PERCEPTIONS, VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN ETHIOPIA

Seyoum Yunkura Hameso

US- 2021

Perceptions, vulnerability and adaptation to climate change in Ethiopia

Seyoum Yunkura Hameso (PhD)

New York – 2021

Perceptions, vulnerability and adaptation to climate change in Ethiopia

15.03.2021

ISBN 978-1-955094-02-3

15.03.2021 by
Liberty Academic Publishers
New York, US

Cover design by Andrew Singh

New York- 2021

Perceptions, vulnerability and adaptation to climate change in Ethiopia

About the book

Climate change is one of the most complex problems of our time presenting unique challenges for societies. For developing countries such as Ethiopia, it complicates existing challenges of development. The problem is aggravated for Sidama's smallholder farmers' who depend on rain-fed agriculture to produce coffee for global market and Enset for subsistence. Yet farmers' understanding and responses to climate change have not been seriously acknowledged nor empirically studied.

This book explores perceptions, vulnerability and adaptation to climate change. More specifically it seeks to explore, document and analyse perceptions of climate change, examