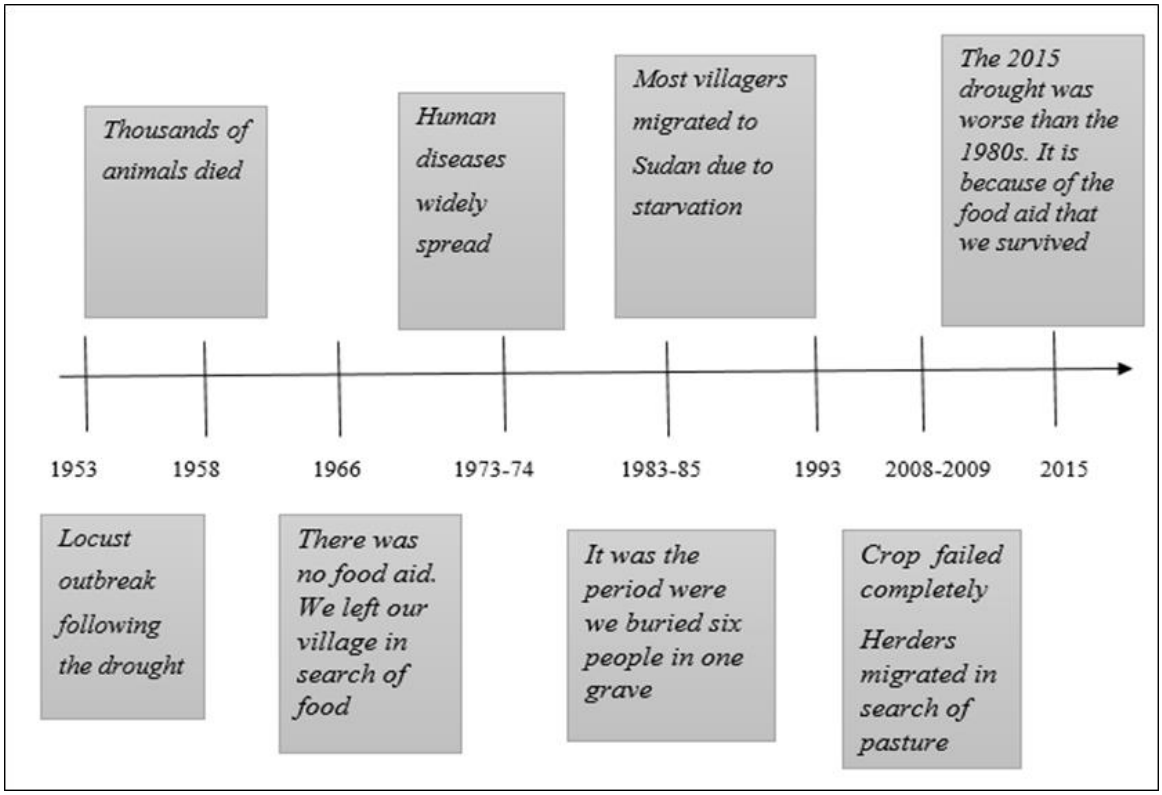
This chapter focuses on how the identified climatic and non-climatic stressors affect the farmers' lives and livelihoods. The stressors that will be examined further in this chapter include: (1) drought, (2) destruction of cactus plant, (3) imposed fertilizer, (4) land grabbing, (5) lack of access to climate information and (6) ineffective agricultural extension program. The chapter is divided into two main sections. The first section examines how the climate-related stressor – drought – contributes to livelihoods vulnerability. The second section will focus on the non-climatic stressors that influence the farmers' lives and livelihoods.

6.2 Livelihood vulnerability to climate-related stressors – Drought

The findings of the vulnerability assessment in the studied villages indicate that farmers' lives and their livelihoods are affected by climate-related stressors, particularly by the occurrence of recurrent droughts. The theme of drought risk recurred throughout men's and women's focus groups and during interviews conducted with government officials at district and regional level. Through a Participatory Rural Appraisal tool (Historical timeline), community members were asked to identify major drought events that have occurred in their lifetime and how they have affected them.

As seen in Figure 6.1, villagers narrated how droughts that have occurred at a different stage in their villages affected their lives and livelihoods. Since 1950, severe drought has occurred at least once within a 10-year period interval. Participants perceive drought as either insufficient rain or a total lack of rainfall over crop growing seasons (*Beleg* and *Meher*). Interestingly, the historical timeline of drought events identified by the participants corresponds with studies that have assessed the occurrence of drought episodes in Ethiopia, including in the Tigray region (Ghebrezgabher & Yang, 2016; Suryabhagavan, 2017; Viste & Sorteberg, 2013; Wolde-Georgis, 1997).

Figure 6.1: A historical timeline of drought events and their impacts in the study area



Source: Historical timeline exercise with villagers

The analysis of the qualitative results suggest that drought affects farmers' lives and livelihoods through its impact in the following main areas: (1) agriculture, livestock production and household income (2) food security, (4) children schooling, (5) migration and conflict, (6) human health. The following sections explore in more detail the impact of drought in those areas.

6.2.1 Impacts of drought on agriculture, livestock production and household income

Survey respondents were asked about their perception of drought impacts on livelihoods using various socio-economic indicators (multiple responses were possible). As shown in Figure 6.2, 91% of the surveyed households perceive that the impact of drought on crop yield is high. In the entire data collection period, interviewed farmers frequently complained about how the recent 2015 drought has impacted their harvest. In the study area, the rainfall pattern is bimodal with two cropping seasons *Belg* (January- March) and *Kiremt* (June - September). According to the farmers, spring *(Belg)* rain was unusually poor in the study area. The majority of the farmers reported they did not plant *Belg* crops (*Teff*, Maize and Sorghum) as the rain was inadequate to prepare the land. In March, some farmers attempted to plant *teff*, sorghum and

maize. However, most of the planted crops completely failed. For example, one farmer recalling the 2015 failed *belg* rain said:

> *The 2015 belg rain was so frustrating. It was too dry in January and February. There was some rain in March. Hence I planted Teff, sorghum and Maize. Except the Sorghum, all the other crops failed. But the yield [sorghum] was by half lower than what I usually get in normal years. (Respondent ≠ 5, Household survey 2016/17).*

For instance, according to the crop assessment report from the Bureau of Agriculture in Raya Azebo district, of the total 19368 ha of land planted with sorghum in the 2015 year, 12383 ha of land was damaged by the drought. Studies show that in many arid and semi-arid parts of the developing world, drought is among one of the climate-linked risks which impact the agricultural sector (Keshavarz et al., 2017). Particularly in rain-fed agriculture, the impact of drought is immediate which often undermines crop yield (Devereux, 2007). In fact, the negative impact of drought on crop yield has been observed globally (Daryanto & Jacinthe, 2016).

Citing the 2015 drought, farmers reported that the scarcity of water and fodder for livestock resulted in poor livestock condition. The majority of interviewed farmers have sold livestock to cope with the drought. However, according to the farmers, the cattle prices declined drastically in local markets. One reason given for the decline of the cattle price in the local market was due to the poor body condition of the cattle. For example, farmers explained that the price of ox in 2014 normal year was ETB 9,000 and it declined to ETB 3,500 in August 2015. As shown in Figure 6.2 below, almost 94% of the surveyed farmers perceive that the impact of drought on livestock production is high. A study of Warner & Geest (2013) similarly indicate that the majority of the households in Burkina Faso and Gambia perceived the negative impact of drought on livestock production.

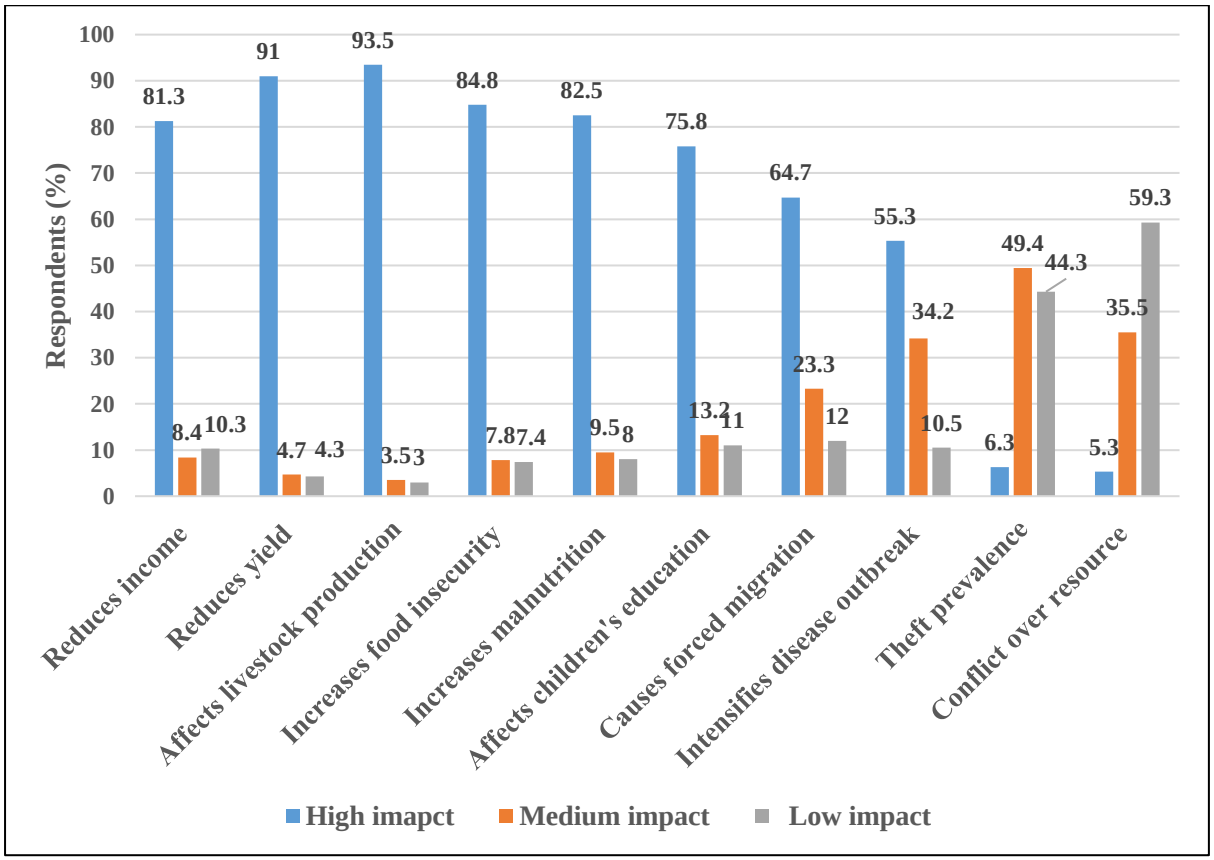
Farmers noted that the impact of drought on crop yield and livestock has a direct influence on their income. As can be seen in Figure 6.2 below, 81% of the household perceive the negative impact of drought on income is high. For example, many of the interviewed farmers stated that their annual income has been highly affected in 2015, as they did not harvest surplus crop to sell for the market and since they sold their livestock assets at a very cheap price. This situation led them to borrow money to cover their living expenses. While farmers attributed forced

fertilizer adoption as the primary reason for household indebtedness, they also cited that drought has made it worse.

6.2.2 Impacts of drought on food security and prevalence of malnutrition cases

The interviewed farmers reported that recurrent droughts have had a serious negative impact on food availability in the study area. Studies indicate that in many African nations, even moderate droughts can lead to food scarcity and can exacerbate the food security situation of rural households (Rojas & Rembold, 2011). The majority of the households (85%) perceive that the impact of drought in causing food insecurity is high (Figure 6.2). For instance, recalling the 2015 drought, interviewed farmers reported that drought led to high food scarcity and as a result, they relied on food aid. Indeed, reports on the 2015- 2016 drought in Ethiopia show that in almost all regions of Ethiopia, El Niño-induced drought conditions significantly threatened local and national food security, which led to 10.2 million people requiring food assistance (Rojas et al., 2011).

Figure 6.2: Impacts of drought on farmers' lives and livelihoods



There was a consensus among men and women focus group participants regarding the effect of the 2015 drought in creating food shortages for all community members. However, the men's focus group participants emphasized that the poor were more severely affected by the drought and were more food insecure. This finding is in agreement with Webb's (1993) which showed that poor farmers in the lowland and highland regions of Ethiopia were harder hit by the drought-induced food crises as compared to the better off farmers. For example, one of the focus group participants from the men's said:

> *I am a poor farmer. My land size is very small [0.25 ha]. I do not reserve food for the next season. Because what I produce is hand to mouth. If the rains do not come in one of the growing seasons, I usually experience severe food shortage for the rest of the months. For example, last year [2015] I did not harvest any crop. My family and I totally relied on the small amount of food aid that we received from the government. (Participant # 5, FGD 1).*

Women focus group participants stressed that during drought times, especially pregnant and lactating mothers are more exposed to the risk of malnutrition. This affects newborn babies and infants. Mentioning the 2015 drought, participants stated that they all had struggled to feed their young children during the drought crisis. The local health extension officer in Hade Alga described the situation in 2015 as follows:

> *Last year we [health officials] were so overwhelmed by the increasing number of undernourished children coming to our health post. The drought must have contributed this. I have never seen quite a large number of children receiving malnutrition treatment since I started working in this health post. (Respondent # 1, Interview 2016/17).*

6.2.3 Impacts of drought on children's schooling

The other widely reported concern associated with the drought impact was how it affects the schooling of children. Participants in FGD mentioned various individual circumstances that limit their children from attending school. However, they reported that when drought hits their local area, it is almost impossible to send children to school. One reason given by FGD participants was that young children had to miss school to look after the little ones when parents leave home to look for alternative income sources, water and food. For instance, FGD participants from the women's focus group told that on average they spent 6 hours/day at the food distribution centre to receive food aid. In addition, the school dropout rate among children is high when they suffer from malnutrition during extended drought periods. Interviews conducted with a school director in Hade Alga village confirmed this situation

> *Most of our teaching classes became empty immediately after the local farmers experienced the recent drought [2015]. Students slowly started dropping out of school. But thanks to the NGOs support [school feeding program] most of our students were able to return to school. (Respondent # 2, Interview 2016/17).*

Various studies have observed malnutrition cases and high school dropout rates due to the 2015/2016 drought in Ethiopia. For example, Ethiopia's Humanitarian Requirement Document (HDR) indicates that 1.3 million children were unable to attend their education throughout the country and that 435, 000 were at risk of acute malnutrition as a result of drought (HDR, 2016).

6.2.4 Impacts of drought on migration and conflict

Farmers during the survey gave various reasons for their migration decision (See chapter 8). Among the reasons, drought is one of the factors for migration decision. The women's focus group participants indicated that typically during severe drought periods at least one family member of the household migrates to a new location. In fact, studies have documented drought as a common reason for migration decision in developing countries (Jülich, 2011; Meze-hausken, 2000). As Figure 6.2 above shows, 67% of the surveyed households perceive that the incidence of forced migration typically during drought period is high.

Women FGD participants note that sometimes such types of involuntary migration exposes migrants to new economic risk in the destination area, and as a result, the remaining household members suffer. The story of one of the FGD participants illustrates this situation.

> *The condition was not so good in the previous year [the 2015 drought year]. My young daughter migrated to Saudi Arabia in June 2015. I sold two of my cows to cover her travel expenses. She returned to her village after 6 months of stay. Her employer refused to pay her monthly salary, so she came with an empty pocket! I expected that she would send me money to replace the old cows. It never happened. Now, where would I get the money? (Participant # 1, FGD 2)*

Farmers also explained that migration weakens the social bond that exists within family and community members as a whole. In fact, this has been recognized by Adger et al (2012) who argue that climate change responses, such as migration, can threaten the community's cohesion, their culture, and identity.

During the historical timeline exercise, participants noted that during extended drought periods, conflict is common among community members due to competition over scarce water and pasture resources. During normal years, community members store rainwater for multipurpose use. However, when drought strikes, there will not be sufficient water that can be used for domestic purposes, particularly in Adetela and Dalata villages. Conflicts occur when water users compete over the limited water source. During focus group discussions with men, participants also reported that when there is drought, pastoralists from the neighbouring region (Afar) migrate to Hade Alga in search of pasture and water. According to the participants, this creates more pressure on scarce resources and it is one main cause of conflict between Hade Alga community members and the Afar pastoralists. This finding is consistent with the study of Hundie (2010), who found drought-induced resource scarcity as one of the drivers of conflict between the Afar pastoralists and their neighbours in Ethiopia. A similar observation was made by Opiyo et al., (2012) in Kenya.

6.2.5 Impacts of drought on human health

As shown in Figure 6.2 above, 53% of the surveyed households perceive that health-related problems are particularly high during drought times. During the historical timeline exercise, participants mentioned common health-related problems they experience when drought is severe in their locality. For example, they observed a higher incidence of malaria, yellow fever and skin-related diseases in times of drought than in normal years. In an interview, the local health extension officer explained how drought increases the prevalence of human diseases as follows:

> *During critical drought periods, farmers in this study area experience acute water shortages. That is why we [health staff] observed a high incidence of scabies diseases during a drought period. Malaria outbreak is also increasingly common in these areas when the temperatures get really high in drought years. The communities lack basic malaria controlling mechanisms such as using a mosquito net and thus they are highly susceptible to the disease when the number of mosquitos increase during and following the drought. (Respondent # 1, Interview 2016/17).*

Overall, the results above suggest that smallholder farmers in the study area are highly vulnerable to the impacts of drought. It has been shown that the effect of climate change, mainly in the form of drought poses a serious challenge to the lives and livelihoods of smallholder farmers.

6.3 Livelihood vulnerability to non-climatic stressors

So far, the findings of the previous sections suggest that farmers are at risk due to their vulnerability to climate-linked stressors (particularly drought). In addition to climate change, however, smallholder farmers in the study area are facing a wide range of other non-climatic stressors that constrain their lives and/or that contribute to livelihood vulnerability. Some of these non-climatic stressors also increase the farmers' vulnerability to climate change and undermine their capacity to cope with or to adapt to climate change conditions. The following sections explore these non-climatic stressors – including imposed fertilizer adoption, destruction of cactus plant, land grabbing, lack of access to climate information and ineffective agricultural extension system – and show how they are contributing to livelihood and climate change vulnerability.

6.3.1 Agricultural-related policy challenges - imposed fertilizer distribution

As the above findings demonstrate, climate change is a big challenge to farmers and it is having a profound impact on their livelihoods. However, besides climate change, farmers in the study area are facing agricultural-related policy challenges that influence their vulnerability. One of these policies is related to agricultural inputs. By distributing chemical fertilizer to smallholder farmers, the Ethiopian government aims to boost the country's agricultural production and productivity (MOFED, 2010). However, in the study area, the fertilizer distribution program is not largely based on the farmers' demand for fertilizer, but rather by the government push. This section illustrates how the government's imposed fertilizer distribution program affects the farmers and contribute to their vulnerability to climate change impacts.

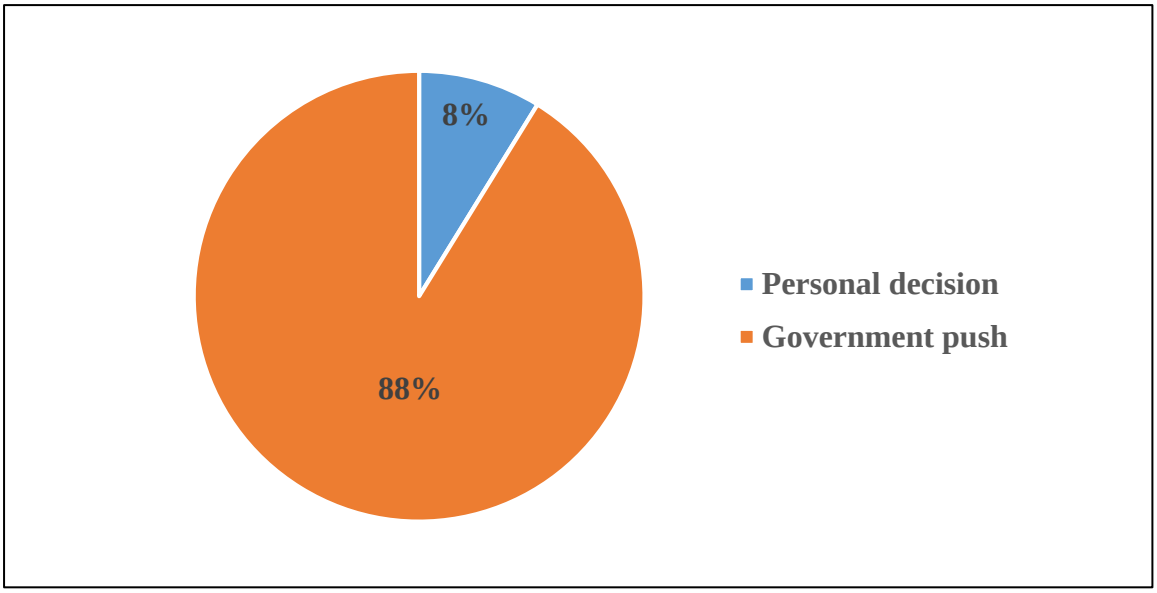
Imposed fertilizer distribution and reasons for low fertilizer demand

The issue of forced fertilizer purchase came up in all the focus group discussions. For example, one participant from the men's focus group expressed his resentment:

> *This government is killing us by forcing us to take fertilizer without our interest. Eight years have passed since the government imposed this [fertilizer] on us. (Participant #4, FGD 1).*

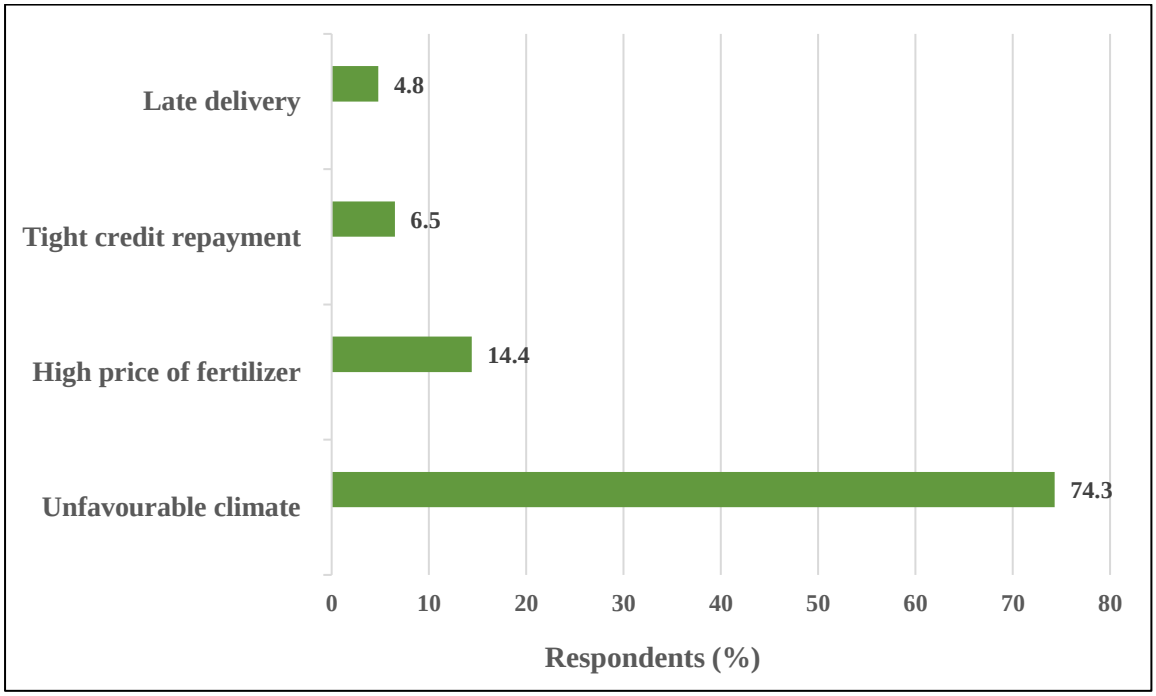
Out of the 400 sampled household, 385 (96%) have taken fertilizer over the last five years. These respondents were asked about their main reason for buying the fertilizer package. Only very few households (8%) reported it is their personal decision. Nevertheless, an increasingly large number of households (88%) complained that they are continuously pushed by the government to take fertilizer (Figure 6.3). These findings confirm the view of Planel (2014), who highlights that fertilizer distribution in Ethiopia is indeed a "rule" imposed on peasants. Survey respondent was asked whether they are interested to buy fertilizer for the next agricultural season and only a few respondents (4.8%) showed their interest.

Figure 6.3: Farmers' reason for buying fertilizer



Survey participants who reported they were 'pushed" by the government to take fertilizer were asked to indicate the main reason for not wanting to buy fertilizer As shown in Figure 6.4, the majority of the households (74%) attributed unfavourable climate (i.e. shortage of rain/droughts) as their main reason for not wanting to take fertilizer. Indeed, one of the many determinants for the low demand of fertilizer input in Sub-Sharan Africa is the climate reason (Mwangi, 1997).

Figure 6.4: Farmers' reason for not wanting to buy fertilizer



During focus group discussions, the problem of climate-linked factor (particularly drought) was frequently mentioned by participants as the main reason for low fertilizer demand in the study area. One focus group participant explained the situation as follows:

> *We can't deny the fact that fertilizer is useful for maximizing crop yield. Those farmers who have irrigation access are benefiting from fertilizer use. But most of us rely on rain-fed agriculture. As you know, we do not receive enough rain in this area. How can we use fertilizer where there is no enough rain? We are being hit by drought almost every year. When we apply fertilizer without enough moisture, it burns the soil. That is why we do not want to use fertilizer. We just do not get it how the government failed to understand our problem. (Participant # 10, FGD 1)*

The adverse consequences of imposed fertilizer distribution on farmers and their livelihood

Throughout the survey and qualitative interviews, farmers complained about the unintended negative consequences they experience when they refuse to take fertilizer. One of the frequently mentioned consequences they face is exclusion from foreign food aid programs. This result is in agreement with Panel's (2014) observation where farmers in other regions of Ethiopia experience the same problem when they stop taking fertilizer. A poor man from this case study area explained the situation as follows:

> *If we refuse to take fertilizer, they [development agents and local leaders] do not let us receive food aid even if we are starving. They also exclude us from community programs and projects that might be beneficial for our livelihoods. Is this fair? (Respondent # 11, Household survey 2016/17)*

The other adverse consequence commonly mentioned by farmers when they are unable to repay fertilizer debt was the problem of facing imprisonment. This finding is consistent with the study of Albin-Lackey (2005), who also found that farmers in the Oromia region of Ethiopia face similar problems associated with fertilizer debt. One local farmer who himself faced prison explains the situation in interviews like this:

> *If we fail to repay the debt, the Melitia [local soldiers] will take us to prison. I have faced this myself two years ago. They released me after my wife sold one of my oxen and paid the loan. (Respondent # 6, Household survey 2016/17)*

Farmers will face imprisonment not only when they fail to repay their debt but also if they are caught reselling their own fertilizer quota to brokers. Talking about this issue, one key informant said:

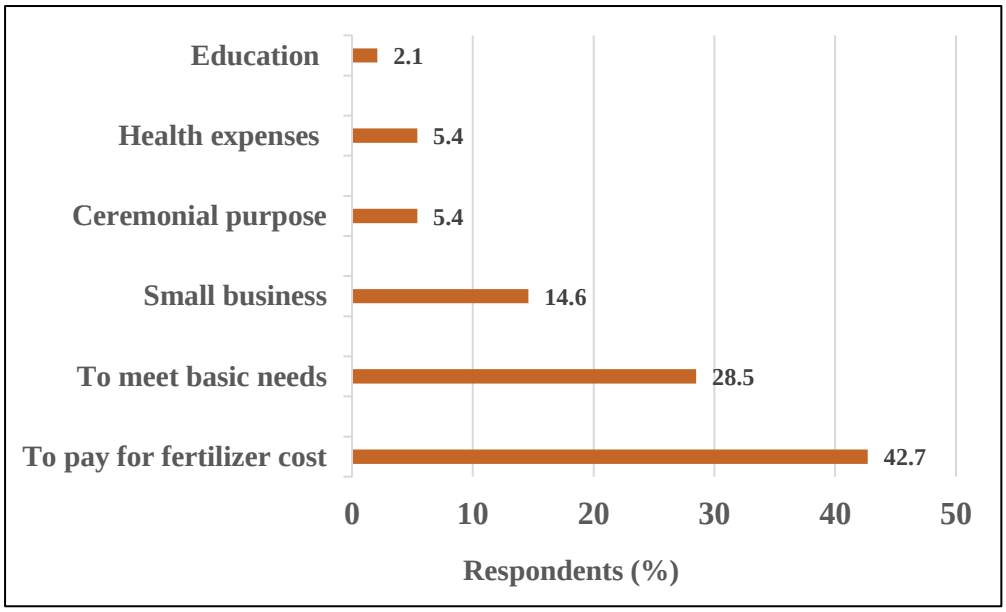
> *The price for a 50 KG bag of fertilizer is 1200 ET Birr. Farmers cannot sell fertilizer for a third party, it is illegal. But some farmers resell it on a reduced price, just for 300 ETB for other farmers who have irrigation access. If they are caught, they will be thrown into prison. If you go to the police station [prison house], you will see many farmers in jail because of this issue. (Respondent # 3, Interview 2016/17)*

During focus groups and individual interviews, households repeatedly complained that they are economically vulnerable as a result of frequent borrowing to purchase fertilizer input. As one interviewee said:

> *Most of us [farmers] borrow money to pay for the fertilizer cost we do not use at all. We do not produce much mainly due to the drought conditions. Where would we get the money to repay back fertilizer debt? We are heavily indebted from year to year. Some farmers flee from their village to nearby town. Some will come back to their village after they earn little money but others may not return back at all. You may see poor farmers from our area begging in Mekelle city, just to repay back their loans. (Respondent # 21, Household survey, 2016/17).*

Of the 400 sampled household, over half (59.8%) replied they have borrowed money the previous year. These respondents were asked to indicate their main reason for borrowing. It can be seen from Figure 6.5 below that the majority of them (42.7%) borrowed to pay for fertilizer cost, followed by (28.5%) to meet basic needs. At the time of the interview, the cost of 50-Kg of Urea and DAP fertilizer were 600 and 450 ETB respectively. If a farmer owns 0.5 ha of land, he/she is expected to take a mixture of 50 KG of Urea and 50 KG of DAP fertilizer. Thus the total cost for the two amounts of fertilizer types would be 1050 ETB. The amount of fertilizer required to be taken by each household increases as the land size increases. The amount of money borrowed by household to pay (purchase) fertilizer ranged from 500 ETB up to 2000 ETB.

Figure 6.5: Main purpose of borrowing in the study area



The households who took the loan for fertilizer purpose were asked if they have experienced repayment failure, whether partially or fully. Out of 102 respondents who borrowed loans for fertilizer purposes, nearly all (91) household were not able to pay back the fertilizer debt. This result is not surprising partly because farmers' were unable to produce crop because of the drought they experienced last year and they may not have the chance to sell the crop and pay back their debt.

Overall, the agricultural policy (i.e., forced fertilizer distribution) is harming the farmers and potentially increasing their vulnerability to climate change. As the findings above revealed, farmers are being excluded from food aid programs when they refuse to buy fertilizer. However, such programs can potentially help the farmers to recover from climate-related stressors and lessen their overall vulnerability to climate change effects. Again, when farmers are unable to pay for a fertilizer that is imposed upon them, they are being thrown into prison. Obviously, this hinders the farmers from using their time and labour towards implementing adaptation strategies that can moderate the impacts of climate change. In addition, since the forced fertilizer distribution system is exposing the farmers to economic risks and debt, farmers will be constrained to implement climate change adaptation strategies that require financial capital.

6.3.2 Destruction of the cactus plant by human-made factors (institutional failures)

Farmers' livelihoods, which are already affected by the impacts of climate-linked stressors (drought) and agricultural-related policy, is further threatened by human-made destruction of the cactus plant. The destruction of the cactus plant has also exacerbated the farmers' vulnerability to climate change by undermining their ability to cope with drought conditions. To demonstrate this, the following section will first highlight how important the cactus plant has been for farmers' livelihoods and their climate change adaptation efforts. It then looks at the factors that led to the destruction of cactus plant and subsequently it shows how the destruction of cactus has now contributed to the vulnerability of the farmers' livelihoods and increased their vulnerability to climate change impacts.

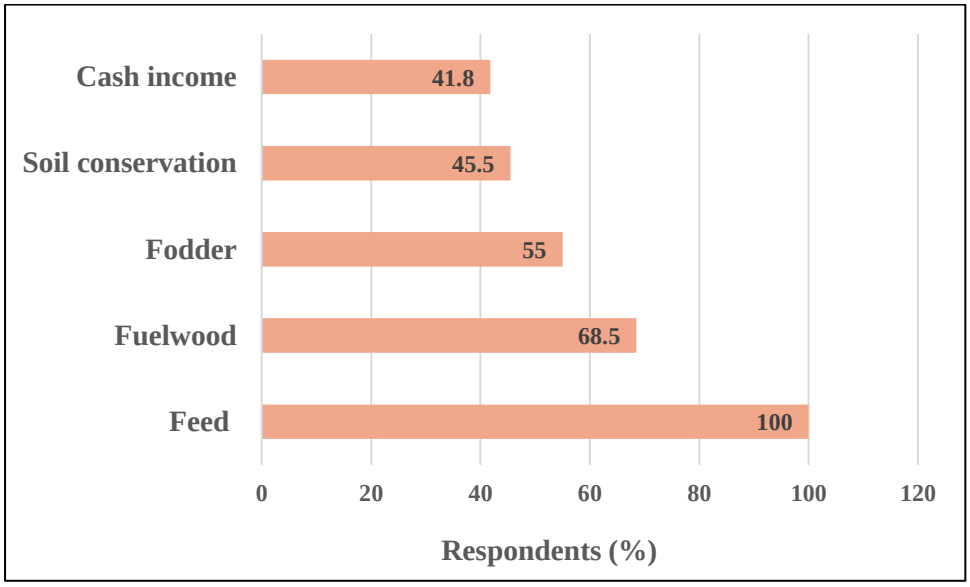
What were the different purposes of the cactus plant before its destruction?

Before its destruction, cactus plants had contributed significantly to the farmers' livelihoods and their climate change adaptation efforts. The plant is extremely drought tolerant with numerous benefits. In fact, the primary reason why the farmers planted cactus is due to its drought-tolerant nature. Cactus has had multiple benefits in the past. As can be seen in Figure 6.6, all of the surveyed farmers (100%) used a cactus plant as a source of food. In the past, most farmers consumed cactus pear during months of food shortages (June to August). Most importantly, however, the farmers almost entirely depended on cactus pear during drought periods. Throughout the data collection time, all the surveyed household and focus group participants reported how cactus pear was a safety net in previous droughts. In the words of one woman focus participant:

> *Beles [cactus plant] is our life. It is everything for us. It is the only plant that withstands severe drought. In the past, we survived major food crises periods by eating the fruits of Beles. (Participant # 10, FGD 2)*

As can be seen in Figure 6.6, the cactus plant has been an important source of cash income for 40% of the surveyed farmers who depended on the sale of cactus fruits. Results also suggest that instead of cutting trees, 63% of the farmers used to rely on the abundant cactus plant for fuelwood consumption. Moreover, 42% of the surveyed farmers planted cactus plant to protect the soil from erosion (Figure 6.6). Indeed, the significant role cactus hedges play in protecting environmental degradation problems such as soil erosion is well acknowledged (Nefzaoui & Mourid 2010).

Figure 6.6: The multiple uses of the cactus plant



In addition, the cactus plant has been used as livestock fodder by 50% of the farmers for many years (Figure 6.6). Since cactus is the only plant that can survive harsh climate conditions, farmers used to depend heavily on cactus cladodes to feed their animals during drought periods. According to the farmers interviewed, because of the high water holding capacity of the cladode, the animals do not necessarily have to drink water for a certain amount of time once they consume it. Indeed, evidence shows that the high moisture content of the cactus cladode is suitable for livestock production in arid and semi-arid areas (Nefzaoui et al., 2014). In their assessment of the role of cactus as livestock feed in Northern Ethiopia, Gebretsadik et al., (2013) found similar results supporting the long-held tradition of farmers feeding cactus cladodes to their ruminants particularly during drought periods.

Overall, the survey results revealed that for the majority of the farmers (76%) cactus plants made a very important contribution to their livelihoods before the damage. The above findings suggest how important cactus pear has been for the maintenance of the farmers' food security during periods of food shortages and how it helped the farmers to cope with drought conditions in the past. The next section will explore the factors that led to the destruction of the cactus plant.

What are the various factors that led to the destruction of the cactus plant?

With the aim of maximizing the benefit from the abundant cactus pear vegetation cover in Tigray, a workshop was conducted by Mekelle University in collaboration with the University of Wiesbaden-Polytechnic, Germany in 1997 (Belay & Bustamente, 2010). One of the recommendations forwarded during this workshop was to introduce carmine cochineal – a commercial insect used to produce red dye from a cactus plant (Belay, 2015). According to the key informant, this recommendation was later pursued by Mekelle University with the support received from the Food and Agriculture Organization of the United Nations (FAO). As earning foreign currency through the production of cochineal was the main target, Mekelle University started looking for a foreign company which can produce and export the dried cochineal (Key informant # 1).

As a result, a Chilean company called FoodSafe showed interest to start a business in producing carmine cochineal. According to the information gathered from the Tigray Agricultural office, the company was granted 300 ha of land for cochineal farming in 2007. The company requested the regional government to train some local people in the production and harvesting of carmine cochineal so that they can sell back the insect to the company and the regional government's response was positive (Key informant # 1, Key informant # 2). According to key informants, the locals who were targeted for this training were landless youth and women who were organized in the form of cooperative. FoodSafe in partnership with the German Development Agency (GTZ), was able to train 500 out-growers (landless youth) (GAFÉIAS, 2012). The youth were then provided with the cochineal insects to reproduce them in the *Machew-Mehoni* area (i.e., around the study area) (Key informant # 1).

Due to the conducive climate condition, the FoodSafe company became very successful in producing more cochineal within a short period of time (Key informant # 3). Evidence shows that in 2009, the company was able to export 100 tonnes high-quality cochineal to Mexico (Portillo, 2013). The suitable climatic condition in south Tigray contributes to the extraction of high carminic acid out of the cochineal insect, which has its own commercial significance (Belay & Bustamente, 2010). Indeed, Portillo (2013) reports that the Ethiopian Cochineal was excellent quality as it contains more than 23% carminic acid. Hence, the cochineal business was very promising for Foodsafe **(**Key informant # 3).

Key informants believe that the profit motivated the company to seek alternative means of producing cochineal insects in large quantities. So in this case, the supply of cochineal from the trained out-growers and the company's own farm was not enough (Key informant #1, #2). As a result, the company started encouraging other untrained local youth to farm cochineal insect and to sell it back to the company (Key informant #1, #2). This is partly explained by the company's strong interest to buy cochineal insect at a price of USD $8/Kg from local farmers, which was previously purchased at USD $2/Kg (Key informant #3). Selling cochineal became a very attractive business for the local youth, thus an increasing number of young individuals started increasing and harvesting cochineal insect in a communal land that is covered with cactus plants (Key informant # 1).

Soon, however, farmers of the area started recognizing the cochineal insect as a big threat to their *beliefs* (prickly pear), once it infects the cactus plant. Farmers realized that even their cattle could not eat the cladodes or stems of the cactus plant (Key informant # 4). At this stage, the community of the area started dividing into two groups. The first group was dominated by the youth who saw the short-term immediate benefits of cochineal business and who still preferred to continue harvesting the insect. The second group consisted of other community members who recognized the danger of cochineal insect and who wanted to stop the youth from expanding the cochineal farming (Key informant # 4). According to key informants, the second community group has made some efforts, such as prohibiting the youth from collecting cochineal at the communal land and reporting the case to the district level administrators since 2009. However, the efforts were not effective and the dispute between the two groups intensified, as they did not receive an effective response from the district authorities (Key informant # 4). Even though the company's staffs were well aware of the emergence of disputes among the community groups, they kept buying the cochineal from the youth.

The cochineal insect started spreading at an alarming rate to other places beyond the project area. However, in this case not only having been spread by humans, but also by other mechanisms such as wind. Cochineal destroyed cactus plants started to be observed everywhere in the southern part of Tigray, including in the current case study area (Key informant # 4). In 2010, the problem grabbed the attention of district and regional level officials ((Key informant # 4). Thus, the regional government revoked FoodSafe Company's investment licence in 2010 after cochineal insects caused significant damage to the cactus resource.

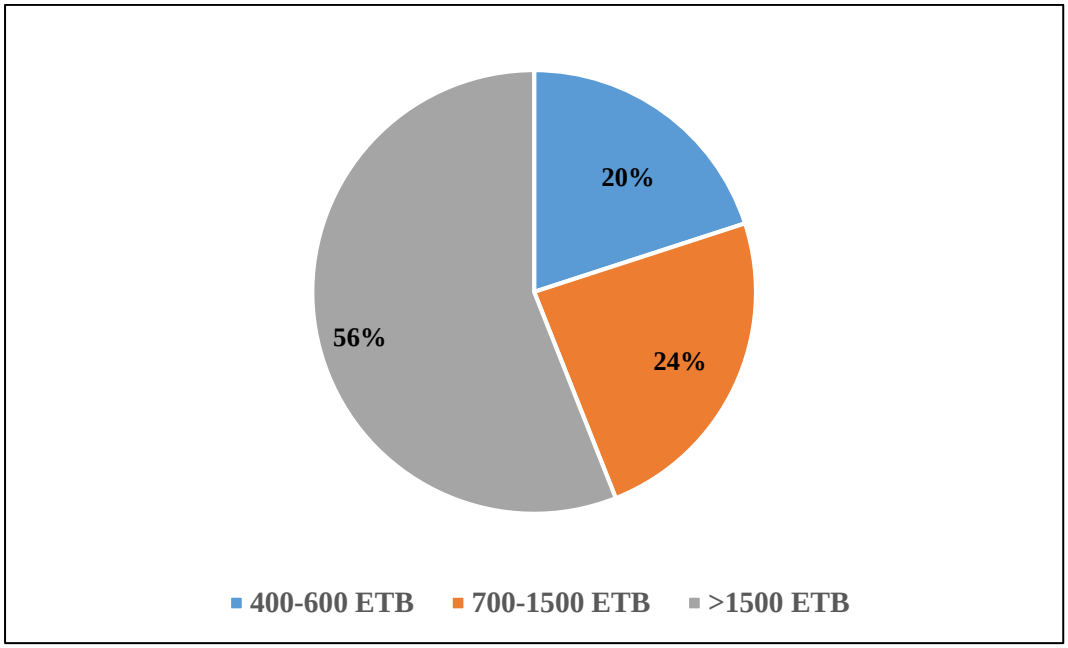
According to the information gathered from the Agricultural office of Raya Azbo district, efforts were made to control the spread of the insect by mechanical means. For example, farmers stated that they have used mechanical controlling measures (e.g., burning cochineal infested cactus plants) to control and eradicate cochineal. However, the method is not effective. They feel that the government has not made a strong effort to restore their cactus plant. Currently, a large tract of land is being invaded by the cochineal insects and mechanical prevention mechanisms are ineffective and beyond control in southern Tigray (Gebretsadik et al., 2013). Currently, 16,255 ha of land is infested by cochineal, which is more than half of the land under cactus cover in Tigray (Belay, 2015).

This study revealed some important insights as to why the cochineal investment project introduced to the project area went wrong. The qualitative interviews conducted at the district and regional level offices indicate that prior to the commencement of the cochineal investment project, no baseline study was conducted on the likely positive or negative impacts it might have on the environment and the community. This is also supported by other researchers who reported that there was no pest risk analysis conducted by the responsible government offices when the insect was introduced to the area (Zeweld & Meles 2017). The empirical evidence collected directly from the affected communities also revealed that farmers' of the project area were neither consulted nor informed about the project. In the case study area, all interviewed farmers (100%) reported that they were not aware of the harmful nature of the cochineal insect until it destroyed their cactus plant.

How did the destruction of the cactus plant affect the farmers' livelihoods and increase their vulnerability to climate change?

Due to institutional failures, the cactus plant is completely damaged. This has contributed to farmers' livelihood vulnerability. For instance, survey results show that selling cactus fruit was one among the main sources of livelihood income for 42% of the farmers. Among those farmers who used to sale the fruits, over half (56%) of the households have lost more than 1500 ETB (74 AUD) annually, as a result of the devastating damage to the cactus plant (Figure 6.7). Clearly, the cactus damage has contributed to negative livelihood outcomes by exposing the farmers to financial insecurity.

Figure 6.7: Amount of cash income farmers lost from the selling of cactus fruit



The destruction of the cactus plant has also increased the farmers' vulnerability to climate change by undermining their capacity to respond to drought conditions. As indicated in the previous section, the primary reason why farmers widely planted cactus is due to its drought-tolerant nature. Hence, cactus was basically an adaptation plant in the study area. Results suggest that since the farmers can no longer harvest the fruits of cactus, they cannot cope well during drought conditions and this has exacerbated their vulnerability. Some farmers who used to depend on the sale of the cactus fruit as an income generating mechanism reported that during the 2015 drought period, they were unable to purchase food from the market to cope with the 2015 drought condition as they did not have enough income.

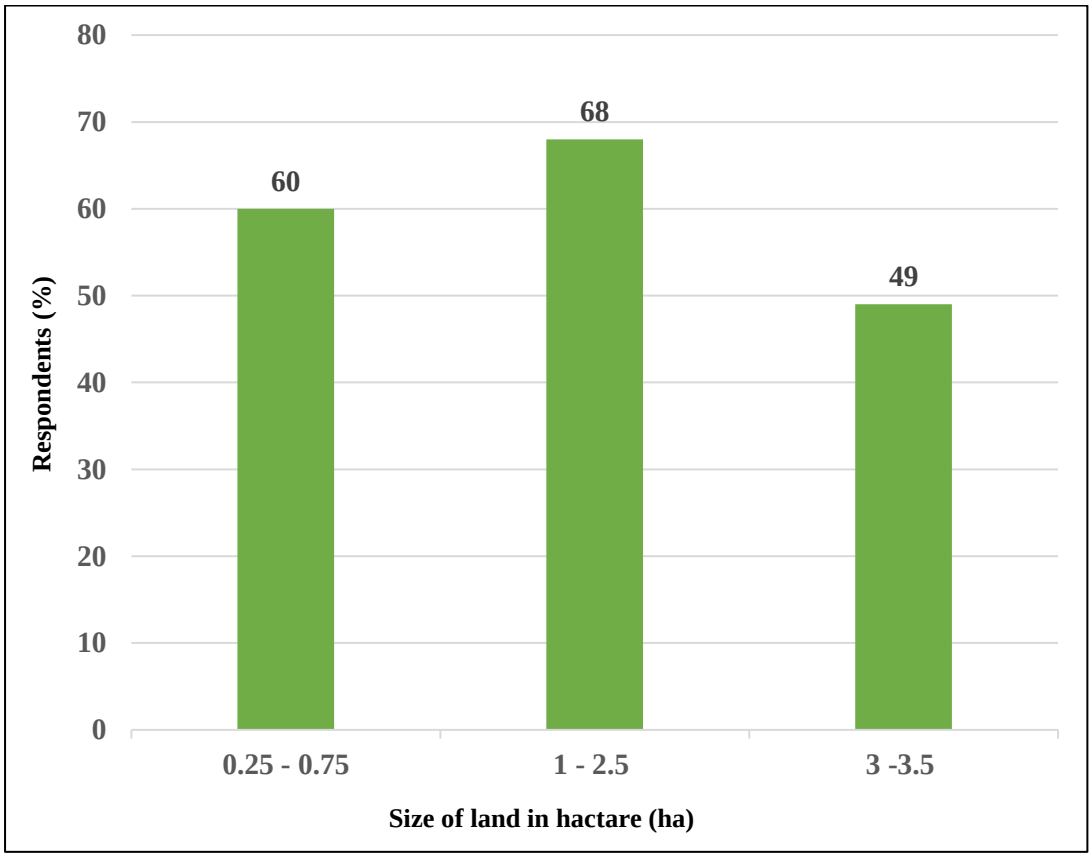
6.3.3 Development related policy challenge - Land grabbing

So far, the previous sections have demonstrated how a climatic stressor (drought) combine with other non-climatic-stressors (i.e., imposed fertilizer policy, and the destruction of the cactus plant) to shape livelihood vulnerability in the study villages. The following section will illustrate how land grabbing – an outcome of a policy measure that aimed to bring economic and agricultural transformation through large-scale farming in Ethiopia – puts additional pressure on the already vulnerable livelihoods of the local farmers. This section will also show how land-grabbing accentuates the vulnerability of the farmers to climate change impacts by reducing their capacity to respond to climate stressors.

The adverse impacts of land grabbing on farmers' livelihoods, food security and the local environment

The government of Ethiopia has transferred huge tracts of land to foreign investors for large-scale agricultural investment purposes (Lavers, 2012b). Often, such large-scale land acquisitions by foreign investors in Ethiopia have resulted in the dispossession and displacement of local farmers from their land (Rahmato, 2011). In the study area, land is the most basic livelihood asset. Yet, out of the 400 surveyed respondents, 177 households (43%) have lost their farmland as a result of the land transferred to a foreign agro-processing company in their locality. The company currently owns 1,100 hectares of land in the local villages of Ade Tela and Dalata and have started investment since 2014/2015. As can be seen in Figure 6.8 below, among the affected farmers, the majority (68%) have lost between 1-2.5 hectares of land. This is a huge loss for the farmers, given the key role of land to rural livelihoods.

Figure 6.8: Size of land taken from farmers for large-scale farming purpose



In many cases, land grabbing involves violation of human rights, with no consultation and consent of the pre-existing land-holders, and without due consideration of the socio-economic impacts of land transfer on local communities (ILC, 2011). Information collected from farmers who are directly affected by the land grabbing activity confirmed this incident. For example, an elderly man in his 70s from Dalata village remembers how he and his neighbours were informed by local officials about the transfer of their farmland to a foreign investor as follows:

> *Suddenly they [district officials] came and informed us that we are displaced from our land. We were shocked to hear that. We asked them, how can we move from our forefather land? This is the land we know. They told us that a foreign company will develop this area and that will bring multiple benefits to the community. We did not trust them. We knew it was not for our best interest. We refused, but they took our land by force. They did not even wait until we harvest the crop that was growing on our farmland. (Respondent # 99, Household Survey 2016/17).*

In the current land tenure system of Ethiopia, the government has the right to expropriate land-users if the land is required for development purposes. However, in the event of expropriation, the land use proclamation clearly states that land holders "*shall be given the compensation proportional to the development he, has made on the land and the property acquired, or shall be given substitute land thereon*" (Proc. 456/2005). The findings of this research suggest that in reality, this is not the case. The following statement made by a 56-year-old widowed woman from Dalata village demonstrates the ineffectiveness of this law on the ground. The woman said:

> *The ferenji [investor], took my land in 2015. They [district officials] asked me to sign a form that will enable me to receive compensation. However, so far, I have not received any monetary compensation nor exchange farmland. No one heard my voice even if I complained at the district office. (Respondent # 200, Household survey 2016/17).*

Throughout the data collection period, all farmers who lost their land for large-scale farming claimed that they have not received any monetary compensation and/or a substitute land. Since these farmers are unable to produce crops as well as to generate farm income, they are experiencing food shortages. The following quote taken from a 57-year-old man from Ade Tela village illustrates this situation.

> *It has been two years since I lost my 2-hectare land. The investor has fenced it, so there is no way I could produce crops. It is now a very good season [2016]. My neighbours are preparing their land to plant seeds. I am just watching them. I have sold all my assets to buy crops from the market. I do not have any asset anymore. I am struggling with food shortage with my family. (Respondent # 112, Household survey 2016/17).*

Survey results also confirmed that those farmers who are affected by land grabbing are more exposed to food insecurity than those farmers who are not affected. At the time of the data collection period, the Coping Strategy Index (CSI) developed by Maxwell & Caldwell (2008) and the Food Consumption Score (FCS) used by the World Food Programme (2008) were used to assess the food security status of households. A higher SCI score reflects a higher food insecurity status, while a higher FCS score suggests a higher food security status.

Table 6.1: Farmers' food security status based on Coping Strategy Index (CSI) and Food Consumption Score (FCS)

Food security status based on CSI	Affected households		non-affected households	
	Frequency	%	Frequency	%
Food secure	43	24.3	145	65
Mildly food insecure	22	12.4	26	11.7
Moderately food insecure	30	17	29	13
Severely food insecure	82	46.3	23	10.3
Total	177	100	223	100
Food security status based on FCS	Affected households		No affected households	
	Frequency	%	Frequency	%
Acceptable	39	22	140	63
Border line	47	26.6	47	21.1
Poor	91	51.4	36	16.1
Total	177	100	22.3	100

Source: Household survey

As seen in Table 6.1 above, the results based on the CSI score indicate that 46% of the affected households belong to the severely food insecure category, as compared to 10% of the non-affected households. Again, the FCS score shows that a larger percent of the affected households (51%) were under "poor'' food security status compared to only 16% of the non-affected households (Table 6.1).

The consequence of land grabbing is not limited to its negative impact on the food security of local communities, but it has direct implications for the local environment. Deforestation was the major environmental concern raised by participants during focus groups and key informant interviews. Farmers largely attributed this problem to the clearing of the forestland for the large-scale farming purpose. All focus group participants commonly stated that the land that was covered with woodland and forest has now been cleared completely after the company started its agricultural operation.

The influence of land grabbing on farmers' vulnerability to climate change

Results suggest that land grabbing has increased the affected farmers' vulnerability to climate change by reducing their capacity to respond to its impacts. For instance, findings of the focus group discussions revealed that farmers who have lost their farmland were more severely affected by the 2015 drought as compared to past drought events. This is because, since most of the farmer's farmlands were taken in 2014, they did not produce crops. As a result, they were not able to preserve crops for bad years (i.e, drought years) and nor they were able to generate income from the sale of crops. Due to these two reasons, they had very limited capacity to respond to the 2015 drought condition. In addition, one way farmers cope with drought is by selling livestock. However, since the communal grazing land is taken away from the farmers for the large-scale farming purpose, the farmers can no longer rear livestock. Due to this when the 2015 drought hit the local villages, farmers who used to cope during drought periods by selling livestock were not able to cope this time.

Farmers who have lost their land access due to the land grabbing phenomena, as well as those who did not lose their land, might be vulnerable to future impacts of climate change. This is because, with respect to the farmers who have lost their land tenure right, unless they are given alternative farmland, they cannot make any farm related-adaptation strategies (e.g. crop diversification). However, crop diversification is one of the most important adaptation strategies farmers in the study area commonly used to adapt to climate change effects (this will be discussed in the next chapter).

With regard to the farmers who have not lost their land, survey results revealed that nearly half of the respondents (48%) are very worried about future land grabbing. Further, the survey findings also indicated that, despite having a land certificate, the majority of the surveyed farmers (85%) are insecure about their land tenure rights. These two factors (i.e., fear of land grabbing and tenure insecurity) may constrain the farmers from making long-term climate change adaptation investments (e.g., investing in irrigation farming) that can potentially reduce their vulnerability to climate change.

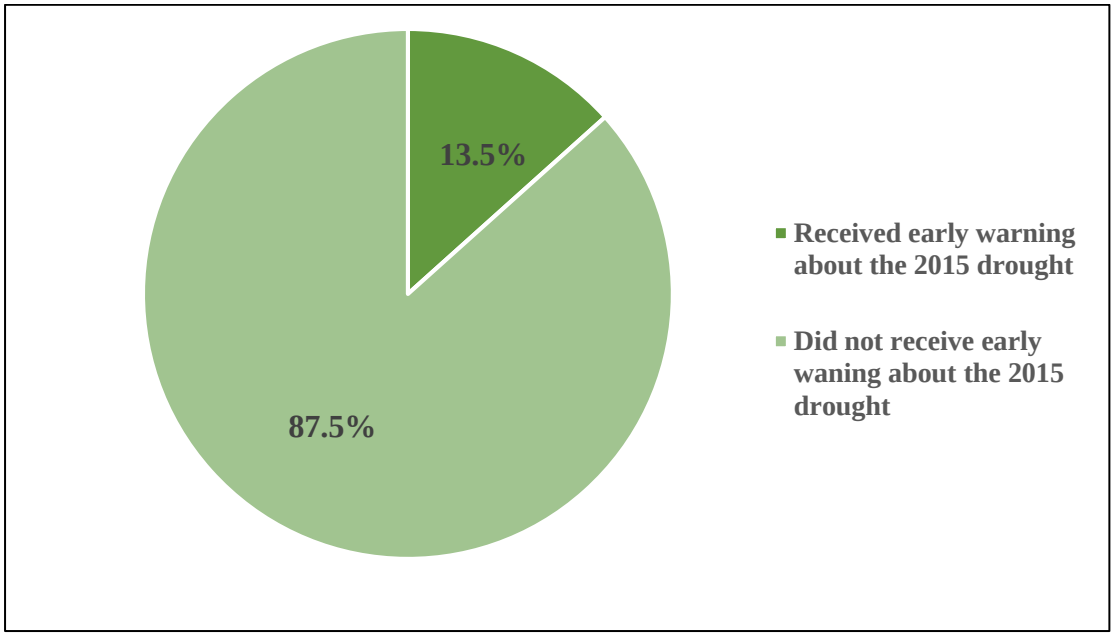
In sum, the above findings suggest the policy measure that aims to bring economic and agricultural transformation through large-scale farming in Ethiopia has exposed the local farmers to land grabbing. In turn, the consequence of land grabbing has contributed to increased livelihood vulnerability by reducing the farmers' ability to adapt to climate-related stressors. The farmers who have depended on the land for their livelihood will be more vulnerable to

future impacts of climate change unless they are given land access. The next section will focus on how a lack of access to climate information contributes to livelihoods vulnerability and enhance the farmers' exposure to the impacts of climate change.

6.3.4 Lack of access to climate information (drought early warning messages and seasonal climate forecasts)

A lack of access to climate information is another stressor that is threatening the farmers' climate-sensitive livelihoods and making them more vulnerable to the impacts of climate change. During focus groups, one of the major challenges raised by the participants was a lack of access to climate information and how it constrains their livelihoods. As indicated in Chapter 5, a lack of access to climate information (particularly drought early warning) is perceived by survey respondents as a significant contributor to livelihood vulnerability. The findings of this study suggest that the majority of the farmers in the studied villages do not have access to climate information. For instance, survey respondents were asked if they have received any seasonal forecast about the late onset of summer rain and/or early warning message about the occurrence of drought in 2015. Surprisingly, 86.7% of the farmers did not receive any drought early warning information or seasonal forecasts about the late onset of rain. Those who reported having received drought early warning (13.3%) said it was not timely.

Figure 6.9: Farmers' access to early warning information



Access to climate information in the form of rainfall forecasts and drought early warning messages can assist farmers to take proactive adaptation measures that can potentially lessen their vulnerability to impacts of climate change and which could also improve their livelihoods. However, in the study area, since the majority of the farmers were lacking access to this important service, it has undermined their capacity to effectively respond to anticipated climate risks. For example, since the majority of the farmers were not informed about the 2015 drought in advance, they planted crops that are less drought tolerant. However, since the rain that season was below-normal, most of the crops they planted did not survive and farmers incurred financial loss. Some farmers regretfully stated that if they had known that the 2015 summer rain would be unusually low, they could have saved their seeds for the next good season rather than planting them all in that bad season. Other farmers also stated that since they did not receive an early warning message about the 2015 drought, they were unable to make important decisions such as seeking alternative off-farm income sources and selling livestock in advance. For instance, one farmer said:

> *You see…. we were not informed about the 2015 drought. We could have sold our cattle at a better price in advance. When it is drought, what can we feed the animals? Our option was to sell them at a very cheap price, otherwise, they could have died. (Respondent # 315, Household survey 2016/17).*

Overall, findings of this study indicate that the farmers' farm-level decisions, such as when to plant crops and what crop types, are not guided by locally available seasonal climate forecasts. As a result, their livelihood sources are highly vulnerable to climate risks. Hence, these findings suggest, a lack of access to climate information also contributes to livelihoods vulnerability by reducing their capacity to respond to anticipated climate risks.

6.3.5 Ineffective agricultural extension programs and political control

Farmers perceive that the ineffectiveness of the agricultural extension program provided by the local development agents (DAs) is among the key non-climatic stressors that contributes to livelihood vulnerability. The survey results show that nearly all households (95%) have close contact with the development agents (DAs). However, the majority of the surveyed households (74%) reported that they are dissatisfied with the extension service provision. Farmers' dissatisfaction with the extension program largely emanates from the feeling that the DAs, instead of doing their job (i.e., providing advisory service to the farmers), are largely involved in other government tasks which are not in the best interests of the farmers.

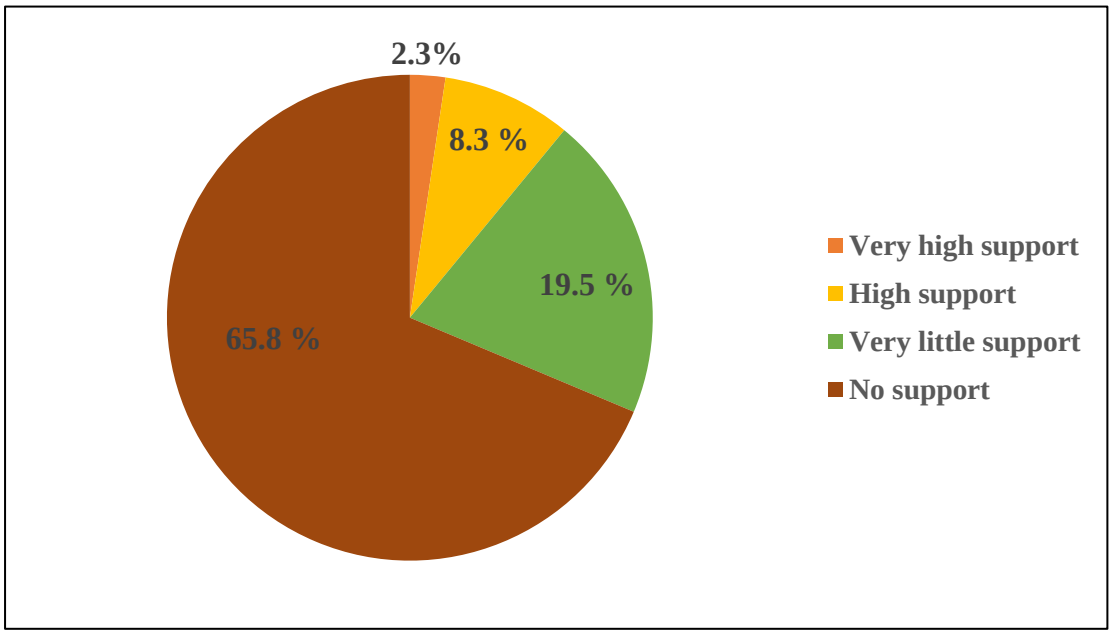
From the findings, it appears that the DAs tasks in the study area are forcing farmers to buy fertilizer, punishing farmers when they refuse to buy fertilizer, and most importantly ensuring the state's political control by pressurizing farmers to support (vote) for the ruling party (EPRDF). Due to these reasons, the farmers perceive the DAs as a threat to their lives and livelihoods. During the data collection period, the author observed that farmers of the study area do not openly oppose the Ethiopian government due to fear of prosecution, but most of them hold grudges against the government.

The DAs involvement in political affairs means that farmers do not freely raise their voices on issues that constrain their livelihoods. Throughout the data collection period, the fear to talk local problems in front of DAs was observed and there was a sense of insecurity among the interviewed farmers when the DAs were around. For example, before the beginning of focus group discussion with men, two of the DAs were assisting the author in organizing the event. The author was informed by one of the participants not to involve the DAs when the focus group starts. One of the participants said:

> *Did you come here to ask us to raise our problems in front of the DAs? Do you think we will tell you the truth in front of them? They are not here to help us….they are here to control us. (Participant # 15, FGD 1)*

During the focus groups, participants noted that they depend on their traditional agricultural knowledge to sustain their livelihoods and to respond to climatic and non-climatic risks. Their knowledge is not complemented by modern farming knowledge, which should be provided by development agents. As seen in Figure 6.6 below, over half of the respondents (66%) said they receive almost no support on agricultural related advice.

Figure 6.10: Farmers' assessment on the level of agricultural related support



During the male focus group discussion, most of the participants felt that one of the main reasons why their livelihood has not improved yet is because they lack the needed support from the development agents. Specifically, it was mentioned that the DAs do not share their knowledge and skills about effective climate change adaptation strategies and this, according to these participants limits farmers' ability to try on new adaptation technologies that can effectively reduce climate change vulnerability.

6.4 Conclusion

This chapter has examined how climatic and non-climatic stressors influence the farmers' lives and livelihoods in different forms. The chapter also looked at how non-climatic stressors exacerbate the farmers' vulnerability to climate change, by undermining their capacity to adapt. The findings revealed that smallholder farmers in Raya Azebo district are vulnerable to multiple stressors that have climatic and non-climatic origins. Among the climate-linked stressors, drought events had a significant influence on the farmers' lives and livelihoods. The results also demonstrate that various non-climatic stressors – including imposed fertilizer adoption, destruction of cactus plant, land grabbing, lack of access to climate information and ineffective agricultural extension system – contribute to livelihood vulnerability.

Chapter 7: Farmers' adaptation strategies to climatic and non-climatic factors and maladaptive outcomes

7.1 Introduction

This chapter presents the results of the analysis of the type of adaptation strategies implemented by smallholder farmers in Raya Azebo district and the climatic and non-climatic factors that trigger those adaptation actions. The chapter also examines the risk of maladaptation resulting from the implementation of the farmers' adaptation responses. The first section of this chapter looks at the non-farm related adaptation responses, while the second section examines farm related adaptation responses. The last section of this chapter assesses maladaptive outcomes from the implementation of the farmers' adaptation strategies.

7.2 Non-farm and off-farm adaptation strategies

In the focus group discussions with both genders, livelihood strategies (i.e, non-farm/off-farm and farming practices) that are common in the study area were identified. Once the strategies were identified, participants were then asked to discuss the driving forces that motivate farmers to undertake the identified livelihood strategies, without reference to climate-related factors (to avoid bias in the responses). The questionnaire survey was then updated to include the identified locally relevant livelihood strategies along with the possible reasons for undertaking the strategies.

7.2.1 Temporary migration as an adaptation strategy

Migration is one of the non-farm adaptation strategies conducted by farm households in the study area. Survey participants were asked whether the household head or any household member from the family had conducted migration over the last five years. As can be seen in Table 7.1, of the total of 400 surveyed respondents, over half (65.3%) reported that a household member had engaged in migration over the last 5 years. Looking into the four villages, a higher proportion of Ade Tela (74.8%) and Dalata (68.4%) villagers conducted migration compared to Hade Alega (51.5%) and Keyehe Tekely (62.3) villagers (Significant at 99%; see Table 7.1).

Table 7.1: Migration strategy conducted by farm households over the last five years

Village name	Household member conducted migration (%)		
	Yes	No	Total
Hade Alega	51.5%	48.5%	100
Ade Tela	74.8%	25.2%	100
Dalata	68.4%	31.6%	100
Keyeh Tekely	62.3%	37.7%	100
Total	65.3%	34.8%	100
X^2 (3, N = 400) = 8.092, p < 0.01			

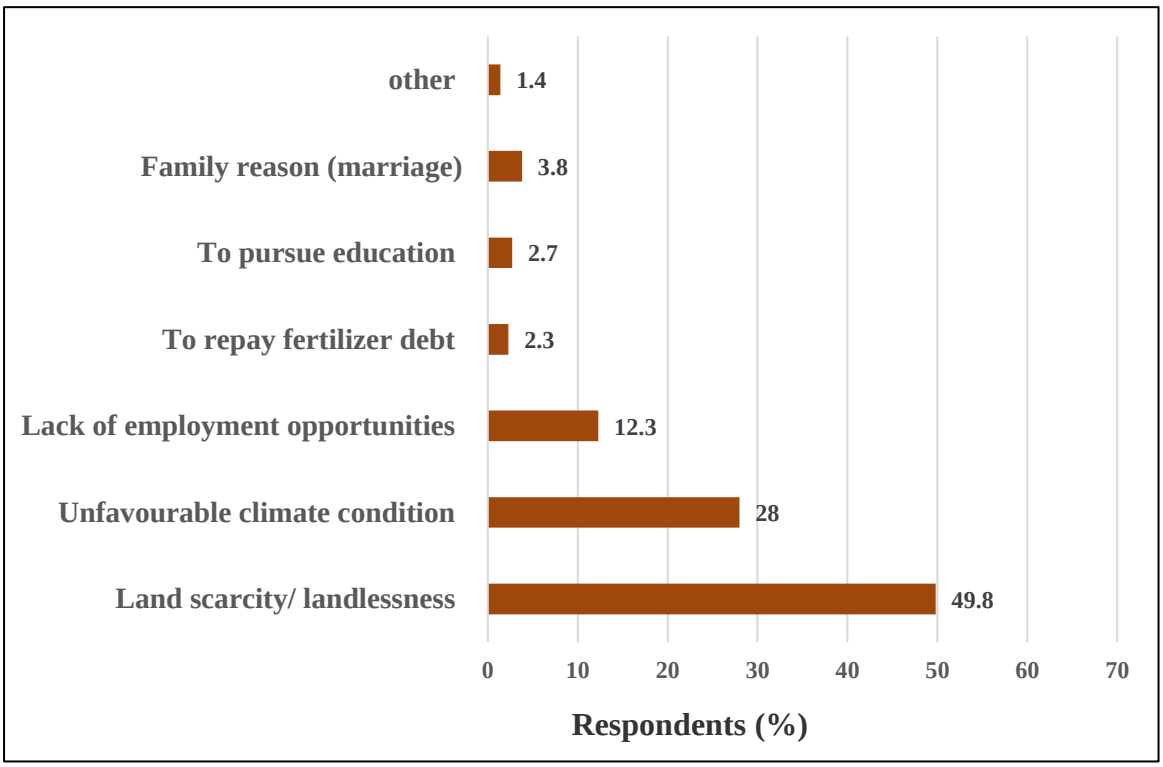
Source: Household survey

Those participants who used temporary migration as a strategy were asked to indicate the main reasons for their migration decision. As shown in Figure 7.1, nearly half (49.8%) of the respondents cited land scarcity/landlessness rather than climate factor as the main motivation for their migration decision. The survey result shows that of those households who mentioned land scarcity (landlessness) as a driver of migration, 77 (43.5 %) are farmers who were affected by the large-scale agricultural investment and thus they do not have farmland. The rest of the 53 households own relatively small farmland – an average land size of 0.51 ha. For example, one survey respondent explained why his two sons migrated to Addis Ababa as follows:

> *Back then [1985], my grandfather owned sufficient land [3ha] before he passed away. My father inherited 1 hectare of land from him and I got 0.5 hectares of land from my father. When my elder son got married, I gave him 0.25 ha of land. Now I have only 0.25 ha of land. I cannot divide this land anymore. This is why my two sons migrated to Addis Ababa. If they were here with me, they will not have an income source. Even though they are not satisfied with their jobs in Addis, at least they get some money. I receive a small amount of remittance from them because they know that I cannot produce enough crop from 0.25 ha of land. (Respondent # 330, Household survey 2016/17).*

Previous studies have indicated a shortage of productive farmland as the most common driver of rural-to-urban migration in Ethiopia (Hunnes, 2012; Morrissey, 2008). A study by McDowell & Hess (2012) who explored climate change adaptation in the context of other stressors similarly found land scarcity as a major reason for migration in Bolivian highlands.

Figure 7.1: Respondents' reasons for migration over the last five years



For 28% of the survey households, the climate-related factor is the primary reason for using migration as a strategy over the last 5 years (Figure 7.1). During focus group discussions, some participants from men and women's groups explained that during extreme drought periods, temporary migration is a common strategy employed by household members to support livelihoods. For example, of the surveyed respondents who answered unfavourable climate condition as a reason for migration over the last five years, the 2015/2016 drought was mainly reported as a driving force for their migration decision.

For example, one household head during the questionnaire survey explained the reason for his migration decision as follows:

> *The 2015 belg season rain was very disappointing which caused poor harvest because of rain shortage. I was so worried that meher season [the main rainy season] will be the same. From my previous experience, if the rain is bad in being it is very likely that it will be the same in Meher. So I made the decision to migrate to Mekelle city to do some temporary jobs. My family stayed home. But I was working and sending money to my family for about a year. I returned to my village after the situation improved. It was an important decision. Otherwise, it would have been difficult for us [the family] to cope with the drought. (Respondent 56 #, Household Survey 2016/2017).*

Various empirical studies done in Ethiopia (Alem et al., 2016) and elsewhere in Africa (Fielmua et al., 2017) and Asia (Jha et al., 2018), report migration as a common household response to climate-related factors. In the present study, factors other than climate also trigger migration. As can be seen in Figure 8.1, some respondents (12.3%), mentioned a lack of alternative employment opportunities in their local village as a major reason for their migration decision and 2.3% of the household migrated to repay back debts associated with fertilizer loan. Another (2.7%) households stated that a family member had migrated to other places to pursue further education such as in Mekele or Addis Ababa. The rest (3.8%) of the respondents cited family-related reasons (e.g., marriage, to visit relatives/ friends) for a family member's decision to migrate to other places. Together, these results suggest that household-level migration decisions can be influenced by various socio-economic conditions. Indeed, migration is a complex social phenomenon where various social, economic, political, demographic and environmental factors play a role in shaping an individual's migration decision (Black et al., 2011).

7.2.2 Other non-farm/off-farm adaptation strategies

The qualitative results indicate various other non-farm activities apart from migration strategies. These non-farm activities include various forms of petty trade activities such as: owning-small shops, selling local food and traditional alcohol drinks and wage employment (e.g. participating in construction works) in *Mehoni* town of the Raya Azebo district. Overall, 12% of the households reported diversifying their income into one of these non-farm activities over the last 5 years. Although it was not statistically significant, a greater number of Ade Tela (16.3%) and Dalata villagers (14.7%) participate in non-farm activities, compared with Hade Alega (8.9%) and Keyeh Tekely (4.3%) villagers.

Turning to off-farm activities, overall 27.8% of the households participate in off-farm activities, such as working on other agricultural farms, collecting and selling firewood. However, compared with Hade Alega (10.9%) and Keyeh Tekley villagers (11.6%), Ade Tela (43%) and Dalata villagers (35.8) were involved in off-farm activities to a large extent (significant at 99% level). Those respondents who adopted non-farm/off-farm strategies were asked to state their primary reason. As shown in Table 7.2 below, four common reasons where provided:

Table 7.2: Respondent's reason for diversifying into non-farm/off-farm income activities

Reason (motivation)	Number of households (frequency)	% of households
In response to unfavourable climate conditions (particular drought)	44	11
Poor agricultural markets (low profit from agriculture)	18	4.5
Lack of access to agricultural land or land shortage	74	18.5
Desire to earn more income	13	3.3
Other reasons	10	2.5
Total	159	39.8

From the total 159 (39.8%) households which carried out non-farm/off-farm strategies, 11% stated that the climate-related factor is the main reason for their involvement in non-farm/off-farm strategies. For example, some farmers who diversified into non-farm activities did so with the intention that when drought occurs in particular years, non-farm activities provide alternative income sources to the household and help them overcome some of the impacts caused by drought (e.g. food insecurity). For example, one of the survey respondents stated his primary reason why he is engaged in non-farm work as follows:

> *My wife and I are currently doing both [farming and non-farm]. It is hard to depend only on rain fed agriculture these days. As you see, we sell food and local drinks in this small restaurant. When it is a drought year and farming is not promising, we can still feed our children and send them to school from the money we make from this business. Opening this restaurant really helped us to withstand the previous year [2015] drought. (Respondent # 120, Household survey 2016/2017).*

The interview quote above reflects the potential benefit of non-farm and off-farm strategies to support rural farmers' livelihoods in the face adverse weather conditions. Demeke & Zeller (2012) in their study of off-farm activities in rural Ethiopia also report that households' engagement in off-farm activities serve as an important weather risk coping strategy.

As Table 7.1 shows, of those farm households who conducted non/off-farm activities over the last 5 years, 4.5% reported market-related factors as the main reason for their engagement in those activities. For example, a farmer who runs a small shop business in Hade Alega, explains why he diversified into non-farm activity as follows:

> *Farming is a difficult task. I put a lot of effort to deliver products to the market. But after all the hard work, there is not much profit from agriculture. It is hard to predict the market situation. Sometimes I get better price … but most of the time I lose a lot of money. In the beginning of this month [December 2016], the price of tomato was good [18 birr/ Kg] and by the time I wanted to sell my tomatoes it went really down [4 birr/Kg]. Imagine how much birr I have lost. How can I totally rely in this market? I get a stable income from this shop and it helps me to overcome my financial difficulties when I lose money from agriculture. (Respondent # 15, Household Survey 2016/2017).*

Table 7.1 indicates that for 18.5% of the households who did non-farm/off-farm work, resource scarcity (lack of access agricultural land/land shortage), is the primary reason for their engagement in those activities. Respondents who mentioned land scarcity as a reason to involve in other options (particularly in off-farm activities) mainly work as wage labourers in other farms during wet and/or dry seasons. Some of them reported that they work for domestic and international investors during dry seasons, while others indicated that they work for local farmers who are unable to farm for various reasons. For instance, one survey respondent who works for farmers in local area stated:

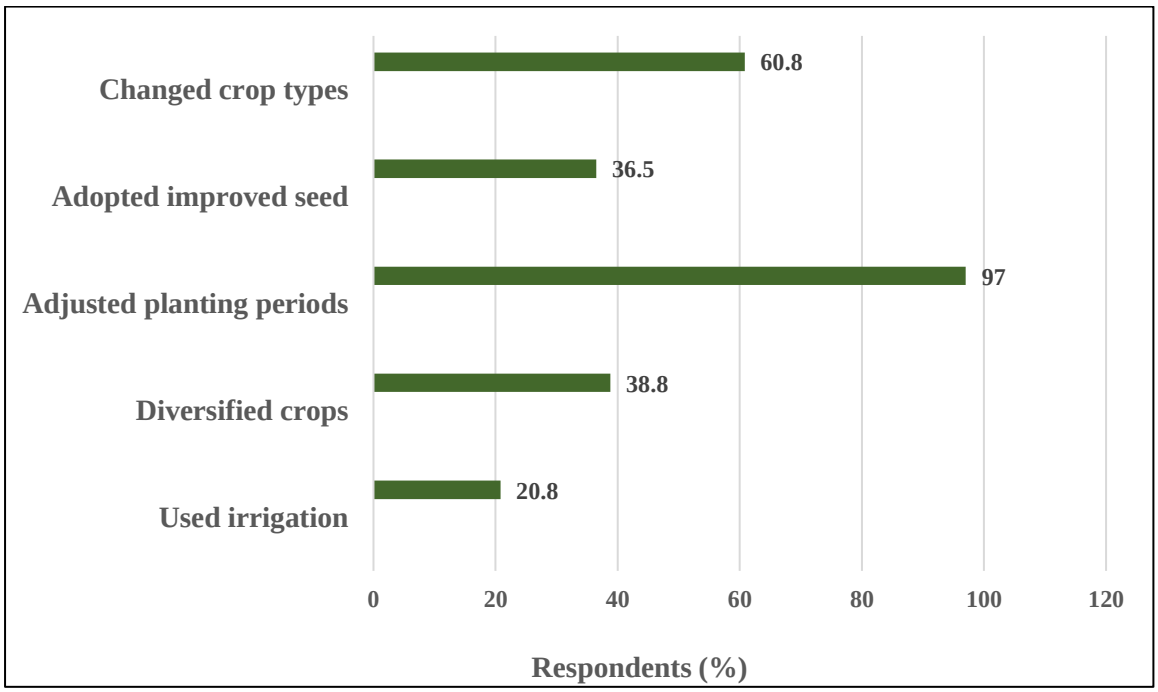
> *My land is small…it does not provide good harvest. In rainy season, half day I work on my farm and half day I work for those who are incapable of farming [e.g. for old farmers].That way I get some money or a share of the crop produced on the owner's land. (Respondent 54 # Household Survey 2016/17).*

Challenges related to climate factors, resource scarcity or market issues are not the only cited reasons why farmers in the study area diversify into non-farm/off-farm activities. As Table 7.1 demonstrates, a minority of the participants (3.3%) indicate a desire to earn more income (or to accumulate wealth), as their primary reason for participating in different on/off-farm activities.

7.3 Farm-related adaptation strategies

The survey asked farmers if they have made any changes to their farming operation over the past 5 years. From Figure 7.2, it can be seen that farmers have made five different types of adjustments to their farming operation. The most commonly used strategy is changes made in crop planting dates (periods), which is practised by the majority of the households (97%). Over have of the surveyed respondents (60.8%) reported making changes to the crop type they use. Some households (38.8%) reported diversifying crops and another 36.5% adopted improved seed varieties over the last 5 years. Although few, some households (20%) indicated using irrigation.

Figure 7.2: Farm related adaptation strategies made over the last 5 years



Survey results indicate considerable differences in some of the farm-related adaptation strategies employed by the four villages. As can be seen in Table 7.2, there is a significant difference in adopting improved seed varieties, with the majority of Hade Hade Alga (63.4%) and Keyeh Tekely villagers (53.6%) adopting this strategy compared with Ade Tela (18.5%) and Dalata (21.1%). Again, a significantly higher proportion of Hade Alega and Keyeh Tekely villagers use crop diversification strategy and irrigation compared with Ade Tela and Dalata villagers (See Table 7.3). This is likely because villagers in these two villages still own their farmland (i.e., they were not affected by the land grabbing phenomena at the time of the study) and hence they rely more on farm-related adaptation strategies). However, no statistically significant difference was observed between the four villages, in terms of changes made in crop types and adjustments in planting periods (See Table 7.3 below).

Table 7.3: Types of farm-related adaptation strategies made by villages

Type of farm-related adaptation strategies	Village locations	Respondents (%)		X^2 value
		Yes	No	
Changed crop types	Hade Alega	66.3	33.7	3.35
	Ade Tela	56.3	43.7	
	Dalata	57.9	42.1	
	Keyeh Tekely	65.2	34.8	
Adopted improved seeds	Hade Alega	63.4	36.6	68.8***
	Ade Tela	18.5	81.5	
	Dalata	21.1	78.9	
	Keyeh Tekely	53.6	46.4	
Adjusted planting periods	Hade Alega	98	2	3.82
	Ade Tela	94.8	5.2	
	Dalata	98.8	1.1	
	Keyeh Tekely	97.1	2.9	
Diversified crops	Hade Alega	67.3	32.7	99.8***
	Ade Tela	17.8	82.1	
	Dalata	17.9	82.2	
	Keyeh Tekely	66.7	33.3	
Used irrigation	Hade Alega	37.6	62.4	36.4***
	Ade Tela	9.6	90.4	
	Dalata	11.6	88.4	
	Keyeh Tekely	30.4	69.6	
Note: *** significant at 1% level				

Source: Household survey

7.3.1 Changes in crop types (crop switching)

As shown in Figure 7.2 above, changing crop types is one of the agricultural adaptation strategies used by 60.8% of the household over the last 5 years. Farmers' motivation for changing crop types or switching crops is diverse. Table 7.4 below shows that 36.2% of the household changed the crop type they use because of climate-related factors. During survey, one of the farmers who changed crop type reported that he is now using a maize variety known as *Melkasa 1-6* instead of *Zoma* (another maize type). The reason why he exchanged *Zoma* with *Melkas 1-6* is that *Zoma* is not drought tolerant as compared to *Melkasa 1-6*. He explained:

> *I do not plant Zoma anymore. Because when there is water shortage [drought] the plant quickly die. Melkasa is better as it can survive even when drought is severe. (Respondent # 22, Household Survey 2016/17).*

Some households (13.2%) changed the crop type they use because of yield related reason (Table 7.4). For instance, during focus group discussion, it was mentioned that farmers in the study area are abandoning *Zom*a and planting Melkasa as it provides better yield. For example, one participant from the focus group estimated that up to 40 quintals/ha can be harvested from *Melkasa*, as compared to *Zoma* which gives a maximum of 25 quintals/ha.

Some farmers' motivation to change the crop type they use is related to low market demand (the price of some crops), which was reported by 15.6% of the respondents. For instance, some of the interviewed farmers during the survey commonly reported that they have changed a sorghum type known as *America* by other types of sorghum crop such as *Kodem*, *Aba Ora*, and *keye Mashela*. This is because, the market demand and price for *America* is lower than *Kodem*, *Aba Ora*, and *keye Mashela*. According to one of the surveyed farmers who changed sorghum type for market reason, *Kodem* sorghum can be sold up to 18 birr/kg as compared to *America*, which is sold only for 13 birr/kg.

Soil fertility issues and biotic-factor (i.e., crop pest and disease) are the driving forces for changing crop types for 14.4% and 9.1% of the households respectively (Table 7.4). For instance, among the surveyed farmers, some indicated that they have switched from sorghum to *Teff* because sorghum crop requires more *reguid* (fertile soil) than *Teff*. During the focus groups, it was noted that due to the outbreak of *Kurtim* (crop disease) in a local maize variety, farmers are switching to barley, which cannot be affected by this particular disease.

Land and labour constraints are primary reasons for switching crops, for 6.6% and 4.9% of the households respectively (Table 7.4). For example, one farmer who used crop-switching strategy stated his reason as follows:

> *Before I used to plant teff but now, I am planting sorghum. Because sorghum gives me high yield in smaller plot than teff. (Respondent # 84, Household Survey 2016/17).*

During a focus group, it was mentioned that some farmers switch from growing cereal crops to pulses when they lack labour power and this strategy is commonly used among old farmers and female-headed households. For example, one old farmer during the survey stated:

> *Growing teff requires high labour power. I have to plough the land five to six times before I plant the seeds. It also requires high labour input for weeding. …I am very old now. I do not have the energy to do grow teff anymore. This is why I switched to pulses because they require less labour. (Respondent # 70, Survey 2016/17).*

7.3.2 Adoption of improved seed varieties

As shown in Figure 7.2 above, 36.5% of the households reported adopting at least one type of improved seed variety as their adaptation strategy. Table 7.4 indicates that for 40.4% of the surveyed farmers, the primary reason for adopting improved seeds was to get better yield. For 25.3% of the respondents, however, the market was the primary motivation. For instance, in the focus group discussion it was revealed that some farmers adopted an improved *Teff* variety known as *Dukem* (DZ-01-974), as the crop gives better yield, and because of its demand in local market.

Table 7.4 also shows that 21.9% of the survey respondents adopted improved seeds primarily for climatic reasons. Participants during the focus group noted that plant-growing seasons are becoming shorter and shorter as the rains in the local area are coming late and ending early. In response, some farmers are using fast maturing improved varieties. Of the survey respondents who adopted new improved seeds, the often-cited improved seed is *Melkam* (sorghum variety), for its drought tolerant and fast maturing nature. As one sorghum grower explained:

> *The reason why I chose to plant Melkam [improved sorghum] is that it is drought resistant as compared to local sorghum varieties. It is also fast maturing. It can be harvested quickly [within 3 months] without requiring more rainwater. (Respondent # 66, Household survey 2016/2017).*

Table 7.4 further indicates that for 12.3% of the households, the major reason for adopting improved seeds is to reduce the spread of pests and diseases in plant. For example, one farmer who adopted the improved sorghum variety called *Melkam*, explained that the variety resists *hetela tekely* (smut disease) compared to the local sorghum variety, which is known as *Degalit*.

Table 7.4: Smallholder households' farm-related adaptation strategies made over the last 5 years and primary reasons behind making the changes

Type of farm-related adaptation strategy	Respondents primary reason for making the change	Respondent (frequency)	Respondent (%)
Changed crop types	Climate-related reason	88	36.2
	Low market price of some crops	38	15.6
	Crop doesn't provide high yield	32	13.2
	Poor soils	35	14.4
	Pest and disease	22	9.1
	Small land	16	6.6
	Labour constraint	12	4.9
Adopted improved seeds	Seeking better yield	59	40.4
	High market demand	37	25.3
	Climate related factor	32	21.9
	Improved seeds resist disease	18	12.3
Diversified crops	Climate-related factor	94	60.6
	To minimize market risks	40	25.8
	To control pests and diseases, and to improve soil fertility	12	7.7
	To balance food demand	9	5.8
Adjusted planting dates	Climate-related factor (e.g., rainfall variability)	343	88.4
	To take market opportunities	45	11.6
Adopted irrigation	To avoid reliance on rain-fed agriculture due to drought	36	43.4
	The desire for more income	29	34.9
	Government support	18	21.7

7.3.3 Crop diversification

As Figure 7.2 above illustrates, 38.8% of the surveyed households reported diversifying crops over the last 5 years. In the study area, crop diversification is a common farming strategy, particularly among farmers who own a relatively large farm size (>1ha of land). These farmers diversify into two or more (up to five) different crop types, depending on the size of their farmland. Among the farmers who used the crop diversification strategy, 60.65% diversified to moderate climate related risks (Table 7.4). For example, focus group participants explained that by choosing to grow different crop types at the same time, they minimize the risk of complete crop failure from climate risk. As one focus group participant explained:

> *I grow four different crops [sorghum, teff, barely, maize] each season. If drought occurs, sorghum and teff tolerate the stress better than barley and maize. This means that I will not lose all my crops, as sorghum and teff might survive. If I am lucky and there is no drought in that season, I get good harvest from all the crops. (Focus Group participant, 2016). (Participant 1, FGD # 3).*

For some households (25.8%), crop diversification is a strategy that is mainly used to minimize market risks and hence to stabilize farm income (Table 7.4). In the words of a farmer who diversified crops for a market reason:

> *I always grow three different types of crops in three different plots; if the market price of one crop type goes down, I might still get better profit from the other crops. (Respondent, Household survey 2016/17). (Respondent # 44, Household survey 2016/17).*

As seen in Table 7.4 above, few households (7.7%) also used a crop diversification strategy (i.e., in the form of intercropping), in order to control crop pest and diseases and to enhance soil fertility. Farmers who used this practice stated that they grow legumes (particularly peas and beans) and cereal crops together. A minority of surveyed households (5.8%) stated that their primary reason to diversify into more crops is to balance their food demand. For example, in the study area, *Teff* is primarily used to make flatbread called *Tayita*, pulses are used to make stews, and sorghum is mainly used to brew the local drink.

7.3.4 Adjustment in crop planting dates (growing periods)

Adjustment in planting dates is one of the most commonly practised farming strategies in the study area. For the majority of the households (88.4%), the climate-related factor is the main reason for making adjustments in crop planting dates (Table 7.4). Farmers change crop-planting dates in accordance with the seasonal weather conditions (i.e, the onset of seasonal rains). Participants during focus group indicated that changing crop-planting dates is the cheapest way of managing climate-related risks, particularly rainfall variability. For instance, most surveyed farmers reported that they shift crop-planting dates both in *Belg* and in *Meher* growing seasons, depending on the onset of the first few rainy days. One farmer explained:

> *Normally February is the month I plant Teff during Belg (the short rainy season). But these days the weather is so unpredictable. If the rain comes earlier than February, I would plant the Teff immediately. If it does not come on time, then I will wait until it rains either in March or April. Some years the Belg rain does not come at all. In this case, I would wait the onset of Meher season rainfall. (Responded # 35, Household Survey 2016/17).*

In Table 7.4, it can be seen that 11.6% of the respondents adjusted plant growing periods to take market opportunities. This is particularly the case among vegetable producers. The following quotes taken from a vegetable grower illustrates this:

> *The problem in our area is that most farmers plant and harvest vegetables at the same time. As a result, there will be excess supply in the market and the price of the produce become very cheap. I used to plant vegetables in wet season as most farmers do. Now I have shifted the growing period from wet season to dry season using irrigation. The market profitability is good when you grow and harvest vegetables in dry season, as there is shortage of market supply. (Respondent # 57, Household Survey 2016/7).*

Some vegetable growers also adjusted plant-growing periods by planting vegetable seeds in different times, in a sequential manner, rather than planting them all at once (i.e., plant staggering). This strategy is income-smoothing mechanism in the face uncertain market. income. As one tomato grower explained:

What I have started now is that I plant the tomatoes in three rounds. If the market price for tomatoes become cheap in the first round harvest, it might go up in the second or third round. (Respondent # 225, Household survey 2016/17).

7.3.5 Using irrigation farming

Of the total 400 sampled survey respondents, 20.8% use irrigation as their farming strategy. Among the users, 21.7% adopted irrigation simply because the government installed small-scale irrigation scheme in their local villages. This scheme is a poverty reduction intervention implemented by the Tigray regional government (Gebregziabher et al., 2009). Currently, there are eight small-scale irrigation sites in two villages of the study area (Hade alega and Adet Tela). However, not all farmers are beneficiaries of the scheme, as the irrigation water points are limited. For this reason, some reported using irrigation by renting land from farmers who have irrigation access. When asked their main reason for renting land that has irrigation access, the households (43.4%) stated climate-related factor. For example, one farmer who is now using irrigation said:

I can never rely on rain fed agriculture alone. Irrigation farming is not without risk, but at least I do not worry about crop failure in case the rain does not come. (Respondent # 114, Household survey 2016/7).

The rest (34.9%) mentioned a desire for more agricultural income as motivation for using irrigation. These farmers (i.e., who mentioned a desire for more income) are relatively better-off farmers who are capable of investing the required capital to do farming using irrigation. For example, one wealthy farmer stated:

I can only harvest once or twice a year with a non-irrigated land. That is why I rented a farmland which has irrigation access...I can harvest and sell high value crops three times a year and earn more money. (Respondent # 25, Household survey 2016/17).

7.4 Maladaptive outcomes in autonomous adaptation strategies

As the previous sections show, farmers of the study area use various adaptation strategies to adapt to climate change as well as to non-climatic challenges and opportunities. However, this does not necessarily mean that some of the adaptation strategies farmers adopt do not carry the risk of maladaptation. Results of the qualitative analysis indicate that some of the existing adaptation strategies farmers use have maladaptive effects. Drawing on the conceptual framework of maladaptation developed by Juhola et al., (2016), the following section describes the farmers' adaptation strategies that have potential maladaptive effects.

7.4.1 Maladaptive outcomes in migration strategy

As indicated in section 7.2.1 of this chapter some households engage in migration as a climate change adaptation strategy, and indeed the findings have shown that the money migrants send helps the family left behind to better adapt to climate change and to meet their basic needs. However, migration as an adaptation strategy does not only have beneficial aspects but it also has risks and unintended outcomes. For instance, in this study, two examples of maladaptive outcomes linked with temporary migration as an adaptation strategy can be identified. The first type of maladaptive outcome that is associated with migration is the negative impact the strategy has on the implementing actors (rebounding vulnerability). The implementing actors, in this case, are the migrants themselves. In the study area, particularly young women migrate to the Middle East countries to support their family through remittances. However, this does not come without cost. In female focus groups, participants reported that in most cases young women migrants experience various forms of physical, sexual and emotional abuse while they engage in domestic works in the destination countries. This was witnessed by one returnee migrant who recalled her experience as follows:

> *Although I was able to support my family financially, I had a very bad experience over there [in Saudi Arabia]. The woman [employer] treated me very badly. She used to beat me for no reason. I used to work day and night. Proper bed time was unthinkable. Although I'm a Christian, I was forced to fast during Remadan. I made the decision to return home after her husband attempted to rape me. My life was in a serious danger. (Participant # 7, FGD 2)*

Those challenges cited above are not new for many Ethiopian domestic migrants. Other studies have also reported evidence of the various forms of domestic abuse migrants encounter in the Middle East including sexual harassment, verbal abuse, physical abuse that involves hitting and burning of body parts, denial of food and sleep, and withholding of payments (De Regt & Tafesse, 2016; Demissie, 2018; N. Jones, Presler-Marshall, & Tefera, 2014).

The second potentially maladaptive outcome that can be linked with the current migration trend in the study area is the loss of family labour from the migrant households and the negative effect it has on farming. During focus group discussions, one of the problems mentioned by the study participants was loss of farm labour, which is primarily attributed to the increasing trend of youth out-migration from the study area. Participants during the focus group explained that since farming is done manually, migration-related labour shortage, particularly during critical planting and harvesting stages, negatively affects both the quality and quantity of crop production.

In the study area, this migration related labour shortage has become a big challenge particularly for female-headed households who previously depended on their male children to execute agricultural tasks. In interviews, key informants have also confirmed that the migration-related labour shortage in the study area has created a burden on female-headed households and young children due to the agricultural workload. For instance, one female focus group participant said:

> *Since my son is not here, I always face a big challenge in finding someone who could support me on my farm. It is hard to find wage labourers during peak agricultural season because they will be busy in their own farm. Most of the time I had to do all the agricultural tasks by myself which is so tiring. (Participant # 2, FGD 2)*

This quote highlights that migration-related labour shortage not only has a knock-on effect on agricultural production, but it also has gender implications by exposing women to a higher agricultural workload. The remittances migrants send to their family may provide short-term benefit to their family. Yet, the long-term implication of youth out-migration is that the loss of farm labour from the study area can create maladaptive outcomes by affecting the local agricultural production and undermining the migrant households' food security (rebounding vulnerability). Overall, the results show how

migration conducted to gain economic benefits can have unintended outcomes for the migrants themselves as well as for the family left behind.

Table 7.5: Types of farmers' adaptation strategies with potential maladaptive outcomes

Adaptation strategy	Indicators of maladaptive outcomes	Type of maladaptive outcomes
Migration	- Female domestic migrants are abused psychologically and physically by their employers in the Middle East	Rebounding vulnerability
	- Migration is creating agricultural labour shortage	Rebounding vulnerability
	- Female-headed households are exposed to high agricultural workload due to male outmigration	Rebounding vulnerability
Collecting and selling firewood	- Contributes to forest degradation - Forest degradation influence climate change and the impact of climate change would in turn affect the farmers' agricultural production	Eroding sustainable development Rebounding vulnerability
Use of irrigation	- Involves high investment costs - Conflict between irrigation water users	Rebounding vulnerability
	- Leakage of nutrients to aquatic environments	Eroding sustainable development

Source: Based on qualitative findings

7.4.2 Maladaptive outcome in selling firewood as an adaptation strategy

As indicated in section 7.2.2, collecting and selling of firewood is one of the adaptation measures undertaken by farmers to respond to climate-related stressors (e.g. drought). Although the farmers' practice of selling of firewood may serve as a short-term drought coping mechanism by providing them a quick cash income, this strategy can lead to maladaptation in the long term. This is because, since selling of firewood in the study area involves cutting of the local trees, the strategy degrades the common pool-resources by contributing to forest degradation and ultimately eroding sustainable development. It is believed that forest degradation is one contributing factor of global climate change (Zhang et al., 2001). The framers' current practice of selling firewood as a coping strategy will have a direct influence on climate change through its contribution to forest degradation. This would eventually affect the farmers' climate-sensitive livelihoods such as farming (rebounding vulnerability).

7.4.3 Maladaptation in irrigation as an adaptation strategy

While irrigation is one of the farm-related adaptation strategies used by farmers to moderate the effects of climate change, the analysis suggests that this strategy has some maladaptive outcomes. The first maladaptive outcome that can be related to use of irrigation, is that, unlike rain-fed farming, irrigation farming involves high investment costs, which increases the irrigation users' farm budget (rebounding vulnerability). Hence, irrigation rebounds vulnerability to irrigation users because of high investment costs. The high investment costs required to do irrigation farming are associated with the need to pay for water usage, electricity and maintenance cost of the irrigation equipment. In addition, irrigation farming requires high financial investments in agricultural inputs such as fertilizer and pesticides. To give an idea, a farmer has to invest a minimum 15,000 Ethiopian birr (735 AUD), if he/she plants onions in 0.25 hectares of land. After all this significant investment, this farmer may not even get a return farm profit if frosts and diseases damage the crops.

Another potentially maladaptive outcome that can be linked with irrigation practice is the issue of conflict between farmers over water usage. In the study area, the type of irrigation system that is being used by the farmers is a traditional farrow irrigation system, where water is pumped from deep wells to the farmlands through hand dug canals. Results of the key informant interviews suggest that the main sources of conflicts over water usage between farmers are the limited availability of irrigation water resources and the mismanagement of these limited water resources by the locally appointed water committee chairpersons. The chairpersons are appointed to distribute the water to all irrigation users through a specifically allocated time schedule. However, key informants indicate that the chairpersons do not carry out their task properly. As a result, the farmers usually compete to use the irrigation water at the same time and this usually leads to conflict. According to the key informants, the conflict between the irrigation users is mostly verbal and it did not lead to any violent situation. This maybe because irrigation is a relatively recent adaptation practice that is being used by few farmers in the study area. In the long term, if more farmers are involved in irrigation practices in the absence of rules and effective local institutions that govern the irrigation water system, farmers' competition over scarce water resources may lead to violent conflicts.

Another maladaptive outcome that can be identified from the farmers' use of irrigation as an adaptation strategy is the negative impact it could have on the aquatic environment. This maladaptive outcome is very likely due to two contributing factors. The first contributing factor is that the adoption of irrigation practice in the study area involves the application of high agricultural inputs such as fertilizer and pesticides. Second, according to the local agricultural expert, irrigation users in the study area generally have a very low awareness of how leakage of nutrients and pesticide from the irrigation run-off could affect the quality of nearby water bodies such as streams, ponds and rivers. Given these two factors, the farmers' use of irrigation as an adaptation strategy can potentially erode sustainable livelihoods through its negative impact on the local aquatic biodiversity.

7.5 Conclusion

This chapter presented the findings related to the adaptation measures undertaken by farmers over the last five years and the key drivers that motivated the farmers' adaptation actions. The findings indicate that farmers are taking various adaptation actions that involved non-farm, off-farm and farm-related strategies. Results show that there are significant differences in the type of adaptation strategies implemented by farmers across the four studied villages: Hade Alga and Dalata villagers diversify more into farm-related adaptation strategies, while Ade Tela and Dalata engage more in non-farm and off-farm strategies. In relation to the motivating factors that trigger the farmers' adaptation actions, the findings show that both climatic and non-climatic factors play a role. Lastly, this chapter presented the results of the research on maladaptive outcomes that result from the implementation of the farmers' adaptation actions. The findings indicate that migration, selling firewood and irrigation practices carry the risk of maladaptation. The findings also show that migration as an adaptation measure mainly increases the vulnerability of the implementing actors (i.e., the migrants and their family). Selling of firewood and irrigation practices rebound on the vulnerability of the implementing actors (the farmers), and they erode sustainable development by degrading common pool resources.

Chapter 8: Planned adaptation interventions and maladaptive outcomes

8.1 Introduction

The previous chapter presented the findings of the farmers' adaptation responses to climate-related factors and maladaptive outcomes resulting from some of their response strategies. This chapter presents the results relating to the status of planned adaptation interventions in the study area and barriers to effective adaptation policy implementation at the local level. The chapter also assesses some of the maladaptive outcomes resulting from the implementation of the available planned adaptation interventions in the study area.

8.2 The status of planned adaptation intervention at the local level

Although various adaptation strategies are outlined in the national as well as the regional climate change adaptation policy documents, the findings of this study suggest that there is a gap in the translation of these policy documents into concrete action at the local level. The study found only two planned adaptation interventions – the natural resource management program and weather index crop insurance program (WII) – that are currently being implemented in the study area to address the impacts of climate change.

The natural resource management program is a government-led adaptation intervention in the study area. The Ethiopian government considers natural resource management as an important adaptation action to reduce the effects of climate-linked risks (FDRE, 2016). In the National Adaptation Program of Action document, community-based natural resource management is one of the twenty prioritized adaptation actions for implementation (NMA, 2007). Thus, in the study area, this natural resource program has been implemented for the last 5 years through the mobilization of the farmers' free labour force. The natural resource management activities include developing soil and water conservation structures, constructing stone bunds and building hillside terraces. All community members between the ages of 18-65 are expected to provide 40 days of their free labour to implement these activities.

The weather index insurance program (WII) is an adaptation intervention that has been implemented in the study area since 2012 by organizations, such as the World Food Program (WFP) and Oxfam America. The program is considered as a promising strategy that can benefit the poor in developing countries, by transferring weather related risks to financial institutions (Mcsharry & Spray, 2017; Skees, 2008). In the study area, the goal of the weather insurance program is to help the farmers to adapt to climate change by insuring their crops in the event of drought.

Apart from the two planned adaptation interventions (i.e., the natural resource management program and the weather index insurance program), the analysis shows that there are no other adaptation-labelled interventions in the study area. Yet, as demonstrated in Chapter 4, adaptation is a key agenda in both national and regional climate-related policies in Ethiopia. The next section will thus examine the barriers to effective adaptation policy implementation at the local level, from the perspective of government officials.

8.3 Barriers to adaptation policy implementation at the local level

In-depth interviews were held with key informants at national, regional and district levels to understand some of the barriers to effective adaptation policy implementation at the local level. The results in this section incorporate the responses of the interviewed key informants and the evaluation of the relevant regional and national adaptation policy documents.

8.3.1 A lack of financial resources at the local level

The Climate Resilient Green Economy (CRGE) strategy of Ethiopia is one of the key national climate strategies that has focused on addressing both climate change adaptation and mitigation goals in the country. A CRGE Facility has been established within the Ministry of Finance and Economic Cooperation (MFEC) to mobilize domestic and external climate finance. It is through this CRGE Facility that climate funds are supposed to be allocated to sectoral ministry offices, and regional and local governments, to support the implementation of adaptation programs.

For example, Ethiopia's National Adaptation Plan (NAP-ETH) states that: "…the financing and implementation of NAP-ETH will be led by the existing CRGE mechanisms that are in place at national, regional and *woreda* levels" (unpublished document). So far, however, there is no CRGE Facility unit established within the Woreda Finance and Economic Development (WOFED) office in the case study area. This means that there is no evidence how climate

change-related funds from the national level are transferred to *woredas* (districts), which suggests that climate finance delivery system is not yet well established at the local level. In another case study from Ethiopia, Paul & Weinthal (2018) also confirmed that the reach of the CRGE policies at the district and local level is very limited.

Interviews held with officials from the Bureau of Agriculture and Rural development both at district and regional levels revealed that there is no budget that is particularly allocated to implement agricultural related adaptation strategies at the local level. For instance, the majority of the budget that is allocated for the agricultural sector from year 2013-2016 has been used to pay staff salaries and for administrative purposes (See Table 8.3). There was no information available at the district level that indicates the use of the budget for support of agricultural adaptation strategies, such as for example to disseminate drought resistant crops to local farmers. In their assessment of climate finance delivery at the local level in selected *woreda*s (districts) in Ethiopia, Eshetu et al. (2014) also found similar findings.

Table 8.1: Raya Azebo district - Annual budget allocated for the year 2013-2016 by sector

Sector	Type	Annual budget in (Ethiopian Birr)			
		2013	2014	2015	2016
Agriculture and Rural Development	Salaries	4,484,578	6,652,772	8,383,724	8,383,724
	Administration	1,1178,093	1,487,510	2,151,460	2,177,805
Education	Salaries	23,991,260	35,480,708	37,897,776	55,890,764
	Administration	1,051,860	35,480,708	1,530,308	1,444,802
Health	Salaries	5,625,472	9,023,306	11,447,209	15,518,543
	Administration	1,502,100	1,860,879	2,147,641	17,735,725
Water, Mines and Energy	Salaries	705,004	932,345	494,554	651,749
	Administration	350,308	310,350	460,009	503,845
Rural roads construction	Salaries	514,371	514,371	460,009	503,845
	Administration	104,174	101,968	186,682	140,304

Source: Raya Azebo district *Woreda* Finance and Economic Development (WOFED)

According to regional officials, their main challenge to translate national and regional policy documents into practice is due to a lack of sufficient finance that is available at regional and (*wordea*) level. Some interviewed key informants from the regional office believe that a significant amount of climate finance is often utilized at the national level, and as a result, regions and district offices often lack the financial capacity to enforce adaptation at local levels. One key informant from the regional office said:

> *We know that the ministry office [Ministry of Finance and Economic Cooperation] receives a huge amount of financial support [Adaptation Fund] from international donors. But we do not see the money here. (Key informant # 1 from TBoARD).*

A similar view was reflected by one of the key informants at the national level who explained his observation during the interview as follows:

> *Most of the climate fund is mainly used for nationally designated priorities [e.g. for national policy documents preparation, capacity building etc…]. Sometimes the resource is misused for irrelevant activities. There is little to no fund that actually goes towards the implementation of real adaptation strategies at the local level. (Key informant # 5 from MEFCC).*

This suggests that climate-related financial resources are concentrated at the national level and do not trickle down to the local level. However, another key informant at national level expressed a divergent view. According to him, financial resources to implement relevant adaptation strategies at the local level are often insufficient, as there is limited capacity to mobilize and access domestic and external climate funds at the national level. Most of the interviewed key informants at national level attributed financial constraints as a barrier for effective implementation of the policies. Similarly, in other African nations, a limited budget is also reported to have constrained the implementation of national adaptation plans, such as the NAPA (Edmond et al., 2015).

8.3.2 Poor coordination among institutional actors

Most of the key informants at the national level identified a lack of strong coordination mechanism among key institutions involved in climate issues, as a reason for this policy implementation gap. This in part stems from the failure of the policy documents to clearly identify key actors, and their roles and linkages to implement the envisioned adaptation plans and programs. For example, the 2007 NAPA document has indicated the involvement of ten institutional actors in the formulation of the policy. However, there is no mention of how the institutions will work together to implement the outlined adaptation strategies. The EPACC document did not provide any information about institutional actors who participated in the formulation of the document as well as how the prioritized adaptation strategies will be implemented. The 2017 NAP-ETH document listed sectoral institutions such as the Ministry of Agriculture and Natural Resource Management, Ministry of Water and Irrigation and other commissions/agencies as key implementers of the adaptation strategies. Again, there is no clear explanation of how the ministry offices will interact and enforce the NAP-ETH plan.

A key informant from MEFCC acknowledged that coordination between key line ministry offices, such as between MEFCC and Ministry of Agriculture and Natural Resource Management (MOANRM)) is poor. According to him, one reason for weak coordination among institutional actors at ministry level is due to continued structural changes within the ministry offices. For example, the key informant explained:

> *Our ministry office [Ministry of Environment, Forest and Climate Change], has been established five years ago. But still there is a structural change within the ministry office every year. If you look at the Ministry of Agriculture and Natural Resource Management and the Ministry of Livestock and Fishery; they were separate ministry offices. Now they have merged. When there is continuous structural change within the ministry offices, the roles and responsibilities of staff members also change and that creates communication gap. Which then leads to poor coordination among institutional actors. (Key informant # 2 from MEFCC).*

A lack of uniform institutional structure across sectors and regions was also considered by national level officials to be the cause of weak top-down coordination between institutional actors and for the subsequent limited implementation of national adaptation plans at the local level. At the national level, the Ministry of Environment, Forest and Climate Change (MEFCC) is the focal institution on climate change. However, this institution has no uniform representation across regions of Ethiopia. For example, the key informant noted that in the Southern region of Ethiopia, the MEFCC has a uniform institutional structure up to regional and district level. However, in the Tigray region, this uniform institutional structure does not exist. This means that there is no separate office that represents MEFCC both at regional and district level. The key informant indicated that in the Tigray region, the forest department is under the Tigray Bureau of Agriculture and Rural Development and environmental related issues are mainly handled by the Tigray Land Use and Environmental Protection Agency. There is no individual institution, agency or department that coordinates climate-related matters in the Tigray region. According to the view of an interviewee, the absence of uniform institutional structure that is observed in most regions of Ethiopia is partly attributed to Ethiopia's governance system that allows regions to have their own institutional autonomy. Mentioning the Tigray case, the interviewee said:

> *Regions in Ethiopia are autonomous. Thus, our office [MEFCC] has no mandate to influence the Tigray region to follow the same institutional structure that we use. We cannot say similar institution must be established to represent MEFCC in Tigray region nor can we say this office or that office should represent MEFCC. It is up to them [regional authorities]. Since there is no uniform institutional arrangement, coordination between us [MEFCC] and regional government actors in Tigray is still very loose. This hampers the conversion of national adaptation policies into practise at the local level. Effort has been made at the ministry level to encourage regions to follow uniform institutional structure as we have, but so far the result is unsatisfactory. (Key informant # 3 from MEFCC).*

Together, the interview findings affirm that coordination among the relevant line ministries, offices, departments and agencies that are involved in climate issues in Ethiopia is still weak and unstructured. The implication of this is that, even if sufficient climate funding might be readily available in the future, the existence of inefficient coordination may still cause delays in adaptation policy implementation. In Kenya (Mburu, 2017) and Tanzania (Yanda et al., 2013), poor coordination among implementing actors has been identified as one of the major hindrances for effective climate policy implementation.

8.3.3 Limited knowledge about climate-related policy documents at lower levels

Successful implementation of climate change action depends on how aware and knowledgeable government local actors are about the policies (Eshetu et al., 2014). The interviews held with district level officials revealed limited awareness of both national and regional climate related policy documents. For example, when asked if they have the NAPA document at the district office or if they have at least read the document, most interviewees' response was no. In another study from Ethiopia, Virtanen et al., (2011) found that even at the ministry level, key institutional actors who were expected to lead the NAPA projects were not familiar with the existence of the NAPA document.

The same answer was given when they were asked if they have regional or district level climate related policy document or guidelines. However, regional level officials from Tigray Environmental Protection, Land Administration and Use Agency (TEPLUAA), confirmed the existence of regional climate change adaptation policy document called 'Tigray Regional Program of Plan on Adaptation to Climate Change (TRPPACC). The program was prepared by staff members from TEPLUAA and representatives from other key institutions, including from the Tigray Bureau of Agriculture and Rural Development. Yet, most interviewed staff members from Tigray Bureau of Agriculture and Rural Development were not aware of the existence of the regional adaptation policy document.

On the other hand, the Tigray Bureau of Agriculture and Rural Development has prepared its own sectoral climate change mitigation/adaptation plan known as 'Woreda Disaster Risk Mitigation/Adaptation Planning guidelines', to help district level staffs in planning disaster risk management strategies and climate change adaptation. Through its disaster prevention and preparedness department, the Bureau has conducted vulnerability assessment for all districts in Tigray region, including for Raya Azebo district and has

prepared specific adaptation plans for each district. However, surprisingly, interviews held with various officials in Raya Azebo district revealed that they are unaware of the existence of the adaptation plan that is specifically formulated for the district they work. Interviews were conducted with regional officials from disaster prevention and preparedness office to investigate whether the document has been shared with district level officials and the response given by one of the officials was:

> *Of course, we have shared the document. Maybe they [district staffs] did not understand the document as it is written in English. (Key informant #1 from Tigray Bureau of Agriculture and Rural Development).*

Regional and local officials' limited awareness of the existing important national/regional policy documents signals poor communication and limited information sharing practice among the various government actors, across all levels. The following quote taken from one of the national level officials confirmed exactly that:

> Officials at the ministry level may know nothing about regional adaptation plans and policies, and at the same time regional or district level officials may not be familiar with national policy documents. This has remained one of the biggest challenges for policy implementation. (Key informant # 4 from MEFCC)

Apart from the 2007 NAPA document, which is at available online, the author has observed that the national and regional climate change adaptation policy documents are kept in office shelves and the practice of sharing the documents with relevant institutional actors is limited. An example is the NAP-ETH document which has been prepared both in hard and soft copies since August 2017 and is available at the MEFFC office. To date, however, the document has not been accessed by some of the key regional government actors such as those at Tigray Bureau of Agriculture and Rural Development.

In sum, the findings indicate that knowledge of local government actors about the existing policy documents is very limited. This indicates that they also have little knowledge on how to mainstream climate change issues into their sub-sectors and to translate them into practice. This evidence could partly explain why so few planned adaptation actions are taking place at the local level. In other similar studies, local and district-level staffs' lack

of awareness about climate change policies has been identified as one of the barriers for policy implementation (Edmond et al., 2015; Okolo et al., 2015).

8.3.4 Limited technical capacity at the local level

At regional and district levels, there are no staff members who are particularly tasked to coordinate and lead climate change issues and activities. At both levels, experts from natural resource management and early warning departments oversee climate change related issues, along with other multiple tasks. Results from interviews suggest that these experts are relatively knowledgeable about climate change. Yet, most staff members from other departments generally possess limited knowledge on climate change issues. For example, when asked about the cause and impacts of climate change through interviews, most local staffs expressed their lack of knowledge on the subject matter. Some staff members associated climate change with environmental concerns and they consider both as one and the same issue. After pointing to Raya Azebo's case, an official from MEFCC was asked why a capacity gap is observed at lower levels and what the institution is doing to bridge the technical capacity challenge of lower level staffs. The response provided was:

> *Our mandate is to strengthen the technical capacity of regional officials. Since the establishment of MEFCC; we have spent huge amount of financial resources to equip regional-level staffs with the necessary climate related knowledge and skills. Regions have the same responsibility of building the technical capacity of the respective lower level government actors [i.e. zonal and district level staff]. In my opinion, the regional officials are not doing their job… so it is not a surprise if the district officials know nothing about climate change! In fact, this is a big challenge for us [low technical capacity of district-level staffs]. When we sometimes work closely with district officials to implement pilot adaptation projects, they have no idea what we talk about. It is not easy to implement national adaptation policies in such a context. (Key informant # 6 from MEFCC)*

When it comes to translating national/regional adaptation polices and plans into action at local level, it is the district-level staffs who can play a key role. However, the findings suggest that the individuals' technical capacity on climate change is not yet strong, and that it is indeed presenting a challenge for policy implementation. The study by Ampaire et al., (2017) also found limited technical capacity of local governments as one of the underlying causes for the climate policy implementation gap in Uganda.

8.3.5 Low participation and inclusion of local actors in policymaking

Engaging local government actors in the policymaking process creates a sense of ownership of the policies and thereby enables successful implementation of climate change adaptation (Ampaire et al., 2017). Key informants at the district level stated that their participation in climate-related consultative workshops or training is very limited. When asked if they were involved in national or regional level climate policy formulation, the responses were "no". Only one regional official from Tigray Bureau of Agriculture and Rural Development had participated in the formulation of the regional climate change adaptation program (i.e., TRPPACC). There is no evidence that indicates the participation of local community actors either in regional policy formulation or their inclusion in climate-related consultative workshops.

Some of the key informants from the government office at district level attributed their inadequate involvement in policy formulation process as the reason for their limited understanding of climate change issues as well as their lack of awareness about the existing climate national/regional policies and plans. In an important regional workshop related to strengthening the seasonal climate forecast system in the Tigray region, various stakeholders from national and regional level had participated in the program. Nevertheless, the author has observed that none of the district level staffs were involved in such an important workshop. When one district-level official was asked if he had received any training related to climate related matters, he responded:

> *I have worked as an early warning expert in this department [Disaster Prevention and Preparedness office], for 11 years. Part of my work is to conduct drought risk assessment in every Tabias [villages] of Raya Azebo district. To answer your question…well I was never invited to any workshop that is related to climate change. (Key informant # 1 from RDAE).*

For example, in the 2017 NAP-ETH policy document, let alone district level actors, regional level officials did not participate in the preparation process. Information received from the Ministry of Environment, Forest and Climate Change (MFCC), indicates that only representatives from line ministries had participated in the preparation and consultation of NAP-ETH.

8.4 Maladaptive outcomes in planned adaptation interventions

In Ethiopia, Governments and NGOs may initiative various adaptation projects and programs to tackle global climate change and to increase the capacity of smallholder farmers to manage the impacts of climate change. However, little is known what outcomes such programs might have at the local level. This section identifies maladaptive outcomes from the implementation of the natural resource management and the weather index insurance (WII) programs that are led by the Ethiopian government and NGOs respectively.

8.4.1 Maladaptive outcome from the implementation of the government-led natural resource management program

During the data collection period, continuous field observations were carried out to assess the unintended maladaptive outcomes of the natural resource management activities in the study area. Individual as well as group interviews were also conducted with the farmers while they were participating in the watershed management activities. One major challenge identified by the farmers was that the implementation period of the watershed management activities overlap with the timing of their agricultural activities. As a result, it is diverting their labour away from agriculture.

As mention before, the resource management activities are implemented annually between the months of January-March. However, these months are a very critical period for the farmers, as it is the time where they prepare their land for sowing spring season crops. Despite this, the farmers are forced to participate in the natural resources management activities (i.e. participation is mandatory). What is worse is that the program coordinators do not provide the farmers the flexibility to undertake the resource management tasks when it suits their schedule. As a result, farmers noted that the natural resource management activities are not only diverting their labour away from agricultural tasks, but also from undertaking other non-farm and off-farm income generating activities. The following quote taken from one of the participants while she was undertaking the natural resource management activities demonstrates the seriousness of this issue.

We are all here consumed in these natural resource management tasks. I am here, my husband is also here. Our children are in school. Who would keep the livestock? Who would prepare the land? we have not started farming operation. They force us to invest our time here rather than on our on individual farms. If we miss this work, we are required to pay a non-attendance fee of 100 ETB/day. It is a lot of money. The only reason why we are here is because the work is mandatory. (Participant # 5, FGD 4)

Interviews were conducted with district and regional level officials regarding the time overlap between the natural resource management activities and the farmers' cropping calendar. Admitting the problem, the officials claimed that efforts are being made to implement the natural resource management tasks only in dry seasons (non-farming season). However, farmers stated that for the past five years the problem has not been resolved. In fact, this problem is not only unique to the case study area. For example, Meshesha & Birhanu (2015) observed conflicting time schedules between the government-led natural resource management program and the farmers' crop growing season in the southern region of Ethiopia. Punishing absentee farmers when they do not participate in watershed management campaign is also a common practice in the Amhara region of Ethiopia (Gebreyes, 2018).

In sum, these findings demonstrate how the government-led natural resource management activities are interfering with the farmers' activities. As described before, the farmers adapt to climate change by employing various farm-related and non-farm adaptation strategies. However, the empirical evidence is showing how the farmers' labour is being drawn away from the natural resource management tasks. The program is thus encouraging maladaptation, as it is undermining the farmers' autonomous adaptation efforts by restricting them from undertaking their own tasks.

8.4.2 Maladaptive outcomes from the implementation of the weather index insurance program

To identify some of the maladaptive outcomes associated with the weather index insurance program in the study area, a focus group discussion with farmers who participated in the insurance program and qualitative interviews with the coordinators of the insurance program were conducted. This section describes some of the maladaptive outcomes that emerged from the analysis of the empirical findings.

The analysis of the qualitative findings revealed two main reasons why the current weather index insurance program might be encouraging maladaptation. The first reason is that the program exposes insurance purchasers (farmers) to economic risks. Although the whole concept of the insurance program is to compensate farmers for their loss when they experience drought risk, the analysis shows that farmers may not receive a payout from the insurance company when they should. One of the recurrent themes that emerged from the analysis of focus group results was an ongoing issue related to the insurance payouts. One of the policyholders among the focus group participants expressed his discontent as follows:

> *The compensation was very good when the insurance program first started. We thought this insurance thing is a real solution to reduce some of the risks [crop failures] we experience due to drought. I first purchased insurance for sorghum crop in 2012. As the rain was very low that year [2012], I received a payout 3,000 Ethiopian Birr. Then again, I enrolled in 2015 by paying 500 ETB and I was hoping that I would be insured if drought occurs. However, despite experiencing a very harsh drought, I did not receive compensation. (Participant # 3, FGD 5)*

According to the coordinators of the weather index insurance program, the reason why those farmers who purchased insurance did not receive compensation when they experienced drought in 2015, is due to the prevalence of the "basis risk" problem in the design of the weather index insurance program. Basis risk in weather index insurance arises when there is a: "divergence between measured risks at the meteorological level and the occurrence of weather shocks at the location of the farm of the insured" (Carter et al., 2014, p.5).

The interview results suggest that the reason why basis risk is a major problem in the study area is that the insurance program relies on satellite-based rainfall readings to trigger payouts to the farmers who purchased the insurance premium. However, the challenge is that the satellite technology may not accurately capture the actual climate risks experienced at the farm of the insurance purchasing farmers. As a result, the farmer may not receive a payout from the insurance providers even though they might experience drought.

To overcome the challenge of basis risk, one study suggests that satellite-based rainfall readings should be validated through ground-level rainfall conditions – such as through rainfall records collected from the nearby meteorological stations and by interviewing farmers about the local climate conditions (Bristol Mann et al., 2014). However, analysis suggests that the current insurance program in the study area does not verify the accuracy of the satellite-based rainfall readings by triangulating the information with ground-level data. Indeed, this is one major challenge identified by WII program coordinators.

The second reason why the weather index insurance program might be generating maladaptive outcomes is because the program acts as a disincentive to the farmers' choice of adaptation options. The findings indicate that the program discourages the farmers' crop diversification options by covering only two types of crops – i.e., sorghum and teff. During focus group discussions, farmers stated that they can only participate in the insurance program if they plant either teff or sorghum. However, as indicated in previous sections, crop diversification is one of the most common adaptation strategy farmers use to respond to climatic stressors. In the long-term, if the insurance program would not cover all crops equally, the farmers will be forced to over-specialize only on specific crop types. This means that farmers' cannot spread their risk by diversifying into more crops. In the long term, over-specialization would also have adverse ecological consequences.

Overall, the findings highlight that due the challenges attributed to the basis risk problem, the current weather index insurance program is not reducing the farmers' vulnerability to climate risks. It is evident that the program is exposing the farmers to financial risk, when the satellite based-rainfall readings fail to accurately capture the local climate conditions. This suggests that the insurance program results in rebounding vulnerability to the implementing actors (i.e., the insurance purchasers). In addition, the results suggest that WII is reducing the farmers' incentives to adapt to climate change, as farmers are insured only if they plant specific crops.

Table 8.2: Potential maladaptive outcomes from planned adaptation intervention

Adaptation strategy	Indicators maladaptive outcomes	Type of maladaptation
Natural resource management	Withdrawing labour from agriculture	Rebounding vulnerability to the implementing actors
	Withdrawing labour from non-farm adaptation strategies	Rebounding vulnerability to the implementing actors
	Exposes farmers to economic risks due to basis risk challenge	Rebounding vulnerability to the implementing actor
Weather index insurance program	Exposes farmers to economic risks due to basis risk challenge	Rebounding vulnerability to the implementing actor
	Discourages crop diversity by covering only specific crops	Rebounding vulnerability
	Covering only a few crops might alter the farmers' agronomic practice in the long term (i.e. over-specialization/monoculture (ecological side effects)	Eroding sustainable development

Source: Based on qualitative findings

8.5 Conclusion

This chapter presented findings related to the status of planned adaptation efforts by the government of Ethiopia and other organizations (NGOs) at the local level. The chapter then further examines some of the barriers to the translation of adaptation policies into practice at the local level and assessed the risk of maladaptation from the existing planned adaptation intervention in the study area. The study found only two-planned adaptation interventions – the natural resource management program and weather index crop insurance program (WII) – that are currently being implemented in the study area to address the impacts of climate change. Except for the two planned adaptation interventions, there are no other adaptation-labelled interventions in the study area. At the government-level, the findings indicate that financial constraints, poor institutional coordination, low technical capacities, and limited inclusion of local actors in the policymaking process, combine to constrain the implementation of adaptation policies and strategies at the local level. The results further show that even the two planned adaptation interventions, the natural resource management program and weather index crop insurance program (WII) carry the risk of maladaptation.

Chapter 9: Discussion

9.1 Introduction

This chapter discusses the significance of the key findings of this study, in particular the ways in which they have implications for climate change communication. Specific recommendations about issues that have been identified in this study are incorporated throughout the discussions. This chapter also discusses ways of avoiding maladaptive outcomes in autonomous and planned and adaptation strategies.

9.2 Communicating the issue of climate change

This study found that a large number of farmers relate the causes of climate change to spiritual factors. For most farmers, climate change is a sign that "God is angry due to their sinful acts". Indeed, religion can potentially influence one's perception of the world, including attitude towards climate change and environmental issues (Hope & Jones, 2014). Farmers' interpretation of the causes of climate change largely deviates from the scientific view of climate change causes. Human-induced causes of climate change such as burning fossil fuels, deforestation and agriculture activities (i.e., excessive fertilizer use and rearing livestock) were perceived by a small minority of the respondents.

It is surprising that the majority of the farmers do not consider deforestation to be the cause of climate change. Somehow, this reflects that climate education and communication with regard to the potential causes of climate change is largely missing in the study area. Consistent with the current study, belief in a divine power being responsible for climate change is evident among rural populations in Africa (Speranza et al., 2010), Asia (Hasan & Nursey-bray, 2018) and even in highly developed nations such as in the United States (Roser-Renouf et al., 2016).

In this study, the farmers' dominant belief that a supernatural force is causing climate change rather than human activities, could have serious implications for their uptake of specific climate change adaptation and mitigation measures (e.g. tree planting, adopting climate-smart agriculture). Hence, the human-induced causes of climate change need to be stressed in climate education and communication, with careful consideration of the farmers' religious rationalization of climate change causes. Here, religious leaders can be play a profound role, as they have greater acceptability by their followers (Chitando, 2017).

Thus, for example, climate communicators, such as the National Meteorological Agency of Ethiopia (NAMA), can work with religious leaders to educate local people on the role of human actions in contributing to climate change. In general, this kind of approach may facilitate certain types of climate change adaptation and mitigation efforts, particularly in developing countries where local people strongly associate the climate change cause with a higher power ("the work of God").

Although farmers' perceptions regarding the causes of climate change widely differ from the scientific explanations, the findings suggest that they have recognized the patterns of changes in their local climate (such as low rainfall, higher temperatures, frequent droughts and unusual rains). Although location specific meteorological data was unavailable for comparison, farmers' perceptions of changes in climate parameters are broadly consistent with long-term climate trend analysis available for the Tigray region (Gebrehiwot & Veen, 2013). The consistency in climate observations noted by farmers and historical climate records, suggests the potential role local perceptions can play in climate studies. Especially in developing nations where meteorological stations are largely unavailable or sparse (World Meteorological Organization, 2012), local peoples' observations of climate trends can offer important insights about local climate change conditions. The changes in temperature (i.e., higher temperatures) and rainfall patterns (i.e., late onset, early cessation, decreasing trends), that were detected by farmers of this case study area have also been similarly observed by rural communities across Africa (Bryan et al., 2013; Ayanlade et al., 2017).

The findings of this study indicate that climate change is perceived as a psychologically proximal phenomena by the majority of smallholder farmers in all four dimensions – that is, geographically, socially, temporally and hypothetically. Hence, it is rational to say that in the minds of farmers climate change is not a psychologically distant problem. In another study by Spence et al. (2012), climate change was perceived by the British public both as proximal and a distance matter in relation to the different psychological domains. For example, the majority of their respondents believed that climate change would affect their local area (i.e., it is perceived to be geographically close), but they think that the impacts will be largely felt by people in developing countries (it is perceived to be socially distant). In contrast to the results of this study, other empirical studies conducted in Norway (Lujala et al., 2015) and in the United States (Leiserowitz, 2006) show that the public largely perceive climate change as a psychologically distant issue.

The findings of this study indicate that psychological proximity is strongly positively correlated with concern about climate change. This means that that the more geographically, socially, temporally and hypothetically close the impacts of climate change are perceived to be, the more concerned farmers are about climate change. Specifically, the closer farmers believe climate change impacts are to them, the more they become concerned about climate change. Also, the more they believe climate change impacts are happening now, the higher their concern level. A similar psychological distance study has demonstrated that the more people perceive climate change impacts to be psychologically distant; the less concerned they are about climate change (Singh et al., 2017).

In all, results from this study suggest that higher psychological proximity is associated with higher levels of climate change concern. This implies that, in order to increase people's engagement with climate change, lowering the psychological distance of climate change in climate communication strategies is very important. This can be a powerful strategy, particularly for people who lack direct personal experience of climate change impacts (e.g. drought and flood experience). For instance, communicators (e.g., environmental groups or scientists) can communicate the issue of climate change to lay people like this: (1) climate change is already occurring; (2) it is will soon affect your local area and you. Highlighting the proximal impacts (consequences) of climate change can be an effective mechanism to encourage individuals to take action on climate change. This kind of message framing may increase a sense of urgency in people's mind and it may motivate them to take climate change adaptation and mitigation actions.

In regards to socio-demographic factors, this study found that age is one of the determinants of climate change risk perception. Specifically, the results suggest that older farmers tend to have a higher concern about climate change. This is contrary to evidence provided by Shi et al., (2016) who reported that older people in the UK are less likely to be concerned about climate change. Older people in the UK were found to be sceptical about the climate change (Poortinga et al., 2011; Whitmarsh, 2011), and that may explain why their level of concern about climate change is low. In this study, the positive effect of age on climate change risk perception (concern) could be explained by the fact that older farmers have experienced a higher number of extreme weather events as compared to younger adults and that may increase their concern about climate change.

The results of this study indicate that education has a negative but a statistically significant effect on climate change risk perception. Farmers who have higher education are less likely to report a higher concern about climate change than farmers who have lower education. Although this result differs from many other studies (Lee et al., 2015; Aydogdu & Yenigün, 2016; Sun, 2018), it is consistent with those of Mccright (2009) and Malka et al., (2009) who found also found significant association between higher educational attainment and lower climate change concern. In regards to gender, past studies have indicated that females are more likely to have higher risk perception than males (Brody, 2008; Lujala et al., 2015). However, this study has been unable to demonstrate a significant relationship between gender and climate change risk perception. Moreover, the current research indicates that income has no significant effect on climate change risk perception – this is in line with other studies (Milfont, 2012; Sun, 2018).

The results of this study reveal that frequent drought experience significantly influences climate change risk perception. Farmers who experienced frequent droughts were found to be highly concerned about climate change. Indeed, with the exception of a few studies (Whitmarsh, 2008; Brulle et al.,2012), a link has been found between direct personal experience with extreme weather events and concern about climate change (Spence et al, 2012; kerlof et al., 2013; Demski et al., 2017). Therefore, the findings of this study provide further support on the relationship between extreme weather events (drought) and risk perception of climate change (concern).

Previous studies have identified that individuals' low concern about climate change is partly attributed to their lack of direct personal experience with its impacts (Smith & Leiserowitz, 2012a). Indeed, in the absence of first-hand experience, it may be hard for lay people to be concerned about climate change. Particularly in an urban context, even if extreme weather events occur, it may be difficult for lay individuals to notice the events and to be concerned about the issues, as the damage on personal level might be minimal. However, in a rural context, the occurrence of extreme weather events has serious consequences for most farmers as their livelihoods depend on climate sensitive agriculture. In this case study, this may be why farmers who had more drought experience have a high concern about climate change.

In this study, the finding that frequent drought experience heightens farmers' risk perception of climate change has an important implication for climate change communication strategies. It implies that, in areas where direct personal experience with extreme weather events is lacking or maybe unnoticed by individuals, emphasising extreme weather events (e.g., through social media), and highlighting the direct and indirect negative consequences those events can have at a personal and societal level, can be a good strategy to increase concern levels and also to motivate actions. This study recommends that climate communicators should make more efforts in highlighting the connection between extreme weather events and climate change, since it can be difficult for lay people to experience or detect climate change directly (Swim et al., 2009)

Results from this study suggest that negative affect (emotion) significantly influence farmers' risk perception of climate change. It appears that farmers who have a strong negative feeling (emotion) when they think of climate change, tend to have a higher concern about climate change. Past studies that were conducted mainly in the developed nations, have also found strong relationship between negative affect and climate risk perception (Leiserowitz, 2006; Smith & Leiserowitz, 2012a; Van der Linden, 2014). In this study, farmers' past drought experience and the impact it had on their lives may have triggered a negative emotion (negative affect), and this negative affect might in turn lead to higher risk perception of climate change. In fact, Van Der Linden (2014) has found a causal relationship between personal experience with extreme weather events, negative affect and risk perception of climate change. More broadly, this empirical result contributes to the *risk as feelings* concept which discusses how people rely on affect and emotion when evaluating risks and making decisions (Slovic & Peters, 2006).

In this study, the finding that negative affect (negative emotion) influences climate change risk perception has an important implication for public risk communication. This finding implies that appealing to human emotions in climate change communication, may increase the individual's concern about climate change and it might motivate them to take action. In particular climate information that elicits moderate negative emotions in the individual's mind can be a powerful strategy to raise concern levels. Nevertheless, such kinds of risk communication strategies (i.e., climate communication that provoke negative emotions), should be designed carefully, as they may sometimes have counterproductive effects (Salama & Aboukoura, 2018). For example, a study conducted by O'Neill & Nicholson-Cole, (2009) in

the UK has shown that fear-inducing climate communication strategies created denial and avoidant behaviour among the studied participants, which in turn promoted disengagement with the issue of climate change.

Several authors have noted that people who see climate change as a remote issue lack personal and emotional engagement with climate change impacts (Roeser, 2012; Salama & Aboukoura, 2018). Thus, in places where people perceive climate change as a distance issue, climate communication methods must clearly appeal to emotions in order to increase individual's engagement with the issue of climate change. In general, attention-grabbing and emotionally-engaging climate communication styles can be a powerful tool to engage people in climate change matters.

In regards to value orientations, the findings of this study show that egoistic values shape farmers' risk perception of climate change. Farmers who are more oriented towards personal interests and self-advancement (i.e., who hold strong egoists values), were more likely to show higher concern about climate change. In contrast, previous research has shown that people who hold biospheric values are more concerned about climate change (Shi et al., 2016; Van der Linden, 2015). In line with both studies (Shi et al., 2016; Van der Linden, 2015), however, the current study did not find any significant association between altruistic value orientations and climate change concern.

In the environmental literature, past studies have revealed that people who strongly identify with biospheric and altruistic values have high environmental concerns and that they also demonstrate pro-environmental behaviour (DeGroot & Steg, 2008). In this study, a possible explanation for the non-significant effect of biospheric and altruistic value orientations on climate change risk perception (concern) is that farmers may feel the negative impacts of climate change more on themselves than on the environment (nature) and/or on other people in general.

Often, the media focuses on the impacts of climate change on the natural environment when communicating about effects of climate change (Helm et al., 2018). Also in environmental campaigns, the main strategy of promoting pro-environmental behaviour has concentrated on highlighting the benefits of pro-environmental behaviours to nature (the environment) than appealing to personal benefits for individuals (Dominicis et al., 2017). However, for individuals who are more worried about the negative consequence of climate change (negative

environmental consequences) on themselves, this kind of communication strategy may not be effective.

In this study, the finding that egoistic values shape climate change risk perception, may suggest that climate communication strategies that focus on the negative impacts of climate change more on individuals (for example personal health), than on the environment (nature), can be an effective way of increasing people's risk perceptions about climate change. In other words, risk messages that appeal to human ego may be an effective mechanism to improve people's engagement in climate change matter.

In this study, the significant relationship observed between local media use and climate change risk perception maybe because the national meteorological agency of Ethiopia (NMA), broadcasts daily weather forecasts through Radio and Television, and that may heighten concern about climate change among those farmers who follow local media more frequently. The daily weather forecasts presented through radio and TV might generally increase farmers' risk perception about climate change but that may not necessarily motivate the farmers to take adaptation action (e.g. in farming practice). However, during data collection for this study, farmers complained that the weather forecasts disseminated through Radio and TV programs are very broad (i.e. at regional level) rather than specific to their district or zone. For example, it was noted that the seasonal weather forecast broadcasted by NMA predominantly covers weather conditions in the regional city of Tigray (Mekelle) rather than site-specific weather information for each district within the Tigray region.

In general, the results suggest that if weather forecasts transmitted through TV and Radio programs are more site-specific, the channels can be an effective climate communication instruments. Using TV and Radio programs to communicate climate-related information can be more applicable (particularly in rural areas of developing countries), where other media options such as the internet and printed media, are less commonly used. Indeed, a study in West Africa indicates the significant role, Radio plays in channelling climate-related information to smallholder farmers (Tarhule & Lamb, 2003). If the meteorological information disseminated through TV and Radio is more location-specific to meet the needs of end-users (farmers), not only has it the potential to raise the concern level about climate change, but it may also encourage adaptation action (particularly for agricultural related agronomic practices).

Past studies have found a significant relationship between knowledge about the causes of climate change and climate change concern (Tobler et al., 2012; Shi et al., 2015). In this study, increased knowledge about the causes of climate change has no significant effect on climate change risk perception (i.e., increased concern). One likely explanation for this insignificant effect is that farmers learn about the causes of climate change through information provided by external sources (e.g., such as schools, media, and extension workers). However, as Weber (2006) argued, vicarious learning is unlikely to elicit more strong risk perceptions. Perhaps, knowledge about climate change impacts can be a better predictor of climate change risk perception. This is because farmers mostly learn about the impacts of climate change and its negative consequences from their own direct personal experience and that may evoke more vivid risk perception.

9.3 Multidimensional factors influence vulnerability

The findings of the vulnerability assessment highlight that smallholder farmers in Raya Azebo district are currently exposed to a wide range of stressors that affect their lives and livelihoods. This study finds that some of the identified stressors that contribute to livelihood vulnerability are linked to a biophysical factor such as climate change, while others are closely associated with socio-economic, political, institutional and policy related challenges. Indeed, it is well recognized in the climate change literature that the conditions that produce patterns of vulnerability in rural communities result from environmental, economic, social, and political factors operating at different scales (Leichenko & O'Brien, 2002; Eakin, 2005; Bennett et al., 2015; McCubbin et al.,2015).

Taken together, the findings of this study suggest that the underlying factors that produce vulnerability in rural communities are complex and multidimensional. The findings also indicate that vulnerability is not an outcome of biophysical changes (i.e., climate change) per se, but rather it is a product of the complex interaction of both climatic and non-climatic forces. The results from Raya Azebo district, showing rural farmers' exposure to multiple interacting stressors that have climatic and non-climatic origins, are broadly consistent with those of other community-based vulnerability studies in Africa and beyond (Bunce et al., 2010; McCubbin et al., 2015; Mubaya et al., 2012; Nyantakyi-Frimpong & Bezner-Kerr, 2015; Reid & Vogel, 2006; Shisanya & Khayesi, 2007; Westerhoff & Smit, 2009).

9.3.1 Vulnerability to climatic stressors

The results indicate that the key biophysical factor that is contributing to current livelihood vulnerability in the study area mainly arises out of climate related stressors. It was shown that drought is a key climatic stressor that is affecting the farmers' lives and contributing to their livelihood vulnerability. The majority of the farmers in the study area attributed decline in crop and livestock production, and loss of farm income, to the frequent occurrence of drought events in their local area. Most farmers also associated their high exposure to food insecurity, malnutrition and various health related issues with the occurrence of drought incidents in their community. A study conducted by Menghistu et al., (2018) shows similar findings, indicating farmers' association of food insecurity, loss of livestock, reduced household income and poor health to extreme droughts in the Tigray and Afar regions of Ethiopia. Together, the findings of this study suggest the seriousness of climate change in Raya Azebo district and the high vulnerability of rural farmers to its impacts – and they confirm previous work that indicated the district's high exposure to climatic extremes such as droughts (Tonini et al., 2012; Gebrehiwot & van der Veen, 2013; Gedif et al., 2014).

9.3.2 Government policies shape vulnerability

In addition to a biophysical factor (i.e., drought), the findings suggest that government policies are further contributing to livelihood vulnerability and reinforcing maladaptation. As highlighted in the previous chapter (Chapter 6), the policies related to the distribution of fertilizer to smallholder farmers and the promotion of large-scale farming in Ethiopia seem to be well-intended policies that are being pursued by the government to increase the country's agricultural production and strengthen the national economy. However, the analysis revealed that in trying to achieve these national goals, the policies are causing vulnerability at the local level. Similar studies have shown how national policy measures can contribute to the vulnerability of rural communities in Africa (e.g. see Leichenko & O'Brien, 2002; Westerhoff & Smit, 2009; Bunce et al., 2010).

It is evident from the findings that the current agricultural policy (the fertilizer program) is presenting additional challenge for the farmers at the local level. This is largely attributed to the government's irresponsible act of forcing farmers to buy fertilizer without assessing the suitability of fertilizer for the local agroecology and climate conditions. It was found that this top-down and coercive agricultural development approach has exposed the majority of the farmers to economic risks and contributed to livelihood vulnerability. These findings highlight

that there are important changes the Ethiopian government should make in order to benefit farmers from the agricultural policies. Firstly, the government should pay attention to farmers' needs, priorities and their situations when promoting policies that aim to enhance agricultural growth. When distributing agricultural inputs to smallholder-farmers, factors such as local-level agro-climatic conditions need to be considered. This is because one-size-fits-all type of agricultural policy cannot be successful in Ethiopia where there are diverse agrological zones and farming practices across the country.

It appears that the development policy of Ethiopia that largely favours large-scale farming over smallholder subsistence farming has created the issue of land grabbing at the local level. The findings have clearly shown how the leasing of farmlands to a foreign investor without due consideration of the pre-existing landholders' rights threatened livelihoods and damaged the local environment. These findings underscore the need for the Ethiopian government to consider the following core issues. First, before leasing out rural farmland for large-scale agricultural investment projects, local communities who will be directly affected by such investment projects should be adequately informed. This will definitely help affected communities to prepare for adverse outcomes. Second, the government should provide timely and fair compensation to the affected communities, if the likely benefits of a particular large-scale agricultural investment for the country is largely greater than the impact it might have on certain local communities. The constitution has given landowners the right to receive compensation during expropriation and government must strictly follow this law in the process of land transfer from local communities to investors. Doing so will help the affected communities to maintain sustainable livelihoods. Third, before transferring land to investors, the government should critically assess the environmental damage that can be caused due to forest clearing. Short-term benefits that can be gained from agricultural investments should not outweigh the long-term environmental costs.

9.3.3 Institutional failures contribute to vulnerability

The results indicate that institutional failures can contribute to livelihood vulnerability. The destruction of the cactus plant is not simply caused by the natural occurrence of cochineal insect in the study area. Instead, the primary factors that led the destruction of the cactus plant are the responsible institutional actors' failure to (1) undertake pest risk assessment on the potential negative consequences of introducing the insect to the project area; (2) inform local farmers about the company, its purpose and the control measures they can take if cochineal

insects spread beyond the investment area; (3) monitor the company's illegal activities on cochineal farming and; (4) provide timely and effective solutions when the farmers raise their concern about the risk of cochineal.

The destruction of the cactus plant in the study area deserves the government's outmost attention. Although ineffective, farmers of the study area have used mechanical control measures to eradicate cochineal insects from their backyard. Therefore, the government should look for other alternative solutions, such as a biological control measure (i.e., introducing natural enemies (insects) that can attack cochineal), to eliminate cochineal from Southern Tigray. Research from Mexico indicates that several natural enemies (e.g. insects) can significantly reduce the cochineal population (Portillo & Vigueras, 1998). In Tigray, natural enemies were not found.

Thus, great effort should be applied to the identification and introduction of the right natural enemies that can successfully eradicate cochineal from Southern Tigray. This requires extensive research and careful experiment (risk analysis) to ensure that the introduction of the natural enemies will not cause unintended effect on other plants and animals. The government should allocate a sufficient budget for research on cochineal control. Studies show that countries such as Israel (Spodek et al., 2014), Morocco (Bouharroud et al., 2016) and Brazil (Torres & Giorgi, 2018) are facing similar challenges. Thus, it might be useful for the Ethiopian government to create a strong partnership with these countries to find lasting solutions to cochineal challenges. Local researchers in Ethiopia should be encouraged to work with researchers from these countries. This study recommends that, in the future, a pest risk analysis must be undertaken prior to the commencement of similar (related) investment projects in Ethiopia in order to avoid economic losses and ecological damage.

9.3.4 Vulnerability results from a lack of access to climate information

The findings also revealed that livelihood vulnerability results from the farmers' lack of access to seasonal weather forecasts and drought early warning information services. Related studies have made similar observations. For example, a study conducted by Harvey et al., (2014) in Madagascar indicates that the farmers' limited access to meteorological information is one contributing factor to livelihood vulnerability. Clearly, the farmers' lack of access to seasonal weather forecasts and drought early warning information services reflects the absence of effective institutional support mechanisms that provide a localized climate information service. Of course, the National Meteorological Agency (NMA) of Ethiopia provides climate information services through the radio and TV programs. However, the challenge is that many farmers in the study area do not own TV/radio. Hence, they cannot access the climate information. Moreover, even if accessible, the seasonal climate forecasts disseminated by the NMA are not location-specific to allow farmers to make the right farm-level adjustments. The provision of climate information can only be useful if the information is easily accessible, timely, accurate, and relevant to the end users (Muema et al., 2018; Rasmussen et al., 2015; Singh et al., 2018).

To protect the farmers' livelihoods from climate risks, improving the accessibility of seasonal climate forecasts and drought early warning information is a necessity in the area. First and foremost, the National Metrological Agency of Ethiopia should work towards improving the reliability and accuracy of climate forecasts in order to provide localized climate information that is tailored to the farmers' specific use. This can be achieved by increasing the availability of weather stations in rural areas that can supply localized climate data. Second, in addition to the existing climate communication mediums (i.e., TV and Radio), the National Metrological Agency of Ethiopia should use alternative channels in disseminating climate information to the farmers. For example, development agents, local authorities and religious leaders can be trained in the use and interpretation of climate forecasts in order to provide localized climate information service to the farmers. Informal institutions, such as *idir* and *equip* that already exist in the study area, can be used as another channel of communicating climate information.

9.3.5 Politics in the agricultural extension system and vulnerability

Another key factor that contributes to the vulnerability of the farmers and their livelihoods relates to the politics around the agricultural extension program. Although the stated objective of the agricultural extension program is to empower farmers and improve their livelihoods through the provision of agricultural advisory services (ATA, 2017), the findings of this study clearly suggest that the Ethiopian government is using the program mainly to exercise its political power over rural farmers. Berhanu & Poulton (2014) argue that the government's heavy investment in agricultural extension program is driven by the motive of maintaining the political authority of EPRDF through the control of the large rural population of Ethiopia. As observed in this and other similar studies in Ethiopia, the development agents are involved in promoting the government's political agenda (Elias, Nohmi, & Yasunobu, 2016; Leta et al., 2017; Planel, 2014). For this reason, most rural households in Ethiopia view the development agents as "government spokesmen" instead of facilitators of agricultural development programs (Kassa, 2003, p.78).

The DAs active involvement in non-extension activities such as political affairs is indeed a huge distraction from undertaking their regular task of transferring agricultural knowledge and technologies to the farmers. The DAs can play a key role in reducing the farmers' vulnerability to climatic risks through the promotion of locally appropriate technologies (e.g. drought-resistant crops) and farming practices that are resilient to climate conditions. However, the DAs engagement in political activities implies that they cannot provide the needed extension support that could enhance the farmers' adaptive capacity to climate change. As the findings revealed, the DAs involvement in politics has already affected their trustworthiness in the study area. Without doubt, this will have a negative impact on the farmers' active participation and willingness to adopt relevant climate-related adaptation technologies recommended by them.

With respect to the challenges of the agricultural extension program, the Ethiopian government should address some of the critical issues identified in this study. Most importantly, the program should not be used as a political instrument to control rural farmers. Development agents who provide extension services should be politically neutral so that farmers can freely talk about their day-to-day challenges. If the agricultural extension program is to improve smallholder farmers' livelihoods, it should serve farmers in areas where they need agricultural support. This requires improving the technical competencies of DAs through regular training and ensuring that a positive relationship exists between DAs and the farmers.

9.3.6 Socio-economic conditions influence vulnerability

The findings show that a final set of factors that increase livelihood vulnerability in the study area relates to socio-economic conditions, particularly poor rural infrastructure (e.g. roads, public transport, and electricity), limited market access and a lack of local employment opportunities. Other empirical studies conducted elsewhere in Africa also indicate how these broad socio-economic factors contribute to livelihood vulnerability in rural areas (Reid & Vogel, 2006; Tschakert, 2007; Harvey et al., 2014). In the present study, it was found that the majority of the farmers located in Ade Tela and Dalata villages have limited access to markets, owing to the poor condition of the village roads and the lack of public transport facilities. The livelihood implication of the farmers' limited access to markets is significant as it determines rural income (Reid & Vogel, 2006b). A lack of employment options in the local area is a further contributing factor to livelihood vulnerability. The implication of these findings is that to improve the livelihoods of vulnerable households, addressing broad development challenges is a crucial task. In the study area, investments that improve rural road infrastructure and the availability of transportation services are required to assist farmers to get their agricultural products to market and thereby improve their livelihoods. There is also a need to create employment opportunities in the area to ensure that the farmers have access to alternative livelihood options. For example, the government could work with the private sector in promoting Micro and Small enterprises (MSEs) in the study area, as this it has been shown to be an effective mechanism in enhancing employment opportunities and reducing poverty in urban areas of Ethiopia (B. A. Abebe & Desulie, 2018; Bereket, 2010). Overall, any policy measure that focuses on rural development in the area will not only improve the farmers' livelihoods, but it will also reduce the farmers' vulnerability to climate change and increase their capacity to adapt.

9.3.7 Difference in perceived vulnerability across geographic locations

In this study, the overall survey results suggest that a climatic stressor – drought – is the most significant contributor of livelihood vulnerability compared to the non-climatic stressors. This result was expected given the farmers' exposure to severe drought in 2015 (i.e., one year before these data were collected). When the results are disaggregated by geographic locations, it was found that Hade Alega and Keyeh Tekely villagers still regard a climate-linked stressor (drought) to be the most significant contributor of livelihood vulnerability. However, for Ade Tela and Dalata villagers land grabbing, a non-climatic stressor, is the most significant driver of livelihood vulnerability than drought. The four villages are part of one peasant association, yet it is interesting to see how perception of the most important vulnerability factor differs even among closely adjacent rural farmers. These findings could have been masked if this study did not take geographical variations into consideration when undertaking the vulnerability assessment, and also if the farmers in the four villages were treated as a homogeneous society. These findings have important implications for vulnerability research.

These findings underscore the importance of paying closer attention to local-level factors that produce vulnerability in a specific-location, as these factors can be ignored or missed in national or regional level vulnerability assessments. Other scholars have also recommended the importance of conducting place-based vulnerability assessments as the drivers of vulnerability vary from location to location (Schröter et al.,2005; Cutter, et al., 2003; Frazier, 2012; Miller & Bowen, 2013). The information gained through place-based vulnerability assessments will allow decision-makers and stakeholders to identify and target communities that are vulnerable to particular stressors and provide specific solutions that can reduce their vulnerabilities.

9.3.8 The role of global forces in influencing vulnerability at the local level

The conditions that produce vulnerability in rural communities may have contributing forces at the global scale. For example, some of the key global drivers that are attributed to the current wave of land grabbing phenomena in developing countries such as in Ethiopia, are the increasing global demand for food, biofuel and minerals (Cotula et al., 2009; Leonard & Keeley, 2009; Zoomers, 2010; Davis & Odorico, 2011). In Ethiopia, the government has played a key role in attracting foreign investors and causing the land grabbing issues in the country. However, the global drivers (e.g. the increasing global food demand) could also motivate foreign investors to rush and buy huge tracts of land in the country. Hence, the factors that are contributing to land grabbing and threatening the farmers' livelihoods in the study area can be linked to these global forces.

To give another example, Ethiopia's input-related agricultural policies – including the imposed fertilizer distribution to the smallholder farmers, are influenced by the Green Revolution push in Africa that is largely supported by international donors (e.g. USAID, UK's DFID, Bill and Melinda Gates Foundation, Rockefeller Foundations, Yara foundation) (Daño, 2007; ACB, 2014). This implies that externally driven policies or initiatives directly or indirectly contribute to the vulnerability of smallholder farmers by influencing national policies in poor countries like Ethiopia. It is also widely recognized in the vulnerability literature that large-scale forces that operate at the global scale interact with national-level policies to increase the vulnerability of communities at the local level (Adger & Kelly, 1999; Leichenko & O'Brien, 2002; O'Brien et al., 2004).

9.3.9 Government policies reinforce maladaptation

Some scholars argue that strategies and policies should be assessed for their risk of maladaptation if they are explicitly undertaken to address the risk of climate change (Barnett & O'Neill, 2010; Juhola et al., 2016). This perspective is too narrow and limiting since broad development decisions or policies that are unrelated to climate change (or climate change is not their primary focus), can, directly and indirectly, reinforce maladaptation (Jones et al., 2015). The findings of this study suggest that the agricultural policy (fertilizer) and the development policy related to the large-scale farming in Ethiopia are two current examples that increase the risk of maladaptation. Jones et al., (2015) argue that a strategy can be maladaptive not only when the strategy increases climate risks, but also if it has an adverse impact on people's livelihoods and their well-being. In this study, both policies are maladaptive and carry

the risk of maladaptation due to the negative influence they have on farmers' lives and livelihoods. In addition, both policies encourage maladaptation because they tend to exacerbate the farmers' vulnerability to climate change by undermining their ability to deal with its adverse impacts through various adaptation measures. For example, the agricultural policy is exposing many farmers to economic risks and this would definitely constrain their ability to taking climate change adaptation strategies that require financial investment. In addition, farmers whose farmlands are grabbed for the large-scale farming purpose can no longer take farm-related adaptation measures (e.g. crop diversification strategies), that can potentially reduce their vulnerability to climate risks. Landlessness can force these farmers to engage in strategies that are maladaptive (e.g., migration).

The development policy that encourages large-scale farming in Ethiopia can be considered maladaptive because it also contributes to the worsening of climate change. As the findings of this and other similar studies (Moreda, 2017; Rahmato, 2011) in Ethiopia indicate, this policy measure typically involves clearing of forests in order to lease out huge tracts of land for large scale farming purposes. However, the role that forests play in mitigating the effects of climate change is well recognized (Jackson et al., 2008; Ellison et al., 2017). When forests are damaged, they can influence and alter local, regional and even global climates (Betts et al., 2008; Bradshaw, 2012; Nobre et al., 2016). Studies are now linking large-scale land acquisitions (or land grabs) with worsening of climate change due to the increasing problem of forest losses (Seo & Rodriguez, 2012; GRAIN, 2016).

9.4 Autonomous and planned adaptation responses

9.4.1 Various factors motivate autonomous adaptation actions

Regardless of the motivation, the findings show that at the household level, farmers of this study area undertake various adaptation practices that involve non-farm/off-farm and farm-related activities to sustain their livelihoods. Both non-farm (e.g. migration, petty trade, wage employment) and farming strategies (e.g., crop diversification) reported in this study are widely practiced by smallholder farmers across rural Africa (Liyama et al., 2008; Rider et al., 2001) and Asia (Martin & Lorenzen, 2016; Rahut et al., 2014).

Looking at the type of adaptation strategies practiced across the four villages, the study revealed some interesting findings. It was found that Hade Alga and Keyeh Tekley villagers are more engaged in farm-related adaptation strategies, while Ade Tela and Dalata villagers

participate more in non-farm adaptation measures. There is one possible explanation for the difference in the type of adaptation strategies implemented across the four villages. It could be that, since most villagers in Ade Tela and Dalata have lost their farmland due to the land grabbing phenomena, they do not have the resource capacity to diversify into farm related adaptation options.

Unlike previous studies that have documented farm households' adaptation responses to climate-related factors (Bryan et al., 2009; Silvestri et al., 2012; Le Dang et al., 2014; Kabir et al., 2017), the results of this study demonstrate that farmers are adapting to climatic and non-climatic factors. The findings are broadly consistent with a few other studies (Eakin et al., 2014; Ahmed et al., 2016; Burnham & Ma, 2018), that have reported adaptation actions driven by both climatic and non-climatic forces. The results of this case study support the argument that: 'adaptation always has, and arguably should, refer to more than just responses to climate change'(Sabates et al., 2008:53).

The results show that through migration, some farmers have tried to adapt to droughts; which suggests that they have directly responded to climate-related factors. However, other farmers, for example, used migration mainly to adapt to resource scarcity (e.g., land shortages/lack of access to farmland). In other words, resource scarcity is one of the driving forces for smallholder farmers' adaptation actions. This finding is consistent with those of Forsyth & Evans (2013) who found resource scarcity, particularly agricultural land, to be a trigger for autonomous adaptations in Karen villages in Thailand.

In terms of agricultural adaptation practices made, some farmers changed the crop types they use as a way to adapt to the climate risks (e.g., from non-drought tolerant crops to highly drought resistance crops). Others used the strategy to minimize the occurrence of pests and diseases which are prevalent in some crops than in others, and to respond to soil fertility issues. These results reflect that climate-related reasons are not always key motivating factors behind changes made in farming practices. These results correspond well with a previous study which showed pests, diseases and soil conditions in prompting changes in farming operations beyond climate factors (Smit et al., 1996).

In response to the shortening of growing seasons due to inadequate rainfall, the findings indicate that some farmers have started using improved seeds that can mature faster with less water. This result clearly shows the farmers' adaptability to a changing climate. On the other

hand, the findings provide evidence that some farmers adopted improved seeds because of their high demand in agricultural markets. This implies that, beyond a climate-related reason, market is an important driving force in farmers' adaptation decision making.

Similar to what has been reported in previous studies (Alemayehu & Bewket, 2017; Belay et al., 2017), adjustment in planting dates is one of the low cost and common adaptation strategies farmer of the study area use in response to erratic rains. However, interestingly, the results revealed that this strategy is practiced in the study area not only for climate purpose, but also to manage market uncertainty and/or to take market advantage.

On the one hand, some of the adaptation measures reflect the farmers' vulnerability to climatic and non-climatic risks. For instance, the findings have indicated farmers' vulnerability to drought, market, and biotic risks and the way they responded to those risks through crop diversification. On the other hand, some of the adaptation strategies suggest farmers' responsiveness to opportunities. For example, the findings have shown that some farmers exploit the local small-scale irrigation facilities to increase their income. Other farmers experiment with new improved seed varieties to enhance crop yield and to take market advantages. Together, these findings highlight that farmers are not simply passive victims of the risks posed by climate and non-climate factors. This study demonstrates that farmers rationally and actively respond to risks as well as opportunities. The responses of farm households suggest that some of the strategies they use are geared towards building *generic* capacities (e.g., using irrigation to increase income level); while some are directed at building *specific* capacities to manage climate risks (e.g., adoption of drought-tolerant improved seeds) (Eakin et al., 2014; Singh et al., 2018). Overall, the results of the present study confirm other research results that discuss about the role of climatic and non-climatic factors in smallholder farmers adaptation decision making (Adger et al., 2005; Mertz et al., 2009).

9.4.2 Inadequate planned adaptation interventions at the local level

A number of scholars emphasize the need for planned adaptation interventions as autonomous adaptation conducted at an individual level is insufficient to effectively reduce the risk of climate change (Deressa et al., 2009; Mertz et al., 2009; Bryan et al., 2013; Tambo & Abdoulaye, 2013; Ford et al., 2015). In the study area, it was found that except for the natural resource management and the weather index insurance (WII) programs, other interventions that support smallholder farmers with their adaptation needs simply do not exist. At government level, although there are national and regional climate change adaptation policies in Ethiopia,

the findings of this study suggest that there is a gap in the translation of the policy documents into concrete adaptation action at the local level. It was found that financial constraints, weak institutional coordination, low technical capacities and limited participation of local actors in the policy formulation process constrain effective adaptation policy implementation at the local level. These constraints are similar to what has been reported in other regions of Africa (Ampaire et al., 2017; Edmond et al., 2015; Mburu, 2017; Okolo et al., 2015).

The results emphasize that the Ethiopian government should play a key role in addressing the constraints of adaptation policy implementation, in order to support farmers with their adaptation efforts. To enable implementation of adaptation policies at local levels, effective decentralization of climate finance is needed. The government must ensure that financial resources are transferred from the national to the local level. This is a necessary step to reach communities that are most vulnerable to climate change. To ensure sufficient delivery of financial resources at local levels, substantial action should be taken in mobilizing climate funds from domestic and external sources. There is also a need to overcome communication and coordination challenges that exist between actors responsible for implementing climate change adaptation policies in Ethiopia. These challenges can be addressed by carrying out regular national (regional) workshops on the need for climate change adaptation actions and the roles and responsibilities of relevant institutions in executing them. In addition, great investment is required in developing the technical capacity of local level staffs on climate change issues. National level staffs should provide regular technical support to lower level staffs on climate change causes, its impacts and solutions so that the adaptation implementation process will be easy and fast. It is also useful to translate the existing adaptation policies into a language local actors can understand.

9.5 Avoiding the risk of maladaptation

The findings in Chapter 7 and 8 revealed the existence of maladaptation risks resulting from the implementation of autonomous adaptations by farmers as well as from the existing planned adaptation interventions by government and NGOs, respectively. From the farmers' current adaptation practices, the findings highlight that migration, the use of irrigation and the collection and selling of firewood, have maladaptive outcomes of more than one type. These findings confirm the argument that not all implemented adaptation actions are effective or successful (Adger et al., 2005; Rahman & Hickey, 2019). For example, this study revealed that migration as an adaptation measure has benefits and risks. Overall, it was shown that remittance

provides economic benefits to the migrant households but the loss of labour for migration has a knock-on effect on farming and the strategy often exposes female domestic migrants in the Middle East to various forms of abuses that affect their well-being. These findings imply that, in the long term, the unintended negative outcomes of migration might be greater than its benefits. Hence, the government should take long-term proactive measures to address the unintended (maladaptive) outcomes associated with the farmers' migration strategy.

Given that climate-induced migration is very common in the study area and in other regions in Ethiopia (Kassie et al., 2013; Kidane at al., 2018). The government should strive towards creating non-farm employment options that are less sensitive to climate effects, particularly for the rural youth. In addition, since a lack of farmland access and/or land shortages are big push factors for migrants, the government can limit migration flow and avoid maladaptation risks by providing farmers with access to this basic livelihood asset. As a short-term strategy, one way to avoid the risk of maladaptation from migration is to implement awareness creation campaigns that inform rural young women (i.e., prospective migrants) about the risks of conducting migration in the Middle East. For those female domestic migrants who are already working in the destination countries, the government should collaborate with international human rights organizations to promote and protect their rights.

This study also highlights that the risk of maladaptation is higher in using irrigation as an adaptation strategy, as the strategy requires high investment costs compared to alternative adaptation options (Barnett & O'Neill, 2010). This risk of maladaptation is higher when farmers get low profit due to local market risks or when their agricultural products fail because of plant diseases or frosts. Given that the high investment costs are associated with electricity, water usage and maintenance costs required in motorized irrigation schemes, the government should introduce low-cost small-scale irrigation technologies. In addition to developing low-cost irrigation technologies, the government should focus on market development (e.g., linking farmers with potential market centres in towns and cities). Otherwise, the farmers' use of irrigation practice may not bring sufficient economic benefits or it may not even cover the investment costs. To avoid or at least minimize the risk of maladaptation from the farmers' current irrigation practice, investment in the development of market infrastructure is critical.

The study also suggests that conflict is one of the maladaptive outcomes resulting from the farmers' current use of irrigation as an adaptation strategy. A similar case of maladaptive outcome has been reported from Ghana (Antwi-Agyei et al., 2018). In this study, the results

indicated that conflict has become a common problem among irrigation users, mainly because of the water committee leaders' lack of accountability in allocating the limited irrigation water resources. These findings suggest that the existing local water committees are weak in governing the water resources and that conflict resolution mechanisms are not in place at the local level. Irrigation is a recent adaptation practice in the study area. However, since the Ethiopian government is aiming to expand small-scale irrigation in rural areas as part of its growth and transformation plan (NPC, 2016), conflict may likely intensify among irrigators in the absence of strong local bodies (water committees) that govern the water resource. Therefore, before investing heavily in irrigation development in areas like Raya Azebo, the government's first task should be to establish accountable irrigation committees/associations at the local level. These committees should receive continuous support in developing effective by-laws for improved irrigation resource management. To avoid conflicts that may arise due to water resource competition, the government should provide on-going training on conflict management mechanisms for both water committee members and irrigation users. In addition, the government should support and strengthen the existing traditional/indigenous conflict resolution mechanism (*Shimgelena*), which is mediated by religious or traditional old leaders in many parts of rural Ethiopia.

The study suggests that the government-led natural resource management program is reinforcing maladaptation rather than facilitating adaptation at the local level. The mandatory nature of the program and the lack of time flexibility in program implementation divert the farmers' labour from autonomous adaptation actions. The time overlap between the implementation period of the NRM activities (e.g., soil and water conservation), and that of the farming season in the study area clearly suggests that the government simply follows a top-down approach in the planning and implementation of the natural resource management activities at the local level. For the NRM program to be successful as well as to avoid maladaptive outcomes in the future, at first, farmers' participation in the natural resource management activities should be on a voluntary basis.

Second, the Ethiopian government should adopt a bottom-up approach in NRM programs, by actively involving farmers in the planning as well as implementation phases of the natural resource management activities at the local level. For example, involving farmers in the planning phase of the NRM program would enable them to execute the NRM tasks in the right times, without affecting their own autonomous adaptation actions. Chirenje et al., (2013) argue

that NRM programs would be effective and sustainable when local communities actively participate in the planning of the resource they manage. Otherwise, local communities may lack motivation and sense of ownership if the natural resource management activities are externally initiated and imposed on them (Measham & Lumbasi., 2013; Ariti et al., 2018). Third, even if the NRM program will have long-term benefits for the local area, farmers should gain short-term benefits in cash or kind for their labour and time investment in NRM activities. This is very important given that most farmers are poor and chronically food-insecure due to their vulnerability to various climatic and non-climatic shocks. Providing the farmers with economic incentives (compensation) can greatly contribute towards effective NRM outcomes and also avoid program failure (Measham & Lumbasi., 2013; Gruber, 2010).

The results of this study suggest that the existing NGO-led weather index insurance program (WII) in the study area promotes maladaptive outcomes by exposing smallholder farmers to economic risks. As indicated in Chapter 8, although the whole concept of the insurance program is to compensate farmers for their loss when they experience drought risk, farmers do not receive payouts from the insurance company when they should, due to the prevalence of basis risk challenges in the WII product design. This finding underscores the need to overcome the basis risk problem before promoting weather index insurance to poor farmers in developing countries. Insurance designers should address the problem of basis risk through, for example, complementing remotely sensed precipitation datasets (i.e., satellite technology) with ground-level verification mechanisms. This may include: (1) collaborating with climate information providers, such as the National Meteorological Agency of Ethiopia, to validate the satellite-based rainfall readings with station observations; (2) introducing cost effective rain gauge instruments (plastic gauges) at farm level that can be used by insurance purchasers, so that they can provide additional location-specific rainfall records; (3) using district-level crop assessment could also provide important information about the level of crop damage incurred by farmers due to climate factors.

The current weather index insurance program (WII) that is being promoted in the study area might also be increasing maladaptation risk, as it discourages crop diversity by covering only specific types of crops in the study area. Skees (2008) argues that insurance products should not be a disincentive to the policyholder's choice of adaptation strategies. In the long run, if the program promotes only *teff* and sorghum crops, it will undermine the farmers' autonomous adaptation options (i.e., crop diversification), and it may lead to monoculture as observed in

Mexico (Fuchs & Wolff, 2011). Although there is no enough evidence to suggest that the current insurance program discourages other adaptation strategies in the case study, other studies indicate that insurance discourages the use of on-farm conservation practices (Capitanio et al., 2015; Schoengold et al., 2015), and investment in irrigation technologies (Fuchs & Wolff, 2011). To avoid the risk of maladaptation, the current insurance program that is being implemented in the study area should promote sustainable practices by encouraging rather than discouraging agro-biodiversity.

9.6 Conclusion

This chapter discussed the findings of this study in relation to other empirical studies done in and beyond Ethiopia. The chapter has also discussed the broader implications of the key findings for climate communication efforts and provided specific recommendations to the Ethiopian government concerning practical issues identified in this study. The findings demonstrate the influence of various socio-psychological factors in determining farmers' risk perceptions of climate change, suggesting the need to consider these factors in climate communication efforts. The study argues that farmers are vulnerable to climatic and non-climatic stressors and they are adapting by responding to stressors and opportunities, and thus climatic and non-climatic factors need to be given equal emphasis in vulnerability and adaptation interventions in rural Ethiopia and beyond.

Chapter 10: Conclusion

10.1 Introduction

This study investigated perceptions, vulnerability and adaptation to climate change in the context of non-climatic stressors, focusing on smallholder farmers in Raya Azebo district, Tigray region of Ethiopia. The following research questions were raised to achieve this aim: (1) How do smallholder farmers perceive climate change and what factors influence their risk perceptions?; (2) what are the climatic and non-climatic factors that contribute to vulnerability and how do they affect the farmers' lives and livelihoods? ; (3) What are the different types of adaptation actions employed by smallholder farmers and what motivates those actions? (4); what planned adaptation interventions exist to support farmers to adapt to climate change and what are the barriers (if any) that constrain effective adaptation policy implementation at the local level?; (5) Do the existing planned adaptation initiatives and farmers' adaptive strategies carry the risk of maladaptation? If yes, how can maladaptation be prevented? The study investigated these questions by adopting a mixed-method case study approach. Both qualitative and quantitative data collection methods that involved a survey of 400 smallholder farmers, focus group discussions, participatory rural appraisal techniques and interviews were employed to answer the research questions posed in this study. The study integrated a contextual vulnerability framework, the concepts of adaptation and maladaptation and theories of risk perceptions to guide the data collection and analysis.

This chapter concludes the thesis. A summary of the key findings and their implications for policy and practice is presented in section 10.2 Section 10.3 identifies the study's limitations and provides recommendations for future research opportunities.

10.2 Summary of key findings and their implications

The study illustrates smallholder farmers in this case study do indeed perceive climate change but their understanding of its cause differs from the scientific explanation. The cause of climate change is widely believed to be God's punishment. This raises the need to bridge the gap between the scientific explanation of the cause of climate change and that of smallholder farmers' understanding of its cause. The National Meteorological Agency of Ethiopia in collaboration with religious leaders can play a key role in bridging this gap through improved communication of climate change causes to the local public using carefully crafted messages and dialogues. Lower psychological distance was linked to higher levels of climate change concern. This finding implies that climate communication techniques framed to reduce psychological distance can be effective in increasing public engagement with the issue of climate change. This study further revealed that various socio-psychological factors shape farmers' risk perceptions of climate change, suggesting the need to design communication strategies in light of these complex and multidimensional factors.

The case study demonstrates that in Raya Azebo district of Ethiopia, livelihood vulnerability is the result of a complex synergy between climatic and non-climatic stressors. In addition to climate-linked stressors such as drought, the study found that non-climatic stressors including agricultural policies (imposed fertilizer adoption), destruction of cactus plant, land grabbing, a lack of access to climate information, ineffective agricultural extension system, inadequate rural infrastructure and poor agricultural markets negatively affect smallholder farmers' lives and livelihoods. These non-climatic stressors were also found to increase the farmers' vulnerability to climate change and undermine their capacity to adapt its impacts.

The findings of this study also revealed that farmers are taking non-farm and farm-related adaptation strategies, and various climatic and non-climatic factors motivate their adaptation actions. Some of the key non-farm adaptation strategies implemented by farmers included migration, wage employment, selling local food and drinks, and owning small shops, while the farm-related adaptation strategies consisted of crop diversification, changing planting dates and using irrigation. It was found that drought, rainfall variability, market conditions, land scarcity, labour shortage, soil fertility issue, crop diseases motivated the farmers' adaptation actions.

The results of this study further revealed a deficit in planned adaptation efforts by the state and NGOs at the local level. This study found just only two planned adaptation interventions – the natural resource management program and the weather index insurance program, which are being implemented by the government and NGOs respectively. At the state level, despite the progress made in the formulation of various national and regional adaptation policies, the Raya Azebo case revealed that actual adaptation actions targeted at supporting smallholder farmers at the local level are still very limited. Results show that financial constraints, poor institutional coordination, low technical capacities, and limited inclusion of local actors in the policymaking process, combined to constrain the implementation of adaptation policies and strategies on the ground.

Finally, this study revealed the existence of maladaptation risks that arise from the implementation of some of the autonomous adaptation strategies (i.e., migration, firewood extraction and irrigation), and from the planned adaptation interventions carried out by the government and NGOs (i.e., the natural resource management and weather index crop insurance programs). Concerning the autonomous adaptation strategies, migration and the use of irrigation practice were shown to increase the vulnerability of the farmers, while the extraction of firewood mainly contributed to negative environmental outcomes. The findings also show that the two planned adaptation interventions contributed to the vulnerability of the targeted actors (i.e., the farmers).

Overall, this study argued that climate change is not the only factor that produces vulnerability and smallholder farmers are not just adapting to climatic risks alone. Rather, they are responding to non-climatic stressors as well. In most of the existing adaptation policy documents of Ethiopia, vulnerability is understood to be a product of climate change rather than the combined effect of other socio-economic, political, institutional, and policy-related factors. However, such climate change-focused understanding of vulnerability may draw attention away from other pressing issues (i.e., non-climatic stressors) that significantly affect the farmers' lives and livelihoods.

This argument is not meant to ignore or downplay the importance of tackling climate change issues. Rather, it is to underscore the importance of addressing the challenge of climate change in conjunction with other non-climatic stressors in order to effectively reduce vulnerability and improve the livelihood outcomes of rural communities in Ethiopia and beyond. Adaptation programs and projects are likely to be successful if the non-climatic drivers that produce

vulnerability at the local level are also considered in the formulation of adaptation policies in Ethiopia and elsewhere in Africa. Otherwise, initiatives and projects that focus on addressing a single factor about climate change may become ineffective or even maladaptive when in reality the conditions farmers experience are the combined effects of climatic and non-climatic stressors.

The findings emphasize the need for the Ethiopian government to fund and mainstream climate change adaptation actions into national development programs. While it is fundamentally the responsibility of the Ethiopian government to facilitate climate change adaptation at the local level, this study recommends that much support is needed from NGOs, the private sector and development agencies to meet smallholder farmers' adaptation needs in the face of changing climate. The findings of this study also highlight the need to screen the risk of maladaptation before making any significant resource investment towards the implementation of adaptation projects. The risk of maladaptation needs to be carefully considered and identified during the formulation phase of adaptation policies and prior to the implementation of projects to avoid unintended negative outcomes on the targeted smallholder farmers as well as the environment.

10.3 Limitations and further research

This study mainly focused on investigating the underlying factors that contribute to vulnerability and answering how these factors influence the farmers' lives and livelihoods in different forms. While such investigation is useful, the study did not quantitatively measure the state of vulnerability itself to identify the most vulnerable groups among the studied rural communities. Hence, further study is required in this area to determine the most vulnerable groups of farmers within rural communities. For example, future studies should concentrate more on investigating which segments of smallholder farmers (e.g., which gender, age and wealth groups) are the more vulnerable and why. Such an investigation will provide policy makers and practitioners with useful information on how to best target and prioritize the most vulnerable groups at the local level.

The dynamic and contextual nature of vulnerability is widely recognized in the vulnerability literature. This implies that information collected from one particular location within a specific time bound will not adequately capture the complexity of vulnerability and thus it cannot fully inform policies aimed at vulnerability reduction. Due to time and budget constraints, this study focused only in one case study region in Ethiopia. It is recommended that future studies should replicate the research approach and methods applied in this thesis in other regions of Ethiopia.

This will contribute to a better understanding of vulnerability in the climate change research field and it can guide policymaking in Ethiopia.

One important insight that emerged from this study is that not all autonomous adaptation strategies implemented by smallholder farmers make them resilient to climate change impacts, as some of them carry the risk of maladaptation. Hence, future studies should not simply document the type of adaptation strategies adopted by smallholder farmers but focus more on assessing which adaptation strategies are actually effective in building their resilience to climate change and which ones are maladaptive. Such a focus will assist practitioners to take lessons from autonomous adaptations and thereby implement planned adaptation interventions that will enhance the resilience of smallholder farmers by avoiding the risk of maladaptation. For example, participatory research methods are particularly suitable in understanding individuals' and communities' resilience (Buikstra et al., 2010; Ross & Berkes, 2014). Hence, future research should consider adopting a more participatory approach to explore these topics.

In this study, one of the issues identified by regional and district level officials concerning barriers to planned adaptation implementation is that climate finances (particularly international funds) are concentrated at the national level and do not trickle down to the local levels to support smallholder farmers to adapt to climate change. It is a known fact that the country receives adaptation funds from international agencies. However, it is not known to what extent the national government delivers the external financial resources to the local actors to support the implementation of actual adaptation actions and whether the international agencies undertake monitoring and evaluation to ensure the effective delivery of climate finance at the local level. This study was unable to answer these important questions and hence future studies should investigate how and for what purposes national level actors spend international adaptation funds in Ethiopia. Such an investigation may yield useful information on ways of effectively channelling climate finance to the local level actors, so that they can effectively use the resource for the intended purpose of improving the local adaptation capacities of smallholder farmers. In general, since the focus of this study was autonomous adaptation by farmers in the Tigray region, future studies need to research further the role of NGOs, private sectors, and international agencies in facilitating climate change adaptation efforts in Ethiopia.

References

Abebe, B. A., & Desulie, B. S. (2018). The roles of micro and small enterprises in urban household livelihoods: The case of Ambo town, Ethiopia. *International Journal of Innovative Research and Development, 7*(1), 239-248.

Abebe, G. (2017). Long-term climate data description in Ethiopia. *Data in brief, 14*, 371-392.

ACB (The African Centre for Biosafety). (2014). *The political economy of Africa's burgeoning chemical fertilizer rush*. Retrieved November 11, 2016, from https://acbio.org.za/wp-content/uploads/2014/12/Fertilizer-report-201409151.pdf

Adal, Y. (2002). *Review of landholding systems and policies in Ethiopia under the different regimes*. Ethiopian Economic Policy Research Institute Working Paper No.5. Retrieved October 20, 2015, from http://www.eeaecon.org/sites/default/files/working_papers/EEA_working_Paper_2002/WP%205%202002_Yigremew%20Adal_Review%20of%20Landholding%20Systems%20and%20Policies%20in%20Ethiopia%20under%20the%20Different%20Regimes.pdf

Adem, A., & Bewket, W. (2011). *A climate change country assessment report for Ethiopia*. Retrieved June 10, 2016 from https://www.academia.edu/5357744/A_Climate_Change_Country_Assessment_Report_for_Ethiopia_Submitted_to_Forum_for_Environment_on_behalf_of_ECSNCC_By_Epsilon_International_R_and_D_Alebachew_Adem_and_Woldeamlak_Bewket_

Adger, W. N. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. *World development, 27*(2), 249-269.

Adger, W. N., Arnell, N. W., & Tompkins, E. L. (2005). Successful adaptation to climate change across scales. *Global environmental change*, *15*(2), 77-86.

Adger, W. N. (2006). Vulnerability. *Global environmental change, 16*(3), 268-281.

Adger, W. N., & Kelly, P. M. (1999). Social vulnerability to climate change and the architecture of entitlements. *Mitigation and adaptation strategies for global change, 4*(3-4), 253-266.

Adger, W. N, Agrawala, S, Mirza, M. M. Q., Conde, C., O'Brien, K., Pulhin J., Pulwarty R, Smit, B., Takahashi T. (2007). Assessment of adaptation practices, options, constraints and capacity. In: Parry, ML. Canziani, O.F, Palutikof JP (Eds). Climate Change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, pp 717–743. Retrieved August 15, 2016, from https://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter17.pdf

Adger, W. N., Arnell, N. W., & Tompkins, E. L. (2005). Successful adaptation to climate change across scales. *Global Environmental Change, 15*(2), 77-86.

Adger, W. N., Barnett, J., Brown, K., Marshall, N., & O'Brien, K. (2012). Cultural dimensions of climate change impacts and adaptation. *Nature Climate Change, 3*(2), 112–117.

Adger, W. N., Brooks, N., Bentham, G., Agnew, M., & Eriksen, S. (2004). *New indicators of vulnerability and adaptive capacity*. Technical Report 7. Norwich. Tyndall Centre for Climate Change Research. Retrieved April 15, 2017, from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.112.2300&rep=rep1&type=pdf

Adger, W. N., Huq, S., Brown, K., Conway, D., & Hulme, M. (2003). Adaptation to climate change in the developing world. *Progress in development studies, 3*(3), 179-195.

Adger, W. N. (2000). Social and ecological resilience: are they related?. *Progress in human geography, 24*(3), 347-364.

Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockström, J. (2005). Social-ecological resilience to coastal disasters. *Science, 309*(5737), 1036-1039.

African Development Bank group. (2018). *African Economic Outlook Country Note*. Retrieved 16 January, 2017, from https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/African_Economic_Outlook_2018_-_EN.pdf

Agard, J., E.L.F. Schipper, J. Birkmann, M. et al. (2014). IPCC, 2014: Annex II: Glossary. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate (pp. 1757-1776). Cambridge University Press, Cambridge, United Kingdom and New York, NY. Retrieved 18, January 2016, from https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-AnnexII_FINAL.pdf

Ahmed, A., Lawson, E. T., Mensah, A., Gordon, C., & Padgham, J. (2016). Adaptation to climate change or non-climatic stressors in semi-arid regions? Evidence of gender differentiation in three agrarian districts of Ghana. *Environmental Development, 20,* 45–58.

Akerlof, K., Maibach, E. W., Fitzgerald, D., Cedeno, A. Y., & Neuman, A. (2013). Do people "personally experience" global warming, and if so how, and does it matter? *Global Environmental Change, 23*(1), 81-91.

Alem, Y., Maurel, M., & Millock, K. (2016). *Migration as an Adaptation Strategy to Weather Variability: An Instrumental Variables Probit Analysis*. Working Paper No. 665. Retrieved March 15, 2016, from https://gupea.ub.gu.se/bitstream/2077/44636/1/gupea_2077_44636_1.pdf

Alemayehu, A., & Bewket, W. (2017). Determinants of smallholder farmers' choice of coping and adaptation strategies to climate change and variability in the central highlands of Ethiopia. *Environmental Development, 24,* 77-85.

Alemayehu, A., & Bewket, W. (2017). Smallholder farmers' coping and adaptation strategies to climate change and variability in the central highlands of Ethiopia. *Local Environment, 22*(7), 825-839.

Alexander, C., Bynum, N., Johnson, E., King, U., Mustonen, T., Neofotis, P., & Vicarelli, M. (2011). Linking indigenous and scientific knowledge of climate change. *Bio Science, 61*(6), 477-484.

Ambaye, D. W. (2012). *Land rights in Ethiopia: Ownership, equity, and liberty in land use rights.* In FIG Working Week. Retrieved September 16, 2017, from https://www.fig.net/resources/proceedings/fig_proceedings/fig2012/papers/ts02d/TS02D_ambaye_5521.pdf

Ampaire, E. L., Jassogne, L., Providence, H., Acosta, M., Twyman, J., Winowiecki, L., & Van Asten, P. (2017). Institutional challenges to climate change adaptation: A case study on policy action gaps in Uganda. *Environmental Science & Policy, 75,* 81-90.

Antwi-Agyei, P., Dougill, A. J., Stringer, L. C., & Codjoe, S. N. A. (2018). Adaptation opportunities and maladaptive outcomes in climate vulnerability hotspots of northern Ghana. *Climate Risk Management, 19,* 83–93.

Antwi-Agyei, P., Quinn, C. H., Adiku, S. G. K., Codjoe, S. N. A., Dougill, A. J., Lamboll, R., & Dovie, D. B. K. (2017). *Perceived stressors of climate vulnerability across scales in the Savannah zone of Ghana: a participatory approach. Regional environmental change, 17*(1), 213-227.

Arbuckle Jr, J. G., Morton, L. W., & Hobbs, J. (2015). Understanding farmer perspectives on climate change adaptation and mitigation: The roles of trust in sources of climate information, climate change beliefs, and perceived risk. *Environment and behavior, 47*(2), 205-234.

Ariti, A. T., van Vliet, J., & Verburg, P. H. (2018). Farmers' participation in the development of land use policies for the Central Rift Valley of Ethiopia. *Land Use Policy, 71,* 129-137.

Assan, E., Suvedi, M., Schmitt Olabisi, L., & Allen, A. (2018). Coping with and adapting to climate change: a gender perspective from smallholder farming in Ghana. *Environments, 5*(8), 86.

ATA. (2017). Ethiopia's agricultural extension strategy: Vision, systemic bottlenecks and priority interventions. Retrieved February 15, 2019, from http://compendium.g-fras.org/component/phocadownload/category/31-countries.html?download=614:ethiopia-s-agricultural-extension-strategy-draft

Ayanlade, A., Radeny, M., & Morton, J. F. (2017). Comparing smallholder farmers' perception of climate change with meteorological data : A case study from southwestern Nigeria. Weather and *Climate Extremes*, *15*, 24–33.

Aydogdu, M. H., & Yenigün, K. (2016). Farmers' risk perception towards climate change: A case of the GAP- Sanlıurfa region, Turkey. *Sustainability*, *8*(8), 806.

Badmos, B. K., Sawyerr, H. O., Awopeju, S. O., Salako, G. A., & Abdulrasheed, A. A. (2017). The Socioeconomic/Demographic Determinants of Public Perception about Climate Change in Ekiti State of Nigeria. *Journal of Geography, Environment and Earth Science International*, *9*, 1-10.

Ballantyne, A. G. (2016). Climate change communication: what can we learn from communication theory? *Wiley Interdisciplinary Reviews: Climate Change*, *7*(3), 329-344.

Barbour, R. (2007). *Doing focus groups*. London: SAGE.

Barnett, J., & O'Neill, S. (2010). Maladaptation. *Global Environmental Change*, *2*(20), 211–213.

Barnett, J., & O'Neill, S. J. (2013). Minimizing the risk of maladaptation. *Climate Adaptation Futures*, 87-93.

Baxter, J. (2016). Case studies in qualitative research. In L. Hay (ed.), *Qualitative research methods in human geography* (4th ed., pp., 130 -146). Ontario: Oxford University Press.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, *13*(4), 544–559.

Bebbington, A. (1999). Capitals and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty. *World development*, *27*(12), 2021-2044.

Berkes, F. (2007). Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. *Natural hazards*, *41*(2), 283-295.

Berkes, F., & Jolly, D. (2002). Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. *Conservation ecology*, *5*(2), 18.

Blair, E. (2015). A reflexive exploration of two qualitative data coding techniques. *Journal of Methods and Measurement in the Social Sciences*, *6*(1), 14-29.

Belay Tesfay and Bustamente Antonio. (2010). State of cochineal introduction and production in Tigray. In A. Nefzaoui, P. Inglese and T. Belay (Eds.), Cactus net Newsletter special issue on Improved Utilization of Cactus Pear for Food, Feed, Soil and Water Conservation and other Products in Africa (Issue 12, pp.167-175). Retrieved from May 17, 2017, from https://www.researchgate.net/profile/Tesfay_Belay/publication/282204744_Improved_utilization_of_cactus_pear_for_food_feed_soil_and_water_conservation_and_other_products_in_Africa/links/5607900a08ae8e08c092726a.pdf#page=169

Belay, A., Recha, J. W., Woldeamanuel, T., & Morton, J. F. (2017). Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia. *Agriculture & Food Security, 6*(1), 24.

Belay, K., & Manig, W. (2004). Access to rural land in Eastern Ethiopia: Mismatch between policy and reality. *Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS), 105*(2), 123-138.

Belay, T. (2015). Carmine cochineal: fortune wasted in northern Ethiopia. *Journal of The Professional Association for Cactus Development, 17*, 61-80.

Bennett, N. J., Blythe, J., Tyler, S., & Ban, N. C. (2016). Communities and change in the anthropocene: understanding social-ecological vulnerability and planning adaptations to multiple interacting exposures. *Regional Environmental Change, 16*(4), 907-926.

Bennett, N. J., Dearden, P., & Peredo, A. M. (2015). Vulnerability to multiple stressors in coastal communities: a study of the Andaman Coast of Thailand. *Climate and Development, 7*(2), 124–141.

Bereket, T. (2010). The Role of Micro and Small Enterprises in Employment Creation and Income Generation: A Survey Study of Mekelle City, Tigray Region, Ethiopia. Mekelle University, Ethiopia. Retrieved June 19, 2018, from https://opendocs.ids.ac.uk/opendocs/handle/123456789/5150

Berg, B. L. (2001). *Qualitative research methods for the social sciences* (4th ed.,). Boston, Mass. London: Allyn and Bacon.

Bergquist, M., Nilsson, A., & Schultz, P. W. (2019). Experiencing a severe weather event increases concern about climate change. *Frontiers in Psychology, 10*.

Berhanu, K., & Poulton, C. (2014). The political economy of agricultural extension in Ethiopia: Economic growth and political control. *Development Policy Review, 32*(2), 197–213.

Berkes, F., & Jolly, D. (2002). Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. *Conservation ecology, 5*(2), 18.

Berman, R. J., Quinn, C. H., & Paavola, J. (2015). Identifying drivers of household coping strategies to multiple climatic hazards in Western Uganda: implications for adapting to future climate change. *Climate and Development, 7*(1), 71-84.

Berrang-Ford, L., Ford, J. D., & Paterson, J. (2011). Are we adapting to climate change?. *Global environmental change, 21*(1), 25-33.

Betts, R., Sanderson, M., & Woodward, S. (2008). Effects of large-scale Amazon forest degradation on climate and air quality through fluxes of carbon dioxide, water, energy, mineral dust and isoprene. *Philosophical Transactions of the Royal Society B: Biological Sciences, 363*(1498), 1873-1880.

Bewket, W., Radeny, M., & Mungai, C. (2015). *Agricultural adaptation and institutional responses to climate change vulnerability in Ethiopia*. CCAFS Working Paper No. 106. Copenhagen, Denmark. Retrieved October 10, 2017, from https://ccafs.cgiar.org/publications/agricultural-adaptation-and-institutional-responses-climate-change-vulnerability#.XQt7Hv59iM8

Bird, N., Tilley, H., Trujillo, N. C., Tumushabe, G., Welham, B., & Yanda, P. (2013). Measuring the effectiveness of public climate finance delivery at the national level. London: Overseas Development Institute (ODI). Retrieved from https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8303.pdf

Birkmann, J. (2006). Measuring vulnerability to promote disaster-resilient societies: Conceptual frameworks and definitions. *Measuring vulnerability to natural hazards: Towards disaster resilient societies, 1*, 9-54.

Black, R., Kniveton, D., & Schmidt-Verkerk, K. (2011). Migration and climate change: towards an integrated assessment of sensitivity. *Environment and Planning A, 43*(2), 431-450.

Bohensky, E. L., Smajgl, A., & Brewer, T. (2013). Patterns in household-level engagement with climate change in Indonesia. *Nature Climate Change, 3*(4), 348-351.

Bohle, H. G., Downing, T. E., & Watts, M. J. (1994). Climate change and social vulnerability: toward a sociology and geography of food insecurity. *Global environmental change, 4*(1), 37-48.

Bouharroud, R., Amarraque, A., & Qessaoui, R. (2016). First report of the Opuntia cochineal scale Dactylopius opuntiae (Hemiptera: Dactylopiidae) in Morocco. *EPPO Bulletin, 46*(2), 308-310.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9*(2), 27–40.

Bradshaw, C. J. A. (2012). Little left to lose: deforestation and forest degradation in Australia since European colonization. *Journal of Plant Ecology*, *5*(1), 109–120.

Brietzke, P. (1976). Land reform in revolutionary Ethiopia. *The Journal of Modern African Studies, 14*(4), 637-660.

Mann, B., Dinku, T., Gratrex. (2014). *Data for Index Insurance*. *Global Index Insurance Facility Knowledge Notes*. Washington DC: World Bank Group. Retrieved January 18, 2019, from https://www.indexinsuranceforum.org/sites/default/files/Data for Index Insurance.pdf

Brody, C. J. (1984). Differences by sex in support for nuclear power. *Social Forces, 63*(1), 209-228.

Brody, S. D., Zahran, S., Vedlitz, A., & Grover, H. (2008). Examining the relationship between physical vulnerability and public perceptions of global climate change in the United States. *Environment and Behavior, 40*(1), 72-95.

Brooks, N. (2003). *Vulnerability, risk and adaptation: A conceptual framework*. Tyndall Centre for Climate Change Research Working Paper No 38. Retrieved May 17, 2018, from https://www.ipcc.ch/apps/njlite/srex/njlite_download.php?id=5463

Brooks, N., Adger, W. N., & Kelly, P. M. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change, 15*(2), 151-163.

Bruce, J. W., Hoben, A., & Rahmato, D. (1994). *After the Derg: An assessment of rural land tenure issues in Ethiopia.* Land Tenure Center, University of Wisconsin–Madison. Retrieved February 18, 2016, from https://minds.wisconsin.edu/handle/1793/61013

Brulle, R. J., Carmichael, J., & Jenkins, J. C. (2012). Shifting public opinion on climate change: an empirical assessment of factors influencing concern over climate change in the U. S., 2002–2010. *Climatic Change, 114*(2), 169-188.

Bryan, E., Deressa, T. T., Gbetibouo, G. A., & Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa: options and constraints. *Environmental science & policy, 12*(4), 413-426.

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S., & Herrero, M. (2013). Adapting agriculture to climate change in Kenya: Household strategies and determinants. *Journal of Environmental Management, 114,* 26–35.

Bryman, A. (1984). The debate about quantitative and qualitative research: a question of method or epistemology? *British journal of Sociology,* 75-92.

Bryman, A. (2016). *Social research methods* (5th ed.,). Oxford: Oxford University Press.

Buikstra, E., Ross, H., King, C. A., Baker, P. G., Hegney, D., McLachlan, K., & Rogers-Clark, C. (2010). The components of resilience—Perceptions of an Australian rural community. *Journal of Community Psychology, 38*(8), 975-991.

Bunce, M., Brown, K., & Rosendo, S. (2010). Policy misfits, climate change and cross-scale vulnerability in coastal Africa: how development projects undermine resilience. Environmental *Science & Policy, 13*(6), 485–497.

Bunce, M., Brown, K., & Rosendo, S. (2010). Policy misfits, climate change and cross-scale vulnerability in coastal Africa: how development projects undermine resilience. *Environmental Science & Policy, 13*(6), 485–497.

Bunce, M., Rosendo, S., & Brown, K. (2010). Perceptions of climate change, multiple stressors and livelihoods on marginal African coasts. *Environment, Development and Sustainability, 12*(3), 407-440.

Bunce, M., Rosendo, S., & Brown, K. (2010). Perceptions of climate change, multiple stressors and livelihoods on marginal African coasts. *Environment, Development and Sustainability, 12*(3), 407-440.

Burnham, M., & Ma, Z. (2016). Linking smallholder farmer climate change adaptation decisions to development. *Climate and Development, 8*(4), 289–311.

Burnham, M., & Ma, Z. (2018). Multi-scalar pathways to smallholder adaptation. *World Development, 108,* 249-262.

Burton, I. (1997). Vulnerability and adaptive response in the context of climate and climate change. *Climatic Change, 36*(1-2), 185-196.

Burton, I., Huq, S., Lim, B., Pilifosova, O., & Schipper, E. L. (2002). From impacts assessment to adaptation priorities: the shaping of adaptation policy. *Climate Policy, 2*(2-3), 145-159.

Busby, J. W., Smith, T. G., & Krishnan, N. (2014). Climate security vulnerability in Africa mapping 3.0. *Political Geography, 43,* 51-67.

Buys, L., Aird, R., van Megen, K., Miller, E., & Sommerfeld, J. (2014). Perceptions of climate change and trust in information providers in rural Australia. *Public Understanding of Science, 23*(2), 170-188.

Byg, A., & Salick, J. (2009). Local perspectives on a global phenomenon-Climate change in Eastern Tibetan villages. *Global Environmental Change, 19*(2), 156–166.

Capitanio, F., Adinolfi, F., & Santeramo, F. G. (2015). Environmental implications of crop insurance subsidies in Southern Italy. *International Journal of Environmental Studies, 72*(1), 179–190.

Cardona, O. D. (2013). The need for rethinking the concepts of vulnerability and risk from a holistic perspective: a necessary review and criticism for effective risk management. Retrieved June 12, 2016 from https://www.researchgate.net/publication/254267457_The_Need_for_Rethinking_the_Concepts_of_Vulnerability_and_Risk_from_a_Holistic_Perspective_A_Necessary_Review_and_Criticism_for_Effective_Risk_Management1

Carter, T. R., Parry, M. L., & Harasawa, H. (1994). IPCC technical guidelines for assessing climate change impacts and adaptations. London: University College London. Retrieved March 30, 2016 from https://www.ipcc.ch/site/assets/uploads/2018/03/ipcc-technical-guidelines-1994n-1.pdf

Campbell, R., & Ahrens, C. E. (1998). Innovative community services for rape victims: an application of multiple case study methodology. *American Journal of Community Psychology, 26*(4), 537-571.

Chadwick, A. E. (2017). Climate change communication. Oxford Research Encyclopedia of Communication. Oxford University Press USA. Retrieved May 16, 2019, from https://doi.org/10.1093/acrefore/9780190228613.013.22

Chadwick, B. A., Bahr, H. M., & Albrecht, S. L. (1984). *Social science research methods*. Englewood Cliffs: Prentice-Hall.

Chambers, R. (1994). The origins and practice of participatory rural appraisal. World *Development, 22*(7), 953–969.

Chess, C., & Johnson, B. B. (2007). Information is not enough. Creating a climate for change: *Communicating climate change and facilitating social change,* 153-166.

Chirenje, L. I., Giliba, R. A., & Musamba, E. B. (2013). Local communities' participation in decision-making processes through planning and budgeting in African countries. *Chinese Journal of Population Resources and Environment, 11*(1), 10-16.

Chitando, E. (2017). Praying for Courage: African Religious Leaders and Climate Change. *The Ecumenical Review, 69*(3), 425-435.

CIA (Central Intelligence Agency). (2018). *Ethiopia. In the world fact book*. Retrieved January 10, 2019 from https://www.cia.gov/library/publications/the-world-factbook/geos/et.html

Corner, A., Markowitz, E., & Pidgeon, N. (2014). Public engagement with climate change: the role of human values. *Wiley Interdisciplinary Reviews: Climate Change, 5*(3), 411-422.

Cotula, L., Vermeulen, S., Leonard, R., & Keeley, J. (2009). *Land grab or development opportunity?. Agricultural investment and international land deals in Africa.* London/Rome. Retrieved November 9, 2016, from http://www.fao.org/3/a-ak241e.pdf

Cohen, P. J., Lawless, S., Dyer, M., Morgan, M., Saeni, E., Teioli, H., & Kantor, P. (2016). Understanding adaptive capacity and capacity to innovate in social–ecological systems: Applying a gender lens. *Ambio, 45*(3), 309-321.

Collier, W. M., Jacobs, K. R., Saxena, A., Baker-Gallegos, J., Carroll, M., & Yohe, G. W. (2009). Strengthening socio-ecological resilience through disaster risk reduction and climate change adaptation: identifying gaps in an uncertain world. *Environmental Hazards, 8*(3), 171-186.

Creswell, J. W. (2011). *Research design: Qualitative, quantitative, and mixed method approaches* (3rd ed). New Delhi; India: SAGE.

Crewett, W., & Korf, B. (2008). Ethiopia: Reforming Land Tenure. *Review of African Political Economy, 35*(116), 203–220.

Crewett, W., Bogale, A., & Korf, B. (2008). *Land Tenure in Ethiopia: Continuity and Change, Shifting Rulers, and the Quest for State Control*. CAPRI Working Paper No. 91. Washington, DC: International Food Policy Research Institute. Retrieved July 10, 2017, from https://ideas.repec.org/p/fpr/worpps/91.html

Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., & Sheikh, A. (2011). The case study approach. *BMC medical research methodology*, *11*(1), 100.

CSA. (Central statistical agency) (2007). *The 2007 Population and Housing Census of Ethiopia: Statistical Report for Tigray Region.* Retrieved December 20, 2018, from http://phe-ethiopia.org/pdf/tigray.pdf

CSA (Central Statistical Agency of Ethiopia). (2008). *Summary and Statistical report of the 2007 Population and Hosing Census. Addis Ababa, Ethiopia*. Retrieved October 5, 2017, from https://www.scribd.com/doc/28289334/Summary-and-Statistical-Report-of-the-2007

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global environmental change*, *18*(4), 598-606.

Engle, N. L. (2011). Adaptive capacity and its assessment. *Global environmental change*, *21*(2), 647-656.

FEWSNET. (2015). *Illustrating the extent and severity of the 2015 drought. Famine Early Warning Systems Network/USAID*. Retrieved April 3, 2016, from https://reliefweb.int/map/ethiopia/ethiopia-special-report-illustrating-extent-and-severity-2015-drought

Fielding, K. S., Hornsey, M. J., & Swim, J. K. (2014). Developing a social psychology of climate change. *European Journal of Social Psychology*, *44*(5), 413-420.

Fielmua, N., Gordon, D., & Mwingyine, D. T. (2017). Migration as an Adaptation Strategy to Climate Change: Influencing Factors in Northwestern Ghana. Journal of Sustainable Development, 10(6), 155.

Finch, H., Lewis, J., & Turley, C. (2014). Focus groups. In J. Ritchie, J. Lewis, C. M. Nicholas, & R. Ormston (Eds.), *Qualitative research Practice: A guide for social science students and researchers.* London: SAGE.

Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making*, *13*(1), 1-17.

Fisher, M., Chaudhury, M., & McCusker, B. (2010). Do forests help rural households adapt to climate variability? Evidence from Southern Malawi. *World Development*, *38*(9), 1241-1250.

Folke C, Carpenter SR, Walker B, Scheffer M, Chapin T, Rockström J (2010) Resilience thinking: integrating resilience, adaptability and transformability. Ecol Soc 15(4):20

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global environmental change*, *16*(3), 253-267.

Ford, J. D., Berrang-Ford, L., Bunce, A., McKay, C., Irwin, M., & Pearce, T. (2015). The status of climate change adaptation in Africa and Asia. *Regional Environmental Change, 15*(5), 801–814.

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

Ford, J. D., McDowell, G., & Jones, J. (2014). The state of climate change adaptation in the Arctic. *Environmental Research Letters, 9*(10), 104005.

Ford, J. D., McDowell, G., & Jones, J. (2014). The state of climate change adaptation in the Arctic. *Environmental Research Letters, 9*(10), 104005.

Forsyth, T. I. M., & Evans, N. (2013). What is Autonomous Adaption? Resource Scarcity and Smallholder Agency in Thailand. *World Development, 43,* 56–66.

Fosu-Mensah, B. Y., Vlek, P. L. G., & MacCarthy, D. S. (2012). Farmers' perception and adaptation to climate change: A case study of Sekyedumase district in Ghana. Environment, *Development and Sustainability, 14*(4), 495–505.

Frank, E., Eakin, H., & López-Carr, D. (2011). Social identity, perception and motivation in adaptation to climate risk in the coffee sector of Chiapas, Mexico. *Global Environmental Change, 21*(1), 66-76.

Frazier, T. G. (2012). Selection of scale in vulnerability and resilience assessments. *J Geogr Nat Disasters, 2,* 108.

Fuchs, A., & Wolff, H. (2011). Concept and unintended consequences of weather index insurance: The case of Mexico. *American Journal of Agricultural Economics, 93*(2), 505–

Füssel, H. M. (2005). *Vulnerability in climate change research: A comprehensive conceptual framework.* Retrieved December 30, 2015, from https://cloudfront.escholarship.org/dist/prd/content/qt8993z6nm/qt8993z6nm.pdf?t=kro66l

Füssel, H. M. (2007). Vulnerability: a generally applicable conceptual framework for climate change research. *Global Environmental Change, 17*(2), 155-167.

Füssel, H. M., & Klein, R. J. (2006). Climate change vulnerability assessments: an evolution of conceptual thinking. *Climatic Change, 75*(3), 301-329.

Gallopín, G. C. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global environmental change, 16*(3), 293-303.

Gustafsson, J. (2017). Single case studies vs. multiple case studies: A comparative study

Gbetibouo, G.A. (2009). *Understanding farmers' perceptions and adaptations to climate change and variability: the case of the Limpopo Basin, South Africa.* Discussion Paper No.

00849. International Food Policy Research Institute. Retrieved June 13, 2016, from https://oerafrica.org/sites/default/files/oldresources/38093/Understanding%20farmers%27%20perceptions%20and%20adaptations%20to%20climate%20change%20and%20variability.pdf

Gebregziabher, G., Namara, R. E., & Holden, S. (2009). Poverty reduction with irrigation investment: An empirical case study from Tigray, Ethiopia. *Agricultural water management, 96*(12), 1837-1843.

Gebrehiwot, T., & van der Veen, A. (2013). Assessing the evidence of climate variability in the northern part of Ethiopia. *Journal of Development and Agricultural Economics, 5*(3), 104-119.

Gebrehiwot, T., & van der Veen, A. (2013). Climate change vulnerability in Ethiopia: disaggregation of Tigray Region. *Journal of Eastern African Studies, 7*(4), 607–629.

Gebretsadik, G., Animut, G., & Tegegne, F. (2013). Assessment of the potential of cactus pear (Opuntia ficus indica) as livestock feed in Northern Ethiopia. *Livestock research for rural development, 25*(2), 1-10.

Gebreyes, M. (2018). 'Producing institutions of climate change adaptation and food security in north eastern Ethiopia. *NJAS-Wageningen Journal of Life Sciences, 84,* 123-132.

Gedif, B., Hadish, L., Addisu, S., & Suryabhagavan, K. V. (2014). Drought risk assessment using remote sensing and GIS: the case of Southern zone, Tigray region, Ethiopia. *Journal of Natural Sciences Research, 4*(23), 87-94.

Ghebrezgabher, M. G., Yang, T., & Yang, X. (2016). Long-term trend of climate change and drought assessment in the Horn of Africa. *Advances in Meteorology*, 2016.

Gidey, E., Dikinya, O., Sebego, R., Segosebe, E., & Zenebe, A. (2018). Modeling the spatio-temporal meteorological drought characteristics using the standardized precipitation index (SPI) in Raya and its environs, Northern Ethiopia. *Earth Systems and Environment, 2*(2), 281-292.

Glantz, M. H. (1992). Global warming and environmental change in sub-Saharan Africa. *Global Environmental Change*, *2*(3), 183-204.

Glatzel, K., Conway, G., & Alpert, E. (2015). *The farms of change: African smallholders responding to an uncertain climate future. African stallholder responding to uncertain climate change.* A Montpellier Panel Report. Retrieved May 10, 2018, from https://ag4impact.org/wp-content/uploads/2015/09/MP_Climate_Report_Web2.pdf

Goebbert, K., Jenkins-Smith, H. C., Klockow, K., Nowlin, M. C., & Silva, C. L. (2012). Weather, climate, and worldviews: The sources and consequences of public perceptions of changes in local weather patterns. *Weather, Climate, and Society, 4*(2), 132-144.

Gonsalves, J., & Mohan, P. (2012). *Strengthening resilience in post-disaster situations: Stories, experience and lessons from South Asia.* International Development Research Center. Retrieved August 10, 2017, from https://www.idrc.ca/en/book/strengthening-resilience-post-disaster-situations-stories-experience-and-lessons-south-asia

GRAIN. (2016). *The global farmland grab in 2016: How Big, How Bad*?. Retrieved August 17, 2018, from https://www.grain.org/article/entries/5492-the-global-farmland-grab-in-2016-how-big-how-bad

Granberg, M., & Glover, L. (2014). Adaptation and maladaptation in Australian national climate change policy. *Journal of Environmental Policy & Planning, 16*(2), 147–159.

Gray, D. E. (2009). *Doing research in the real world* (2nd ed). Los Angeles ; London: SAGE.

Grothmann, T., & Patt, A. (2005). Adaptive capacity and human cognition: the process of individual adaptation to climate change. *Global Environmental Change, 15*(3), 199-213.

Grüneis, H., Penker, M., & Höferl, K. M. (2016). The full spectrum of climate change adaptation: Testing an analytical framework in Tyrolean mountain agriculture (Austria). *Springer Plus, 5*(1), 1848.

Habiba, U., Shaw, R., & Takeuchi, Y. (2012). Farmer's perception and adaptation practices to cope with drought: Perspectives from Northwestern Bangladesh. *International Journal of Disaster Risk Reduction, 1*(1), 72–84.

Habtemariam, L. T., Gandorfer, M., Kassa, G. A., & Heissenhuber, A. (2016). Factors Influencing Smallholder Farmers' Climate Change Perceptions: A Study from Farmers in *Ethiopia. Environmental Management, 58*(2), 343–358.

Handbook of Climate Change Communication: Vol. 1 (pp. 137-150). Springer, Cham.

Haq, S. M. A., & Ahmed, K. J. (2017). Does the perception of climate change vary with the socio-demographic dimensions? A study on vulnerable populations in Bangladesh. *Natural Hazards, 85*(3), 1759-1785.

Harris, A. (2015*). Expropriation, compensation and transitions to new livelihoods: Evidence from an expropriation in Ethiopia.* Working Paper. Centre for the Study of African Economies. Oxford, United Kingdom. Retrieved January 10, 2016, from
Retrieved from http://www.csae.ox.ac.uk/materials/papers/csae-wps-2015-04.pdf

Harvey, C. A., Rakotobe, Z. L., Rao, N. S., Dave, R., Razafimahatratra, H., Rabarijohn, R. H., ... & MacKinnon, J. L. (2014). Extreme vulnerability of smallholder farmers to agricultural risks and climate change in Madagascar. *Philosophical Transactions of the Royal Society B: Biological Sciences, 369*(1639), 20130089.

Hasan, Z., & Nursey-Bray, M. (2018). Artisan fishers' perception of climate change and disasters in coastal Bangladesh. *Journal of Environmental Planning and Management, 61*(7), 1204-1223.

HDR (Ethiopia Humanitarian Requirements Document) (2016). Ethiopia: Requirements Document. Retrieved November 12, 2016, from https://reliefweb.int/sites/reliefweb.int/files/resources/ethiopia_hrd_2016.pdf

Helm, S. V, Pollitt, A., Barnett, M. A., Curran, M. A., & Craig, Z. R. (2018). Differentiating environmental concern in the context of psychological adaption to climate change. Global *Environmental Change, 48,* 158–167.

Hidalgo, M. C., & Pisano, I. (2010). Determinants of risk perception and willingness to tackle climate change. A pilot study. *Psychology, 1*(1), 105-112.

Hitayezu, P., Wale, E., & Ortmann, G. (2017). Assessing farmers' perceptions about climate change: A double-hurdle approach. *Climate Risk Management, 17,* 123-138.

Hope, A. L. B., & Jones, C. R. (2014). The impact of religious faith on attitudes to environmental issues and Carbon Capture and Storage (CCS) technologies: A mixed methods study. *Technology in Society, 38,* 48–59.

Horne, F., & Mousseau, F. (2011). *Understanding Land Investment Deals in Africa.* Country report: Ethiopia: Oakland Institute. Retrieved June 19, 2017, from https://www.oaklandinstitute.org/sites/oaklandinstitute.org/files/OI_Ethiopa_Land_Investment_report.pdf

Howe, P. D., & Leiserowitz, A. (2013). Who remembers a hot summer or a cold winter? The asymmetric effect of beliefs about global warming on perceptions of local climate conditions in the US. *Global environmental change, 23*(6), 1488-1500.

Howe, P. D., & Leiserowitz, A. (2013). Who remembers a hot summer or a cold winter? The asymmetric effect of beliefs about global warming on perceptions of local climate conditions in the US. *Global Environmental Change, 23(6),* 1488-1500.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual review of ecology and systematics, 4*(1), 1-23.

HRW (Human Rights Watch). (2005). *Suppressing Dissent: Human Rights Abuses and Political Repression in Ethiopia's Oromia Region.* Retrieved May 10, 2016, from https://www.hrw.org/reports/2005/ethiopia0505/ethiopia0505.pdf

Hundie, B. (2010). Conflicts between Afar pastoralists and their neighbors: Triggers and motivations. *International Journal of Conflict and Violence, 4*(1), 134-148

Hunnes, D. E. (2012). An Analysis of Ethiopian Rural-to-Urban Migration Patterns from Primary Interviews. *Journal of Global Health Perspectives,* 1-10.

ILC (International Land Coalition International). (2011). *Securing land access for the poor in times of intensified natural resources competition.* Report of the International Land Coalition International Conference and Assembly of Members. Tirana, Albania. Retrieved April 1, 2017, from https://www.landcoalition.org/sites/default/files/documents/resources/aom_2011_report_web_en.pdf

Inaotombi, S., & Mahanta, P. C. (2018). Pathways of socio-ecological resilience to climate change for fisheries through indigenous knowledge. *Human and Ecological Risk Assessment: An International Journal,* 1-13.

IMF (International Monterrey Fund). (2018). *Staff Report for the 2017 Article IV Consultation – Press release; Staff report; and Statement by the Executive Director for the Federal Democratic Republic of Ethiopia.* IMF Country Report No.18. Retrieved May 9, 2016, from https://www.imf.org/en/Publications/CR/Issues/2018/01/24/The-Federal-Democratic-Republic-of-Ethiopia-2017-Article-IV-Consultation-Press-Release-Staff-45576

IPCC. (2014). Annex II: *Glossary* [Mach, K.J., S. Planton and C. von Stechow (Eds.)]. In: *Cli-mate Change 2014: Synthesis Report. Contribution of Working Groups* I, II and III to the Fifth *Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (Eds.)]. IPCC, Geneva, Switzerland, pp. 117-130. Retrieved July 2, 2018 from https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_Annexes.pdf

IPCC. (2014). *Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, et al (Eds)] Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32. Retrieved June 10, 2017 from https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA_FINAL.pdf

IPCC. (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir (Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1132.

IPCC. (2014). Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the

Intergovernmental Panel on Climate Change [Edenhofer; O.; R. Pichs-Madruga; Y. Sokona; E. Farahani; . Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Irish Aid. (2016). *Ethiopia Climate Action Report for 2015. Irish Aid.* Retrieved January 5, 2016 from https://www.irishaid.ie/media/irishaidpublications/ETH-Country-Climate-Action-Reports-Ethiopia-2015.pdf

Jackson, R. B., Randerson, J. T., Canadell, J. G., Anderson, R. G., Avissar, R., Baldocchi, D. D., Field, C. B. (2008). Protecting climate with forests. *Environmental Research Letters, 3*(4), 44006.

Janssen, M., & Ostrom, E. (2006). Resilience, vulnerability, and adaptation: A cross-cutting theme of the International Human Dimensions Programme on Global Environmental Change. *Global environmental change*, *16*(3), 237-239.

Jha, C. K., Gupta, V., Chattopadhyay, U., & Amarayil Sreeraman, B. (2018). Migration as adaptation strategy to cope with climate change: A study of farmers' migration in rural India. *International Journal of Climate Change Strategies and Management, 10*(1), 121-141.

Jones, L., Carabine, E., & Schipper, L. (2015*). (Re) conceptualizing maladaptation in policy and practice: towards an evaluative framework.* Research for Climate Resilient Future. Working Paper. Urban Chania. Retrieved May 15, 2019, from http://prise.odi.org/wp-content/uploads/2015/06/Reconceptusalising-maladaptation.pdf

Jones, L., Ludi, E., & Levine, S. (2010). *Towards a characterization of adaptive capacity: a framework for analyzing adaptive capacity at the local level.* Overseas Development Institute (ODI). Retrieved January 22, 2017, from https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/6353.pdf

Jones, N., Presler-Marshall, E., & Tefera, B. (2014). *Rethinking the 'Maid Trade': Experiences of Ethiopian adolescent domestic workers in the Middle East.* London: Overseas Development Institute. London. Retrieved March 9, 2019, from https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9304.pdf

Juhola, S., Glaas, E., Linnér, B. O., & Neset, T. S. (2016). Redefining maladaptation. *Environmental Science and Policy, 55,* 135–140.

Jülich, S. (2011). Drought triggered temporary migration in an East Indian village. *International Migration, 49,* e189-e199.

Kabir, J., Alauddin, M., & Crimp, S. (2017). Farm-level adaptation to climate change in Western Bangladesh: An analysis of adaptation dynamics, profitability and risks. *Land Use Policy, 64*, 212–224.

Kahan, D. M., Jenkins-Smith, H., & Braman, D. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research, 14*(2), 147-174.

Kandlikar, M., & Risbey, J. (2000). Agricultural impacts of climate change: if adaptation is the answer, what is the question? *Climatic Change, 45*(3), 529-539.

Kassa, B. (2003). Agricultural extension in Ethiopia: the case of participatory demonstration and training extension system. *Journal of Social Development in Africa, 18*(1), 49-84.

Kassie, B. T., Hengsdijk, H., Ro¨tter, R., Kahiluoto, H., Asseng, S., & Ittersum, M. Van. (2013). Adapting to Climate Variability and Change: Experiences from Cereal-Based Farming in the Central Rift and Kobo Valleys, Ethiopia. *Environmental Management, 52,* 1115–1131.

Kates, R. W. (2000). Cautionary tales: adaptation and the global poor. *Climatic change, 45*(1), 5-17.

Kasperson, R. E., & Kasperson, J. X. (2001). *Climate change, vulnerability, and social justice* (pp. 1-18). Stockholm: Stockholm Environment Institute. Academy of Business, Engineering and Science. Halmstad, Sweden

Kebede, B. (2002). Land Tenure and Common Pool Resources in Rural Ethiopia: A Study Based on Fifteen Sites. *African Development Review, 14*(1), 113–149.

Kelley, K., Clark, B., Brown, V., & Sitzia, J. (2003). Good practice in the conduct and reporting of survey research. *International Journal for Quality in Health Care, 15*(3), 261–266.

Kellstedt, P. M., Zahran, S., & Vedlitz, A. (2008). Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. *Risk Analysis: An International Journal, 28*(1), 113-126.

Kelly, P. M., & Adger, W. N. (1999). *Assessing vulnerability to climate change and facilitating adaptation*. Centre for Social and Economic Research on the Global Environment.

Kelly, P. M., & Adger, W. N. (2000). Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change, 47*(4), 325–352.

Keshavarz, M., Maleksaeidi, H., & Karami, E. (2017). Livelihood vulnerability to drought: A case of rural Iran. *International Journal of Disaster Risk Reduction, 21,* 223-230.

Kichamu, E. A., Ziro, J. S., Palaniappan, G., & Ross, H. (2017). Climate change perceptions and adaptations of smallholder farmers in Eastern Kenya. *Environment, Development and Sustainability,* 1–18.

Kidane, R., Prowse, M., & de Neergaard, A. (2018). Bespoke Adaptation in Rural Africa? An Asset-Based Approach from Southern Ethiopia. *The European Journal of Development Research,* 1-20.

Komba, C., & Muchapondwa, E. (2012). *Adaptation to climate change by smallholder farmers in Tanzania.* Economic Research Southern Africa (ERSA). Working Paper No. *299*. Retrieved February 21, 2017, from https://econrsa.org/2017/wp-content/uploads/wp299.pdf

Lacroix, K., & Gifford, R. (2018). Psychological barriers to energy conservation behavior: The role of worldviews and climate change risk perception. *Environment and Behavior, 50*(7), 749-780.

Laube, W., Schraven, B., & Awo, M. (2012). Smallholder adaptation to climate change: Dynamics and limits in Northern Ghana. *Climatic Change, 111*(3), 753–774.

Lavers, T. (2012). "Land grab" as development strategy? The political economy of agricultural investment in Ethiopia. *Journal of Peasant Studies, 39*(1), 37–41.

Le Dang, H., Li, E., Bruwer, J., & Nuberg, I. (2014). Farmers' perceptions of climate variability and barriers to adaptation: lessons learned from an exploratory study in Vietnam. *Mitigation and Adaptation Strategies for Global Change, 19*(5), 531-548.

Lebel, P., Whangchai, N., Chitmanat, C., Promya, J., & Lebel, L. (2015). Perceptions of climate-related risks and awareness of climate change of fish cage farmers in northern Thailand. *Risk Management, 17*(1), 1-22.

Lee, T. M., Markowitz, E. M., Howe, P. D., Ko, C. Y., & Leiserowitz, A. A. (2015). Predictors of public climate change awareness and risk perception around the world. *Nature Climate Change*, *5*(11), 1014-1020.

Leichenko, R. M., & O'brien, K. L. (2002). The dynamics of rural vulnerability to global change: the case of southern Africa. *Mitigation and Adaptation Strategies for Global Change, 7*(1), 1–18.

Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic change, 77*(1-2), 45-72.

Leiserowitz, A. A. (2005). American risk perceptions: Is climate change dangerous?. *Risk Analysis: An International Journal, 25*(6), 1433-1442.

Lei, Y., Yue, Y., Zhou, H., & Yin, W. (2014). Rethinking the relationships of vulnerability, resilience, and adaptation from a disaster risk perspective. *Natural hazards*, *70*(1), 609-627. Lei, Y., Yue, Y., Zhou, H., & Yin, W. (2014).

Leta, G., Kelboro, G., Stellmacher, Ti., & Hornidge, A.-K. (2017). *The agricultural extension system in Ethiopia: operational setup, challenges and opportunities.* ZEF Working Paper No. 158. Centre for Development Research. University of Bonn. Retrieved January 3, 2018, from https://www.zef.de/uploads/tx_zefportal/Publications/zef_wp_158.pdf

Liyama, M., Kariuki, P., Kristjanson, P., Kaitibie, S., & Maitima, J. (2008). Livelihood diversification strategies, incomes and soil management strategies: a case study from Kerio Valley, Kenya. *Journal of International Development, 20*(3), 380-397

Loewenstein, G. (1996). Out of control: Visceral influences on behavior. *Organizational Behavior and Human Decision Processes, 65*(3), 272-292.

Lujala, P., Lein, H., & Rød, J. K. (2015). Climate change, natural hazards, and risk perception: the role of proximity and personal experience. *Local Environment, 20*(4), 489-509.

Magnan, A. (2014). *Avoiding maladaptation to climate change: towards guiding principles.* Surveys and Perspectives Integrating Environment and Society. Retrieved March 10, 2017, from
https://journals.openedition.org/sapiens/1680

Magnan, A. K., Schipper, E. L. F., Burkett, M., Bharwani, S., Burton, I., Eriksen, S., Ziervogel, G. (2016). Addressing the risk of maladaptation to climate change. *Wiley Interdisciplinary Reviews: Climate Change, 7*(5), 646–665.

Mahoo, H., Radeny, M., Kinyangi, J., & Cramer, L. (2013). *Climate Change Vulnerability and Risk Assessment of Agriculture and Food Security in Ethiopia.* CCAFS Working Paper No. 59. Copenhagen, Denmark. Retrieved April 1, 2018, from
https://ccafs.cgiar.org/publications/climate-change-vulnerability-and-risk-assessment-agriculture-and-food-security-ethiopia

Malka, A., Krosnick, J. A., & Langer, G. (2009). The association of knowledge with concern about global warming: Trusted information sources shape public thinking. *Risk Analysis: An International Journal, 29*(5), 633-647.

Maplecroft. (2015). *Climate change vulnerability index 2015*. Retrieved September 10, 2016, from https://reliefweb.int/map/world/world-climate-change-vulnerability-index-2015

Marin, A. (2010). Riders under storms: Contributions of nomadic herders' observations to analysing climate change in Mongolia. *Global Environmental Change, 20*(1), 162–176.

Markowitz, E. M., & Guckian, M. L. (2018). Climate change communication: Challenges, insights, and opportunities. In Clayton, S. & Manning., C. (eds), *Psychology and Climate Change: Human Perceptions, Impacts, and Responses (*pp., 35-63).

Martin, S. M., & Lorenzen, K. A. I. (2016). Livelihood Diversification in Rural Laos. *World Development, 83,* 231–243.

Marx, S. M., Weber, E. U., Orlove, B. S., Leiserowitz, A., Krantz, D. H., Roncoli, C., & Phillips, J. (2007). Communication and mental processes: Experiential and analytic processing of uncertain climate information. *Global Environmental Change, 17*(1), 47-58.

Masih, I., Maskey, S., Mussá, F. E. F., & Trambauer, P. (2014). A review of droughts on the African continent: a geospatial and long-term perspective. *Hydrology and Earth System Sciences, 18*(9), 3635–3649.

Maxwell D; Caldwell R. (2008). *The coping strategy index. A tool for the measurement of household food security and impacts of food aid programs in humanitarian emergency*. Field Methods Manual (2nd). Retrieved November 4, 2016, from https://www.researchgate.net/publication/259999318_The_Coping_Strategies_Index_Field_Methods_Manual_-_Second_Edition

May, T. (1997). *Social research : Issues, methods and process.* Open University Press. Buckingham.

Mburu, J. I. (2017). *Assessing institutional barriers to national adaptation plan (NAP), implementation in Kenya's agricultural sector.* Integrating Agriculture in National Adaptation Plans project. Nirobi, Kenya. Retrieved June 17, 2016 from https://www.undp.org/content/dam/kenya/docs/energy_and_environment/Assessing%20Institutional%20Barriers%20to%20NAP.pdf

Mccright, A. M. (2009). The Social Bases of Climate Change Knowledge, Concern, and Policy Support in the U.S. General Public. *Hofstra L. Rev, 37*(4), 1017.

McCright, A. M. (2010). The effects of gender on climate change knowledge and concern in the American public. *Population and Environment, 32*(1), 66-87.

McCubbin, S., Smit, B., & Pearce, T. (2015). Where does climate fit? Vulnerability to climate change in the context of multiple stressors in Funafuti, Tuvalu. *Global Environmental Change, 30,* 43–55.

McDowell, J. Z., & Hess, J. J. (2012). Accessing adaptation: Multiple stressors on livelihoods in the Bolivian highlands under a changing climate. *Global Environmental Change, 22*(2), 342–352.

McSharry, P. E., Swartz, T., & Spray, J. (2016*). Can index based insurance reduce the vulnerability of farmers to weather?.* International Growth Centre Blog. Retrieved January 10, 2017 from http://eprints.lse.ac.uk/81704/1/Can%20index%20based%20insurance%20reduce%20the%20vulnerability%20of%20farmers%20to%20weather_%20-%20IGC.pdf

Measham, T. G., & Lumbasi, J. A. (2013). Success factors for community-based natural resource management (CBNRM): Lessons from Kenya and Australia. *Environmental management, 52*(3), 649-659.

Menghistu, H. T., Mersha, T. T., & Abraha, A. Z. (2018). Farmers' perception of drought and its socioeconomic impact: the case of Tigray and Afar regions of Ethiopia. *Journal of Applied Animal Research, 46*(1), 1023–1031.

Mercado, R. M. (2016). People's Risk Perceptions and Responses to Climate Change and Natural Disasters in BASECO Compound, Manila, Philippines. *Procedia Environmental Sciences, 34,* 490-505.

Mertz, O., Halsnæs, K., Olesen, J. E., & Rasmussen, K. (2009). Adaptation to Climate Change in Developing Countries. *Environmental Management, 43*(5), 743–752.

Mertz, O., Mbow, C., Nielsen, J. Ø., Maiga, A., Diallo, D., Reenberg, A., & Ouattara, I. (2010). Climate factors play a limited role for past adaptation strategies in West Africa. *Ecology and Society*, *15*(4), 25.

Meshesha, Y. B. (2015). Assessment of the effectiveness of watershed management intervention in Chena Woreda, Kaffa Zone, Southwestern Ethiopia. *Assessment, 5*(17).

Meze-Hausken, E. (2000). Migration caused by climate change: how vulnerable are people inn dryland areas?. *Mitigation and Adaptation Strategies for Global Change, 5*(4), 379-406.

Meze-Hausken, E. (2004). Contrasting climate variability and meteorological drought with perceived drought and climate change in northern Ethiopia. *Climate Research*, *27*(1), 19–31.

Milfont, T. L. (2012). The interplay between knowledge, perceived efficacy, and concern about global warming and climate change: A one-year longitudinal study. *Risk Analysis, 32*(6), 1003-1020.

Miller, F., & Bowen, K. (2013). Questioning the assumptions: the role of vulnerability assessments in climate change adaptation. *Impact Assessment and Project Appraisal*, *31*(3), 190–197.

MOFED (Ministry of Finance and Economic Development) MOFED. (2010). *Federal Democratic Republic of Ethiopia*. *Growth and Transformation Plan 2010/11-2014/2015*. *Volume 1: Main text.* Addis Ababa, Ethiopia.
Retrieved April 3, 2016, from http://extwprlegs1.fao.org/docs/pdf/eth144893.pdf

MOFED (Ministry of Finance and Economic Development). (2002). *Ethiopia: Sustainable Development and Poverty Reduction Program.* Addis Ababa, Ethiopia. Retrieved January 11, 2016, from https://www.imf.org/external/np/prsp/2002/eth/01/073102.pdf

MOFED (Ministry of Finance and Economic Development). (2006). *Ethiopia: Building on Progress. A Plan for Accelerated and Sustained Development to End Poverty (PASDEP).* Annual Progress Report. Addis Ababa. Retrieved March 12, 2017 from https://planipolis.iiep.unesco.org/sites/planipolis/files/ressources/ethiopia_prsp_progress_2005.pdf

Moreda, T. (2017). Large-scale land acquisitions, state authority and indigenous local communities: insights from Ethiopia. *Third World Quarterly*, *38*(3), 698–716.

Morgan, D. L. (2007). Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of mixed methods research, 1*(1), 48-76.

Morrissey, J. W. (2008). *Rural-urban migration in Ethiopia*. Climate change and Displacement. Retrieved March 18, 2017, from https://www.fmreview.org/sites/fmr/files/FMRdownloads/en/climatechange/morrissey.pdf

Moser, S. C. (2016). Reflections on climate change communication research and practice in the second decade of the 21st century: what more is there to say?. *Wiley Interdisciplinary Reviews: Climate Change, 7*(3), 345-369.

Moser, S. C., & Dilling, L. (2011). Communicating climate change: closing the science-action gap. *The Oxford handbook of climate change and society*, 161-174.

Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences, 107*(51), 22026-22031.

Moser, S. C. (2010). Communicating climate change: history, challenges, process and future directions. *Wiley Interdisciplinary Reviews: Climate Change*, *1*(1), 31-53.

Mubaya, C. P., Njuki, J., Mutsvangwa, E. P., Mugabe, F. T., & Nanja, D. (2012). Climate variability and change or multiple stressors? Farmer perceptions regarding threats to livelihoods in Zimbabwe and Zambia. *Journal of environmental management, 102*, 9-17.

Muema, E., Mburu, J., Coulibaly, J., & Mutune, J. (2018). Determinants of access and utilization of seasonal climate information services among smallholder farmers in Makueni County, Kenya. *Heliyon*, *4*(11), e00889.

Mwangi, W. M. (1996). Low use of fertilizers and low productivity in sub-Saharan Africa. *Nutrient cycling in Agroecosystems, 47*(2), 135-147.

Myers, T. A., Maibach, E. W., Roser-Renouf, C., Akerlof, K., & Leiserowitz, A. A. (2013). The relationship between personal experience and belief in the reality of global warming. *Nature Climate Change, 3*(4), 343-347.

Nachmany, M., Fankhauser, S., Davidová, J., Kingsmill, N., Landesman, T., Roppongi, H., Sundaresan, J. (2015). *The 2015 Global Climate Legislation Study: A Review of Climate Change Legislation in 99 Countries.* Summary for policy makers. Retrieved November 2, 2016, from http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2015/05/Global_climate_legislation_study_20151.pdf

Nefzaoui, A., Inglese, P., & Belay, T. (2010*). Improved utilization of cactus pear for food, feed, soil and water conservation and other products in Africa*. In Proceedings of International Workshop, Mekelle, Ethiopia. 19-21 October 2009. Retrieved October 5, 2017, from

https://www.researchgate.net/publication/282204744_Improved_utilization_of_cactus_pear_for_food_feed_soil_and_water_conservation_and_other_products_in_Africa

Nefzaoui, A., Louhaichi, M., & Ben Salem, H. (2014). Cactus as a tool to mitigate drought and to combat desertification. *Journal of Arid Land Studies, 24*(1), 121-124.

Neil Adger, W., Arnell, N. W., & Tompkins, E. L. (2005). Successful adaptation to climate change across scales. *Global Environmental Change, 15*(2), 77–86.

Nerlich, B., Koteyko, N., & Brown, B. (2010). Theory and language of climate change communication. *Wiley Interdisciplinary Reviews: Climate Change, 1*(1), 97-110.

Nelson, D. R. (2011). Adaptation and resilience: responding to a changing climate. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(1), 113-120.

Neset, T. S., Wiréhn, L., Klein, N., Käyhkö, J., & Juhola, S. (2019). Maladaptation in Nordic agriculture. *Climate Risk Management, 23,* 78-87.

Neuman, W. L. (2006). *Social research methods : Qualitative and quantitative approaches* (6th ed). Boston: Pearson/A and B.

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2014). "*Africa". In Climate Change 2014: impacts, adaptation, and vulnerability. Climate Change 2014: Impacts, Adaptation and Vulnerability* - Contributions of the Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge/New York. Retrieved March 15, 2017, from https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap22_FINAL.pdf

NMA (Ethiopian National Meteorological Agency). (2007). *Climate Change National Adaptation Programme of Action (NAPA) of Ethiopia.* Addis Ababa, Ethiopia. Retrieved June 11, 2016, from https://unfccc.int/resource/docs/napa/eth01.pdf

NMA (Ethiopian National Meteorological Agency). (2017). *Guide to the use of weather and Climate Information (WCI) for agricultural practices over selected districts of SNNP and Tigray National regional States*. Ethiopia. Addis Ababa, Ethiopia. Retrieved November 10, 2018, from http://www.wmo.int/pages/prog/dra/raf/documents/Climate%20Guide%20for%20Tigray%20and%20SNNPR.pdf

Noble, I., S. Huq, Y. Anokhin, J. Carmin, et al. (2014). *Adaptation needs and options. Climate Change 2014: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Ch.14*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA (pp., 833-868). Retrieved 2 July 2017, from https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap14_FINAL.pdf

Nobre, C. A., Sampaio, G., Borma, L. S., Castilla-Rubio, J. C., Silva, J. S., & Cardoso, M. (2016). Land-use and climate change risks in the Amazon and the need of a novel sustainable development paradigm. *Proceedings of the National Academy of Sciences, 113*(39), 10759–10768.

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods, 16*(1).

NPC (National Planning Commission). (2016). *Growth and Transformation Plan II (GTP II)* (2015/16-2019/20). Federal Democratic Republic of Ethiopia. Addis Ababa. Retrieved December 22, 2017, from https://europa.eu/capacity4dev/file/30510/download?token=efsF8UiP

Nursey-Bray, M., Pecl, G., Frusher, S., Gardner, C., Haward, M., Hobday, A. J., & van Putten, I. (2012). Communicating climate change: climate change risk perceptions and rock lobster fishers, *Tasmania. Marine Policy, 36*(3), 753-759.

Nyantakyi-Frimpong, H., & Bezner-Kerr, R. (2015). The relative importance of climate change in the context of multiple stressors in semi-arid Ghana. *Global Environmental Change, 32,* 40–56.

Oates, B. N., & Conway, Declan, Calow, R. (2011). *The 'mainstreaming' approach to climate change adaptation: insights from Ethiopia's water sector.* Overseas Development Institute Background Notes. Retrieved April 12, 2016 from https://pdfs.semanticscholar.org/cb27/2d8bcd9dcdfb09c052a4537af356cae382ac.pdf

O'Brien, K., Eriksen, S., Nygaard, L. P., & Schjolden, A. (2007). Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy, 7*(1), 73–88.

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., & West, J. (2004). Mapping vulnerability to multiple stressors: climate change and globalization in India. *Global Environmental Change, 14*(4), 303-313.

O'Brien, K., Quinlan, T., & Ziervogel, G. (2009). Vulnerability interventions in the context of multiple stressors: lessons from the Southern Africa Vulnerability Initiative (SAVI). *Environmental Science & Policy, 12*(1), 23–32.

O'Brien, K., Eriksen, S. E., Schjolden, A., & Nygaard, L. P. (2004). *What is in a word? Conflicting interpretations of vulnerability in climate change research.* CICERO Working Paper No.04 Retrieved July 9, 2017, from https://www.researchgate.net/publication/242171299_What's_in_a_word_Conflicting_interpretations_of_vulnerability_in_climate_change_research

O'Brien, M. J., & Holland, T. D. (1992). The role of adaptation in archaeological explanation. *American Antiquity,* 36-59.

O'Connor, R. E., Bord, R. J., & Fisher, A. (1999). Risk perceptions, general environmental beliefs, and willingness to address climate change. *Risk analysis, 19*(3), 461-471.

Okolo, B. W., Twyman, J., Ampaire, E., & Acosta, M. (2015). *Barriers to successful climate change policy implementation in Uganda Findings from a qualitative policy study in Nwoya and Rakai districts, Uganda.* CGIAR, Research Program on Climate Change Agriculture and Food Security (CCAFS). Retrieved 17 November 2017, from ttps://ccafs.cgiar.org/publications/barriers-successful-climate-change-policy-implementation-uganda#.XQyCk_59iM8

O'Neill, S., & Nicholson-Cole, S. (2009). "Fear won't do it" promoting positive engagement with climate change through visual and iconic representations. *Science Communication, 30*(3), 355-379.

Onwuegbuzie, A. J., & Leech, N. L. (2005). On becoming a pragmatic researcher: The importance of combining quantitative and qualitative research methodologies. *International Journal of Social Research Methodology, 8*(5), 375–387.

Opiyo, F. E., Wasonga, O. V., Schilling, J., & Mureithi, S. M. (2012). Resource-based conflicts in drought-prone Northwestern Kenya: *The drivers and mitigation mechanisms. Wudpecker Journal of Agricultural Research, 1*(11), 442-453.

Ormston, R., Spencer, L., Barnard, M., & Snape, D. (2014). The foundations of qualitative research. In J. Ritchie, J. Lewis, C. M. Nicholls, & R. Ormston (Eds.), *Qualitative research practice* (pp., 1 -23). Los Angeles. London: SAGE.

Paavola, J. (2008). Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. *Environmental Science & Policy, 11*(7), 642–654.

Paul, C. J., & Weinthal, E. (2018). The development of Ethiopia's Climate Resilient Green Economy 2011–2014: implications for rural adaptation. *Climate and Development*, 1-10.

Peña, E. D. (2007). Lost in translation: Methodological considerations in cross-cultural research. *Child development, 78*(4), 1255-1264.

Peters, E., & Slovic, P. (1996). The role of affect and worldviews as orienting dispositions in the perception and acceptance of nuclear Power1. *Journal of Applied Social Psychology, 26*(16), 1427-1453.

Peters, E., & Slovic, P. (2007). Affective asynchrony and the measurement of the affective attitude component. *Cognition and Emotion, 21*(2), 300-329.

Pielke, R. A. (1998). Rethinking the role of adaptation in climate policy. *Global Environmental Change, 8*(2), 159-170.

Planel, S. (2014). A view of a bureaucratic developmental state: local governance and agricultural extension in rural Ethiopia. *Journal of Eastern African Studies, 8*(3), 420–437.

Poortinga, W., Spence, A., Whitmarsh, L., Capstick, S., & Pidgeon, N. F. (2011). Uncertain climate: An investigation into public scepticism about anthropogenic climate change. *Global Environmental Change, 21*(3), 1015–1024.

Portillo, L. (2013). Recent findings on cochineal: Towards the integration of its knowledge. *Acta Horticulturae, 995*, 351–358.

Portillo, L., & Vigueras, a L. (1998). Natural enemies of cochineal (Dactylopius coccus Costa): Importance in Mexico. *Journal of the Professional Association for Cactus Development, 3*, 43–49.

Preston, B.L., Stafford-Smith, M. (2009). *Framing vulnerability and adaptive capacity assessment.* Working Paper No.2. Climate Adaptation National Research Flagship. Canberra, Australia: CSIRO. Retrieved February 18, 2018, from

https://research.csiro.au/climate/wp-content/uploads/sites/54/2016/03/2_Working-Paper2_CAF_PDF-Standard.pdf

Proclamation No. 89/1997. *Federal Rural Land Administration Proclamation,* 3/54. Federal Negarit Gazeta (1997). Addis Ababa Ethiopia. Retrieved September 22, 2016, from

https://www.refworld.org/docid/5a268a774.html

Proclamation No.1/1995. *Proclamation of the Constitution of the Federal Democratic Republic of Ethiopia* (1995). Retrieved September 21, 2016, from

https://www.abyssinialaw.com/quick-links/item/1783-en-constitution

Proclamation No.10/1995. *A Proclamation to Provide for the Establishment of the Disaster Prevention and Preparedness Commission* (1995). Retrieved September 25, 216, from https://chilot.files.wordpress.com/2011/01/proc-no-10-1995-disaster-prevention-and-preparedness-commi.pdf

Proclamation No.31/1975. *A proclamation to provide for the public ownership of rural land* (1975). Retrieved September 25, 216, from http://extwprlegs1.fao.org/docs/pdf/eth3096.pdf

Proclamation No.456/2005. *Rural Land Administration and Use* (2005). Negarit Gazeta Retrieved September 18, 2016, from http://goalgoole.com/proclamation-no-4562005-federal-democratic-republic-of-ethiopia-rural-land-administration-and-land-use-proclamation/

Prowse, M. (2003). *Towards a clearer understanding of' vulnerability in relation to chronic poverty.* PRC Working Paper No. 24. Retrieved November 206, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1754445

Rahman, H. M., & Hickey, G. (2019). What does autonomous adaptation to climate change have to teach public policy and planning about avoiding the risks of maladaptation in Bangladesh? *Frontiers in Environmental Science, 7*, 2.

Rahmato, D. (2011). *Land to Investors: Large-Scale Land Transfers in Ethiopia.* Addis Ababa. Forum for Social Sciences. Retrieved June 10, 2017, from https://theredddesk.org/sites/default/files/resources/pdf/Ethiopia_Rahmato_FSS_2011.pdf

Rahut, D. B., Ali, A., Kassie, M., & Marenya, P. P. (2014). Rural Livelihood Diversification Strategies in Nepal. *Poverty & Public Policy, 6*(3), 259-281.

Rasmussen, L. V., Mertz, O., Rasmussen, K., & Nieto, H. (2015). Improving how meteorological information is used by pastoralists through adequate communication tools. *Journal of Arid Environments,* 121, 52–58.

Rea, L. M., & Parker, R. A. (2005). *Designing and conducting survey research: A comprehensive guide* (3rd ed). San Francisco: Jossey-Bass.

Regassa, S., Givey, C., & Castillo, G. E., Magrath, J., & Pfeifer, K. (2010). *The Rain Doesn't Come on time anymore: Poverty, vulnerability, and climate variability in Ethiopia. Oxfam Policy and Practice: Climate Change and Resilience, 6*(1), 90-134.

Regmi, B. R., Star, C., & Leal Filho, W. (2016). Effectiveness of the Local Adaptation Plan of Action to support climate change adaptation in Nepal. Mitigation and Adaptation Strategies for *Global Change, 21*(3), 461–478.

Reid, P., & Vogel, C. (2006a). Living and responding to multiple stressors in South Africa-Glimpses from KwaZulu-Natal. *Global Environmental Change, 16*(2), 195–206.

Reid, P., & Vogel, C. (2006b). Living and responding to multiple stressors in South Africa—Glimpses from KwaZulu-Natal. *Global Environmental Change, 16*(2), 195–206.

Rennie, J. K., & Singh, N. C. (1996). *Participatory research for sustainable livelihoods: a guidebook for field projects.* Retrieved December 20, 2017, from https://www.iisd.org/sites/default/files/publications/participatory_research.pdf

Rider, D., Gordon, A., Meadows, K., & Zwick, K. (2001). Livelihood diversification in Uganda : patterns and determinants of change across two rural districts. *Food policy*, *26*(4), 421-435.

Roeser, S. (2012). Risk communication, public engagement, and climate change: a role for emotions. *Risk Analysis: An International Journal, 32*(6), 1033-1040.

Rojas, O., Vrieling, A., & Rembold, F. (2011). Assessing drought probability for agricultural areas in Africa with coarse resolution remote sensing imagery. *Remote Sensing of Environment, 115*(2), 343–352.

Ross, H., & Berkes, F. (2014). Research approaches for understanding, enhancing, and monitoring community resilience. *Society & Natural Resources, 27*(8), 787-804.

Ruffeis, D., Loiskandl, W., Awulachew, S. B., & Boelee, E. (2010). Evaluation of the environmental policy and impact assessment process in Ethiopia. *Impact Assessment and Project Appraisal, 28*(1), 29–40.

Sabates-Wheeler, R., Mitchell, T., & Ellis, F. (2008). *Avoiding repetition: Time for CBA to engage with the livelihoods literature?*. IDS bulletin. 39(4), 53-59. Retrieved 10 January, 2018, from https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1759-5436.2008.tb00476.x

Salama, S., & Aboukoura, K. (2018). Role of emotions in climate change communication. In *Handbook of Climate Change Communication: Vol. 1* (pp. 137-150). Springer, Cham.

Savo, V., Lepofsky, D., Benner, J. P., Kohfeld, K. E., Bailey, J., & Lertzman, K. (2016). Observations of climate change among subsistence-oriented communities around the world. *Nature Climate Change, 6*(5), 462.

Scheraga, J. D., & Grambsch, A. E. (1998). Risks, opportunities, and adaptation to climate change. *Climate research, 11*(1), 85-95.

Schoengold, K., Ding, Y., & Headlee, R. (2015). The Impact of AD HOC Disaster and Crop Insurance Programs on the Use of Risk-Reducing Conservation Tillage Practices. *American Journal of Agricultural Economics, 97*(3), 897–919.

Schröter, D., Polsky, C., & Patt, A. G. (2005). Assessing vulnerabilities to the effects of global change: an eight-step approach. *Mitigation and Adaptation Strategies for Global Change, 10*(4), 573–595.

Schultz, P. W. (2001). The structure of environmental concern: Concern for self, other people, and the biosphere. *Journal of Environmental Psychology, 21*(4), 327-339.

Seneviratne, S.I., N. Nicholls, D. Easterling, C.M. (2012). *Changes in climate extremes and their impacts on the natural physical environment*. *In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.* In Field, C.B., V. Barros, T.F. Stocker (Eds.). A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA (pp., 109-230). Retrieved October 2, 2018, from https://library.harvard.edu/sites/default/files/static/collections/ipcc/docs/AR5_WG2_n_SREX_chapters_and_review/ii_SREX/c_Final_draft_SREX/SREX-Chap3_FINAL.pdf

Seo, K., & Rodriguez, N. (2012*). Land grab, food security and climate change: a vicious circle in the Global South.* Human and Social Dimensions of Climate Change. Intech Open. Retrieved January 23, 2017, from https://www.intechopen.com/books/human-and-social-dimensions-of-climate-change/land-grab-food-security-and-climate-change-a-vicious-circle-in-the-global-south

Serdeczny, O., Adams, S., Baarsch, F., Coumou, D., Robinson, A., Hare, W., Reinhardt, J. (2017). Climate change impacts in Sub-Saharan Africa: from physical changes to their social repercussions. *Regional Environmental Change, 17*(6), 1585–1600.

Shao, W. (2016). Are actual weather and perceived weather the same? Understanding perceptions of local weather and their effects on risk perceptions of global warming. *Journal of Risk Research, 19*(6), 722-742.

Shete, M., & Rutten, M. (2015). Impacts of large-scale farming on local communities' food security and income levels – Empirical evidence from Oromia Region, Ethiopia. *Land Use Policy, 47*, 282–292.

Shi, J., Visschers, V. H., & Siegrist, M. (2015). Public perception of climate change: The importance of knowledge and cultural worldviews. *Risk Analysis, 35*(12), 2183-2201.

Shi, J., Visschers, V. H., Siegrist, M., & Arvai, J. (2016). Knowledge as a driver of public perceptions about climate change reassessed. *Nature Climate Change, 6(*8), 759.

Shisanya, C. A., & Khayesi, M. (2007). How is climate change perceived in relation to other socioeconomic and environmental threats in Nairobi, Kenya? *Climatic Change, 85*(3), 271–284.

Siegrist, M. (1998). Belief in gene technology: The influence of environmental attitudes and gender. *Personality and Individual Differences, 24*(6), 861-866.

Siegrist, M., & Cvetkovich, G. (2000). Perception of hazards: The role of social trust and knowledge. *Risk analysis, 20*(5), 713-720.

Siegrist, M., Cvetkovich, G., & Roth, C. (2000). Salient value similarity, social trust, and risk/benefit perception. *Risk analysis, 20*(3), 353-362.

Silvestri, S., Bryan, E., Ringler, C., Herrero, M., & Okoba, B. (2012). Climate change perception and adaptation of agro-pastoral communities in Kenya. *Regional Environmental Change, 12*(4), 791-802.

Singh, A. S., Zwickle, A., Bruskotter, J. T., & Wilson, R. (2017). The perceived psychological distance of climate change impacts and its influence on support for adaptation policy. *Environmental Science & Policy, 73*, 93-99.

Singh, C., Daron, J., Bazaz, A., Ziervogel, G., Spear, D., Krishnaswamy, J., … Kituyi, E. (2018). The utility of weather and climate information for adaptation decision-making: current uses and future prospects in Africa and India. *Climate and Development, 10*(5), 389–405.

Singh, C., Rahman, A., Srinivas, A., & Bazaz, A. (2018). Risks and responses in rural India: Implications for local climate change adaptation action. *Climate Risk Management, 21*, 52-68.

Sjoberg, L. (1998). Worldviews, political attitudes and risk perception. *Risk, 9,* 137.

Skees, J. R. (2008). Innovations in index insurance for the poor in lower income countries. *Agricultural and Resource Economics Review, 37*(1), 1-15.

Slovic, P. (1986). Informing and educating the public about risk. *Risk Analysis, 6*(4), 403-415.

Slovic, P. (1999). Trust, emotion, sex, politics, and science: *Surveying the risk-assessment battlefield. Risk analysis, 19*(4), 689-701.

Slovic, P., & Peters, E. (2006). Risk perception and affect. *Current Directions in Psychological Science, 15*(6), 322-325.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis: An International Journal, 24*(2), 311-322.

Smit, B., & Pilifosova, O. (2003). Adaptation to climate change in the context of sustainable development and equity. *Sustainable Development, 8*(9), 9.

Smit, B., & Skinner, M. W. (2002). Adaptation options in agriculture to climate change: a typology. *Mitigation and Adaptation Strategies for Global Change, 7*(1), 85-114.

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change, 16*(3), 282–292.

Smit, B., Burton, I., Klein, R. J., & Street, R. (1999). The science of adaptation: a framework for assessment. *Mitigation and Adaptation Strategies for Global Change, 4*(3-4), 199-213.

Smit, B., Burton, I., Klein, R. J., & Wandel, J. (2000). An anatomy of adaptation to climate change and variability. *Climatic Change, 45*(1), 223-251.

Smit, B., McNabb, D., & Smithers, J. (1996). Agricultural adaptation to climatic variation. *Climatic Change, 33*(1), 7-29.

Smit, B., McNabb, D., & Smithers, J. (1996). Agricultural adaptation to climatic variation. *Climatic change, 33*(1), 7-29.

Smith, N., & Leiserowitz, A. (2012). The Rise of Global Warming Skepticism: Exploring Affective Image Associations in the United States Over Time. *Risk Analysis, 32*(6), 1021–1032.

Smith, N., & Leiserowitz, A. (2012). The rise of global warming skepticism: Exploring affective image associations in the United States over time. *Risk Analysis, 32*(6), 1021-1032

Smith, N., & Leiserowitz, A. (2014). The role of emotion in global warming policy support and opposition. *Risk Analysis, 34*(5), 937-948.

Smithers, J., & Smit, B. (1997). Human adaptation to climatic variability and change. *Global Environmental Change, 7*(2), 129-146.

Soares, M. B., Gagnon, A. S., & Doherty, R. M. (2012). Conceptual elements of climate change vulnerability assessments: a review. *International Journal of Climate Change Strategies and Management, 4*(1), 6-35.

Songorwa, A. N. (1999). Community-based wildlife management (CWM) in Tanzania: are the communities interested? *World development, 27*(12), 2061-2079.

Soubry, B. (2017). *How Can Governments Support Adaptation to Climate Change by Small-Scale Farmers? A Case Study from the Canadian Maritime Provinces*. Oxford: Environmental Change Institute, University of Oxford. Retrieved December 2, 2018, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3035782

Spence, A, Poortinga, W., Butler, C., & Pidgeon, N. F. (2011). Perceptions of climate change and willingness to save energy related to flood experience. *Nature Climate Change, 1(*4), 46–49.

Spence, A., Poortinga, W., & Pidgeon, N. (2012). The psychological distance of climate change. Risk Analysis: *An International Journal, 32*(6), 957-972.

Speranza, C. I., Kiteme, B., Ambenje, P., Wiesmann, U., & Makali, S. (2010). Indigenous knowledge related to climate variability and change: insights from droughts in semi-arid areas of former Makueni District, Kenya. *Climatic change, 100*(2), 295-315.

Spodek, M., Ben-Dov, Y., Protasov, A., Carvalho, C. J., & Mendel, Z. (2014). First record of Dactylopius opuntiae (Cockerell) (Hemiptera: Coccoidea: Dactylopiidae) from Israel. *Phytoparasitica, 42*(3), 377–379.

Stern, P. C., & Dietz, T. (1994). The value basis of environmental concern. *Journal of Social Issues, 50*(3), 65-84.

Sullivan, A., & White, D. D. (2019). An assessment of public perceptions of climate change risk in three western US cities. *Weather, Climate, and Society, 11*(2), 449-463.

Sun, Y., & Han, Z. (2018). Climate change risk perception in Taiwan: correlation with individual and societal factors. *International journal of environmental research and public health, 15*(1), 91.

Sundblad, E. L., Biel, A., & Gärling, T. (2007). Cognitive and affective risk judgements related to climate change. *Journal of Environmental Psychology, 27*(2), 97-106.

Suryabhagavan, K. V. (2017). GIS-based climate variability and drought characterization in Ethiopia over three decades. *Weather and climate extremes, 15,* 11-23.

Swim, J., Clayton, S., Doherty, T., Gifford, R., Howard, G., Reser, J., & Weber, E. (2009). *Psychology and global climate change: Addressing a multi-faceted phenomenon and set of challenges.* A report by the American Psychological Association's task force on the interface between psychology and global climate change. American Psychological Association, Washington. Retrieved August 5, 2017, from https://s3.amazonaws.com/academia.edu.documents/30279188/climate-change.pdf?response-content-

Stoddard, E. A., & Cantor, A. (2017). A Relational Network Vulnerability Assessment of the North Carolina Hog Industry. *Annals of the American Association of Geographers*, *107*(3), 682-699.

Tambo, J. A., & Abdoulaye, T. (2013). Smallholder farmers' perceptions of and adaptations to climate change in the Nigerian savanna. *Regional Environmental Change*, *13*(2), 375–388.

Tarhule, A., & Lamb, P. J. (2003). Climate Research and Seasonal Forecasting for West Africans: Perceptions, Dissemination, and Use? Perceptions, Dissemination, and Use? *Bulletin of the American Meteorological Society*, *84*(12), 1741-1760.

Tenaw, S., Islam, K. M. Z., & Parviainen, T. (2009). *Effects of land tenure and property rights on agricultural productivity in Ethiopia, Namibia and Bangladesh.* Discussion papers No.33. Retrieved August 12, 2018, from http://www.fao.org/fileadmin/user_upload/fsn/docs/HLPE/Discussion_Paper_33.pdf

Teshome, A. (2006). *Agriculture, growth and poverty reduction in Ethiopia: policy processes around the new PRSP (PASDEP).* Research Paper 04. Retrieved March 18, 2018, from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.386.8131&rep=rep1&type=pdf

The World Bank. (2007). *Ethiopia - Accelerating Equitable Growth: Country Economic Memorandum Part 2: Thematic chapters*. Report No. 38662. Poverty Reduction and Economic Management Unit Africa Region. Retrieved August 18, 2017, from http://documents.worldbank.org/curated/en/949951468030574203/pdf/386621ET0v20REVISED.pdf

Tompkins, E., & Adger, W. N. (2004). Does adaptive management of natural resources enhance resilience to climate change?. *Ecology and society*, *9*(2).

Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., ... & Polsky, C. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the national academy of sciences*, *100*(14), 8074-8079.

Tyler, S., & Moench, M. (2012). A framework for urban climate resilience. *Climate and development*, *4*(4), 311-326.

Thomas, D. S., Twyman, C., Osbahr, H., & Hewitson, B. (2007). Adaptation to climate change and variability: farmer responses to intra-seasonal precipitation trends in South Africa. *Climatic Change, 83*(3), 301-322.

Russell., T. (1997). *Pair-wise ranking made easy*. International Institute for Environment and Development (LIED). PLA Notes, 25–26. Retrieved August 19, 2018, from https://pubs.iied.org/pdfs/G01675.pdf?

Tobler, C., Visschers, V. H., & Siegrist, M. (2012). Consumers' knowledge about climate change. *Climatic change, 114*(2), 189-209.

Tonini, F., Lasinio, G. J., & Hochmair, H. H. (2012). Mapping return levels of absolute NDVI variations for the assessment of drought risk in Ethiopia. *International Journal of Applied Earth Observation and Geoinformation, 18,* 564–572.

Torres, J. B., & Giorgi, J. A. (2018). Management of the false carmine cochineal Dactylopius opuntiae (Cockerell): perspective from Pernambuco state, Brazil. *Phytoparasitica, 46*(3), 331–340.

Totin, E., Traoré, S., Pierre, C., Zougmoré, R. B., Homann-Kee Tui, S., Tabo, R., & Schubert, C. (2015). *Barriers to effective climate change policy development and implementation in West Africa.* CCAFS Info Note. Copenhagen, Denmark. Retrieved July 24, 2018, from https://cgspace.cgiar.org/bitstream/handle/10568/68680/ICRISAT%20Info%20Note%20OCT19.pdf?sequence=1&isAllowed=y

Travers, M. (2001). *Qualitative Research through Case Studies*. London: Sage Publications.

Tripathi, A., & Mishra, A. K. (2017). Knowledge and passive adaptation to climate change: An example from Indian farmers. *Climate Risk Management, 16,* 195-207.

Tschakert, P. (2007). Views from the vulnerable: understanding climatic and other stressors in the Sahel. *Global Environmental Change, 17*(3–4), 381–396.

Tucker, J., Daoud, M., Oates, N., Few, R., Conway, D., Mtisi, S., & Matheson, S. (2015). Social vulnerability in three high-poverty climate change hot spots: What does the climate change literature tell us? *Regional Environmental Change, 15*(5), 783–800.

Tuli, F. (2010). The basis of distinction between qualitative and quantitative research in social science: Reflection on ontological, epistemological and methodological perspectives. *Ethiopian Journal of Education and Sciences,* 6(1).

Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., ... & Polsky, C. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences, 100*(14), 8074-8079.

Uddin, M. N., & Anjuman, N. (2013). Participatory rural appraisal approaches: an overview and an exemplary application of focus group discussion in climate change adaptation and mitigation strategies. *International Journal of Agricultural Research, Innovation and Technology*, *3*(2), 72-78.

UN (United Nations Department of Economic and Social Affairs). (2017). *Population Division. World Population Prospects: The 2017 Revision, Key Findings and Advance Tables.* Working Paper No. ESA/P/WP/248. Retrieved January 10, 2018, from https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf

UNDP (United Nations Development Programme). (2004). *Reducing Disaster Risks: A Challenge for Development.* A Global Report. New York. USA. Retrieved August 9, 2016, from http://www.undp.org/content/undp/en/home/librarypage/crisis-prevention-and-recovery/reducing-disaster-risk--a-challenge-for-development.html

USAID (United States Agency for International Development). (2004). *Ethiopia Land Policy and Administration Assessment*. Final report. Retrieved July 3, 2017, from http://rmportal.net/library/content/land-tenure-and-property-rights-documents/ethiopia-land-policy-and-administration-assessment/at_download/file

USAID. (United States Agency for International Development). (2015). *Climate Variability and Change in Ethiopia: Summary of Findings*. Technical Report. Washington, DC. Chemonics International Inc. Retrieved January 4, 2017, from https://www.usaid.gov/sites/default/files/documents/1866/12.22.15%20-%20ClimateVariabilityChange_Ethiopia_Dec2015%20%281%29.pdf

Van der Linden, S. (2014). On the relationship between personal experiences, affect and risk perception: The case of climate change. *European journal of social psychology*, *44*(5), 430-440.

Van der Linden, S. (2015). The social-psychological determinants of climate change risk perceptions: Towards a comprehensive model. *Journal of Environmental Psychology, 41,* 112-124.

Van der Veen, A., & Gebrehiwot, T. (2011). Effect of policy interventions on food security in Tigray, Northern Ethiopia. *Ecology and Society, 16*(1).

Virtanen, P., Palmujoki, E., & Gemechu, D. (2011). Global Climate Policies, Local Institutions and Food Security in a Pastoral Society in Ethiopia. *The Journal of Sustainable Development, 5*(1), 96–118.

Viste, E., Korecha, D., & Sorteberg, A. (2013). Recent drought and precipitation tendencies in Ethiopia. *Theoretical and Applied Climatology*, *112*(3–4), 535–551.

Wang, X. (2017). Understanding climate change risk perceptions in China: Media use, personal experience, and cultural worldviews. *Science Communication, 39*(3), 291-312.

Warner, K., & Van der Geest, K. (2013). Loss and damage from climate change: local-level evidence from nine vulnerable countries. *International Journal of Global Warming, 5*(4), 367-386.

Washington, R., Harrison, M., Conway, D., Black, E., Challinor, A., Grimes, D., … Todd, M. (2006). African climate change: taking the shorter route. *Bulletin of the American Meteorological Society, 87*(10), 1355–1366.

Watts, M. J., & Bohle, H. G. (1993). The space of vulnerability: the causal structure of hunger and famine. *Progress in Human Geography, 17*(1), 43-67.

Webb, P. (1993). Coping with drought and food insecurity in Ethiopia. *Disasters, 17*(1), 33-47.

Walker B, Abel N, Anderies JM, Ryan P (2009) Resilience, adaptability, and transformability in the Goulburn-Broken Catchment Australia. Ecol Soc 14(1):12

Walker, B., Holling, C. S., Carpenter, S., & Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and society, 9*(2).

Weber, E. U. (2014). Understanding public risk perception and responses to changes in perceived risk. In E. Balleisen, L. Bennear, K. Krawiec, & J. Wiener (Eds.). *Policy Shock: Recalibrating Risk and Regulation after Oil Spills, Nuclear Accidents and Financial Crises* (pp., 58-81). Cambridge: Cambridge University Press.

Weber, E. U. (2006). Experience-based and description-based perceptions of long-term risk: Why global warming does not scare us (yet). *Climatic change, 77*(1-2), 103-120.

Weber, E. U. (2010). What shapes perceptions of climate change?. *Wiley Interdisciplinary Reviews: Climate Change, 1*(3), 332-342.

Weldegebriel, Z. B., & Prowse, M. (2013). Climate-change adaptation in Ethiopia: to what extent does social protection influence livelihood diversification?. *Development Policy Review, 31*, o35-o56.

West, C. T., Roncoli, C., & Ouattara, F. (2008). Local perceptions and regional climate trends on the Central Plateau of Burkina Faso. *Land Degradation & Development, 19*(3), 289–304.

Westerhoff, L., & Smit, B. (2009). The rains are disappointing us: Dynamic vulnerability and adaptation to multiple stressors in the Afram Plains, Ghana. *Mitigation and Adaptation Strategies for Global Change, 14*(4), 317–337.

Whitmarsh, L. (2008). Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of Risk Research, 11*(3), 351-374.

Whitmarsh, L. (2011). Scepticism and uncertainty about climate change : Dimensions, determinants and change over time. *Global Environmental Change, 21*(2), 690–700.

Winterhalder, B. (1980). Environmental analysis in human evolution and adaptation research. *Human Ecology, 8*(2), 135-170.

Wilson, G. A., & Wilson, O. J. (2019). Assessing the resilience of human systems: a critical evaluation of universal and contextual resilience variables. *Resilience*, *7*(2), 126-148.
Zach, L. (2006). Using a multiple-case studies design to investigate the information-seeking behaviour of arts administrators. *Library trends*, *55*(1), 4-21.

Wolde-Georgis, T. (1997). El Nino and drought early warning in Ethiopia. *Internet Journal of African Studies*, (2).

World Bank (2014). *Ethiopia - Third economic update: strengthening export performance through improved competitiveness.* Washington, DC. World Bank Group. Retrieved January 3, 2017, from http://documents.worldbank.org/curated/en/560521468028152818/pdf/895480REVISED00c0Update0v0final0web.pdf

World Bank (n.d). *Ethiopia Economic Update. The inescapable manufacturing – Service Nexus: Exploring the potential distribution services.* Retrieved December 10, 2018, from http://documents.worldbank.org/curated/en/811791526447120021/pdf/126255-WP-PUBLIC-DIGITAL-Ethiopia-Economic-Update-The-Inescapable-Manufacturing-Services-Nexus.pdf

World Bank Group (2018): *Ethiopia Overview.* Retrieved December 10, 2018, from http://www.worldbank.org/en/country/ethiopia/overview

World Bank. (2010). *Ethiopia - Economics of adaptation to climate change.* Washington DC: World Bank. Retrieved August 10, 2018, from http://documents.worldbank.org/curated/en/310391468340238724/pdf/686500ESW0P1130UBLIC00EACC0Ethiopia.pdf

WFP (United Nations World Food Programme) (2008). *Food consumption analysis: Calculation and Use of the Food Consumption Score in Food Security Analysis.* Rome, Italy: United Nations. Retrieved May 19, 2017, from https://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf%3F_ga%3D2.156564155.1258612077.1548845587-217979373.1536222168

World Investment Report. (2018). *Investment and New Industrial Policies*. United Nations Conference on Trade and Development. Retrieved January 14, 2017, from https://unctad.org/en/PublicationsLibrary/wir2018_en.pdf

World Meteorological Organization. (2012). *Investing in weather and climate services for development*. *Integrated African Strategy on Meteorology. Weather and Climate Services.*

Retrieved August 1, 2017, from https://www.wmo.int/amcomet/sites/default/files/field/doc/pages/amcomet-integrated-african-strategy-meteorology-13677_en_0.pdf

Xue, W., Hine, D. W., Marks, A. D., Phillips, W. J., & Zhao, S. (2016). Cultural worldviews and climate change: A view from China. *Asian Journal of Social Psychology, 19*(2), 134-144.

Yanda, P., Mushi, D., Henku, A. I., & Maganga, F. (2013). *Tanzania National Climate Change Finance Analysis.* Shaping policy for development. London. Overseas Development Institute (DOI). Retrieved March 10, 2017, from https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8627.pdf

Yin. (2009). *Case study research: Design and methods* (4th ed). Thousand Oaks, Calif: Sage Publications.

Yohe, G., & Tol, R. S. (2002). Indicators for social and economic coping capacity—moving toward a working definition of adaptive capacity. *Global Environmental Change, 12*(1), 25-40.

Zainal, Z. (2007). Case study as a research method. *Jurnal Kemanusiaan, 5*(1).

Zhang, H., Henderson-Sellers, A., & McGuffie, K. (2001). The compounding effects of tropical deforestation and greenhouse warming on climate. *Climatic Change, 49*(3), 309-338.

Ziervogel, G., Bharwani, S., & Downing, T. E. (2006). Adapting to climate variability: Pumpkins, people and policy. *Natural Resources Forum, 30*(4), 294–305.

Ziervogel, G., Cartwright, A., Tas, A., Adejuwon, J., Zermoglio, F., Shale, M., & Smith, B. (2008). Climate change and adaptation in African agriculture. *Stockholm environment institute*, 17-19.

Zoomers, A. (2010). Globalisation and the foreignisation of space: seven processes driving the current global land grab. *The Journal of Peasant Studies, 37*(2), 429–447.

Zougmoré, R., Partey, S., Ouédraogo, M., Omitoyin, B., Thomas, T., Ayantunde, A., Jalloh, A. (2016). Toward climate-smart agriculture in West Africa: a review of climate change impacts, adaptation strategies and policy developments for the livestock, fishery and crop production sectors. *Agriculture & Food Security, 5*(1), 26.

Appendices

Appendix A: Project Ethics Approval Letter

30 June 2016

RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY
THE UNIVERSITY OF ADELAIDE

LEVEL 4, RUNDLE MALL PLAZA
50 RUNDLE MALL
ADELAIDE SA 5000 AUSTRALIA

TELEPHONE +61 8 8313 6137
FACSIMILE +61 8 8313 3700
EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

Dr T Wanner
School: School of Social Sciences

Dear Dr Wanner

ETHICS APPROVAL No: **H-2016-137**

PROJECT TITLE: **Analysing farmers' understanding and responses to environmental changes in Tigray Ethiopia**

The ethics application for the above project has been reviewed by the Low Risk Human Research Ethics Review Group (Faculty of Arts and Faculty of the Professions) and is deemed to meet the requirements of the *National Statement on Ethical Conduct in Human Research (2007)* involving no more than low risk for research participants. You are authorised to commence your research on **29 Jun 2016**.

Ethics approval is granted for three years and is subject to satisfactory annual reporting. The form titled *Annual Report on Project Status* is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/ethics/human/guidelines/reporting. Prior to expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain. It is also a condition of approval that you **immediately report** anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforeseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol; and
- the project is discontinued before the expected date of completion.

Please refer to the following ethics approval document for any additional conditions that may apply to this project.

Yours sincerely

DR JOHN TIBBY
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Arts and Faculty of the Professions)

DR JOANNA HOWE
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Arts and Faculty of the Professions)

Appendix B: Focus Group Discussion Guide

Focus group interview guides

1. **Questions without reference to climate change (Unprompted)**

A. What are the challenges that have influenced your life and livelihood over the past years?
B. How did [the challenges identified] affect your life and livelihoods?
C. What did you do to cope with [the challenges mentioned]?

2. **Specific questions related to climate change-linked conditions (Prompted)**

A. Did you experience major drought and flooding events over the past few decades?
B. How did [extreme weather events identified] affected your life/livelihood?
C. What kind of adjustment mechanisms have you made to cope with [the identified extreme weather events]?
D. Has any of your past adaptation responses failed? If yes, why?
E. Do you think your current adaptation measures are adequate? If not, why?
F. What supports do you get from institutions to adapt to the impacts of climate change?
G. Are you worried that [the conditions mentioned above] will be a problem in the future?

Appendix C: Interview guide

1. Interview guides for the Ministry of Environment, Forest and Climate Change, Ethiopia (MEFCC)

A. What are the main functions of the Ministry of Environment, Forest and Climate Change, Ethiopia (MEFCC)?

B. What are the main activities MEFCC is doing to support farmers to adapt to the impacts of climate change in Raya Azebo district?

C. In your view, what are the main constraints or challenges that hinder the implementation of the NAPA, NAP-ETH, and other national climate change adaptation policy documents into practice? If there are any constraints (challenges), please explain?

D. Are staff members in your institution familiar with the existing climate change policy documents? If no, why?

E. Do you share climate change related policy documents with other regional and local level staffs?

F. How well do you think the issues of climate change have been recognized in your institution?

G. Did you included regional and local level staffs when you formulate the NAPA and other relevant climate related national policy documents?

2. Interview guides for Tigray Environmental Protection and Land Use Administration agency and Tigray Regional State Bureau of Agriculture and Rural Development

A. What are the main activities your organization is doing to support farmers to adapt to the impacts of climate change in Raya Azebo district?

B. Are there any barriers that obstacle the translation of national and regional climate change adaptation policy documents into concrete adaptation action? If yes, please explain the major ones.

C. Are staff members in your organization well aware of the existing national and regional climate change adaptation policy documents? If no, why?

D. How well do you think the issue of climate change have been recognized in your institution?

E. Have you included local level staffs when you prepare the regional climate change adaption policy documents?

3. Interview guide for the Raya Azebo District Bureau of Agriculture and Rural Development and the Raya Azebo District Finance and Economic Development Office

1. In your understanding, what is climate change, what are its causes, and its impacts?
2. What do you know about national and regional level climate change adaptation policy documents?
3. Have you ever participated in national (regional) level consultative workshops when climate related policy documents were designed? Have you ever received a training on the issue of climate change?
4. Are there activities your office is currently doing to support farmers to adapt to the impacts of climate change in Raya Azebo district? If no, what are the challenges you face to assist farmers to adapt to climate change?
5. Do you receive any climate change related adaptation fund from federal and regional level government to support farmers in their adaptation efforts?

Appendix D: Household Questionnaire

Section 1: Demographic details of household heads

Gender	Male ☐ Female ☐
Marital status	Single ☐ Divorced ☐ Married ☐ Widow/ widower ☐
Age	-----
Educational level	Don't read and write ☐ Primary education ☐ Read and write ☐ Secondary education ☐ Higher education ☐
Religion	Orthodox Christian ☐ Muslim ☐
How many children do you have?	------
Main source of household income?	Labour on own/ other farm ☐ Casual off-farm labour ☐ Trading/ business ☐ Civil service /official ☐ School teacher ☐ Household/ domestic/ housewife ☐ Remittances ☐ Unemployed ☐

Section 2: Household income (Farm and non-farm sources)

In the last 12 months, have you or your household involved in the following activities listed below? If yes, please enter household annual income in Birr (from November 2015 –October 2016)

Description			Quantity	Unit price	Remark
Farm income	Milk produced (litters)				
	Eggs produced				
	Crops produced in (quintal or Kg)	1……			
		2……..			
		3……..			
		4……..			
	Land rent				
	Others				
Non-farm incomes	Petty trading				
	Craft activities				
	Daily labour				
	Remittance				
	Food for work				
	Seasonal migration				
	Others				

Section 3: Household assets

Livestock ownership

Livestock type	Oxen/ Cows	Bulls/ Heifers	Calves	Donkey	Goats	Sheep	Chickens	Honey bees s)	Others
Number of livestock the household has (present)									

Non-livestock assets

Assets type	Land	Cell phone	Radio	Ox cart	Hoes	Machetes	Flash light	Paraffin lamps	Solar light	Water pump	Tables	Chairs	water well	Chairs
Number of units owned														
Value price														

Section 4: Climate change (risk) perceptions

4.1 Climate change perception (observation)

Changes observed	Have you observed the following changes in your local climate?	
	Yes	No
Late onset of rainfall		
Early cessation of rainfall		
Unusual rains		
Low rainfall amount		
High temperature		
Frequent droughts		
Frequent flooding		

4.2 Climate change risk perception

Climate change risk perception	How concerned are you about climate change? A. Extremely concerned B. Very concerned C. Somewhat concerned D. Not concerned E. Not at all concerned
Drought experience	How often have you experienced climate change in your lifetime? ……
Holistic Affect	Please indicate the level that best describes your feeling associated with climate change? A. Very bad C. Fairley bad E. Fairly good B. Bad D. Neutral F. Good G. Very good

4.3 Knowledge about the causes of climate change

	Please state whether the following statements about the causes of climate change are correct/ incorrect		
Causes of climate change	Correct	Incorrect	I don't know
God's punishment			
Volcanic eruptions			
The sun's energy			
Fossil fuel use (contribute to C02)			
Deforestation			
Agricultural activities (excessive use fertilizer use, cattle breeding)			

4.4 The psychological distance of climate change

	Please indicate your level of agreement to the following statements				
Psychological dimensions	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
Geographic					
Climate change is likely to impact my local area					
Climate change will mostly affect places that are far from where I live					
Social					
Climate change will largely affect developed countries					
Climate change is likely to have greater impact on people like me					
Temporal					
We are already experiencing the impacts of climate change in Ethiopia					
We will start feeling the effects of climate change in the next 25 years					
Uncertainty					
I am certain that climate change is happening					
I'm uncertain what the impact of climate change will be					

4.5 Broad value orientation

For each of the 13 values listed below, please rate the options you value most in your life									
	Opposed to my value	Not important	Of little important	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of supreme important
Egoistic Values									
Social power (control over others)									
Wealth (money, material)									
Authority (the right to lead)									
Influential (having an impact on people and event)									
Altruistic values									
Equality (Equal opportunity for all)									
A world at peace									
Social justice (correcting justice)									
Helpful (caring for others)									
Biospheric values									
Preventing pollution									
Respecting the earth									
Unity with nature									

Protecting the environment									

Section 5: Drivers of livelihood vulnerability

Please rate the following stressors (factors) based on your perception of their impacts on your livelihoods					
Stressor type	Likert scale (1 = Not at all significant , 2 = least significant , 3 = Fairley significant 4= Significant, 5 = very significant				
	1	2	3	4	5
Drought					
Flood					
Erratic rains					
Forced fertilizer adoption					
Destruction of cactus plant					
Weak early warning system					
Ineffective extension system					
Land grabbing					
Lack of irrigation access					
Poor agricultural markets					
Low soil fertility					
Crop and livestock diseases					
Transport problem					
Poor roads					
Lack of electricity					
Unemployment					

5.1 Socio-economic impacts of drought

Please rate the socio-economic impacts of drought in your local area				
	High	Medium	low	
Socio-economic Impacts				
Reduces income				
Reduces yield				
Affects livestock production				
Increases food insecurity				
Increases food insecurity				
Increases malnutrition				

5.2 Questions related with fertilizer adoption

Questions in relation to fertilizer adoption	
Have you purchased fertilizer over the last 5 years?	A. Yes B. No
If yes, is it your decision or government forced you to buy fertilizer?	A. Personal decision B. Government push
Are you willing to use fertilizer on your farmland for the coming planting season?	A. Yes B. No
If No to the above question, indicate the main reasons why you don't want to use fertilizer?	A. Late delivery of fertilizer B. High fertilizer price C. High transportation costs D. Unfavourable climate (drought) E. Tight credit repayment
Did you borrow money over the last five years?	A. Yes B. No
If yes, what was your main purpose for borrowing money	A. Education B. Health expenses C. Ceremonial purpose D. Small business E. To meet basic needs F. To pay for fertilizer debt
Where you unable to borrow your loan in 2015?	A. Yes B. No

5.3 Questions in relation to cactus plant destruction

How important is cactus pear for your livelihoods?	A. Very important B. Important C. Less important D. Not important
For what purposes, do you use cactus plant?	A. Feed B. Cash income C. Fodder for animals D. As a fuel E. As soil and water conservation
If cactus was your livelihood income source how much is the amount of money you have lost from selling cactus fruit?	A. 400-600 ETB B. 700-1500 ETB C. > 1500ETB

5.4 Questions in relation to land grabbing

Have you lost land because of the agricultural investment in your local area?	A. Yes B. No
If yes, what is the size of land you have lost?	---------
Do you agree land certificate improve tenure security? (Affected and non-affected households)	A. Strongly agree B. Agree C. Disagree D. Strongly disagree
Are you worried that your land maybe vulnerable to land grabbing? (Perception of land tenure insecurity). (Non-affected households)	A. Very worried B. Worried C. Less worried D. Not worried
Do you feel confident to cultivate crops after 5 years in the same farmland? (Perception of land tenure security). (Non-affected households)	A. Yes B. No
Do you think that your fear of insecure land tenure affects your future climate change adaptation plan (e.g. SWC, Tree planting)? (Non-affected household)	A. Strongly agree B. Agree C. Disagree D. Strongly disagree

5.5 Questions about early warning information

Have you received drought early warning information in the 2015 drought?	A. Yes B. No
If yes, was it timely?	A. Yes B. No
From who did your receive the early warning information?	A. Local media B. Extension agents

5.6 Questions related to agricultural extension system

Do you have access to extension services?	A. Yes B. No
Please rate the level of agricultural-related support your receive from extension agents	A. Vary high support B. High support C. Very little support D. No support
How satisfied are you with the extension program or service?	A. Strongly satisfied B. Satisfied C. Moderately satisfied D. Dissatisfied E. Strongly dissatisfied

Section 6: Questions to determine food security status of respondents

6.1 Coping strategy index (CSI) to determine food security situation

Coping strategy index (CSI) to determine food security situation (Adapted from Maxwell, 2008).			
Coping strategy: In the last 7 days, how did you cope when you do not have enough food, and do not have the money to buy food?	Frequency: Number of days out of the seven past (put 0-7 to answer the frequency of days: use NA for not applicable)	Severity of each strategy: Least severe= 1, moderate = 2, Severe=3 Very severe =4	Weighted score =Frequency x Severity
a. Rely on less preferred and less expensive foods			
b. Borrow food from a friend or relative			
c. Purchase food on credit			
d. Gather wild food, hunt, or harvest immature crops			
e. consume seed stock held for next season			
f. Send children to eat with neighbours			
g. Send household members to beg			

h. Limit portion size at mealtimes			
i. Restrict consumption by adults for small children to eat			
j. Feed working members of HH at the expense of non-working members			
k. Reduce number of meals eaten in a day			
l. Skip entire days without eating			
Total household score			Total=

6.2 Food consumption score (FCS) to determine food security status

Food consumption score (FCS) to determine food security status (Adapted from World Food Programme. WFP, Monitoring Food Security – Technical Guidance Sheet 2, November 2011).

Food item	Food group	Weight (A)	Days eaten in the past 7 days (B)	Score = A X B
Maize, rice, sorghum, millet, bread, and other cereals	Cereals and tubers	2		
Cassava, potatoes, and sweet potatoes				
Beans, peas, groundnuts, and cashew nuts	Pulses	3		
Vegetables, relish, and leaves	Vegetables	1		
Fruits	Fruit	1		
Beef, goat, poultry, pork, eggs, and fish	Meat and fish	4		
Milk, yoghurt, and other dairy products	Milk	4		
Sugar and sugar products	Sugar	0.5		
Oils, fats, and butter	Oil	0.5		
Composite score				

Section 7: Farm household adaptation to climatic and non-climatic stressors and opportunities

7.1 Farm-related adaptation strategies

Changes	If you have made the following changes in your farming practice, please state your primary reason (motivation)												
	Climate-related reason	Low market price	Low (high) yield	Poor soil	Pest and disease	Small land	Labour constraint	High market demand	Desire for more income	Government support	Desire for more income	To balance food demand	To avoid reliance on rain-fed agriculture
Changed crop types													
Adopted improved seeds													
Diversified crops													
Adjusted planting dates													
Adopted irrigation													

7.2. Non-farm related adaptation strategies

Type of non-farm/off-farm activity	Have you conducted the following strategies over the last five years? If you did, please mention your primary reason				
	Climate related	Poor agricultural market	Lack of access to agricultural land (land shortage)	Desire to earn more income	Other reasons
Non-farm (owning-small shops; selling local food and traditional alcohol drinks and wage employment)					
Off-farm (working on other agricultural farms, collecting and selling firewood)					

Non-farm related adaption strategy (Migration)

	If you (your) family members have conducted temporary migration) over the last 5 years, please state the primary motivation
Land scarcity/landlessness	
Unfavourable climate condition	
Lack of employment opportunities	
To repay fertilizer debt	
For education reason	
Family reason (marriage)	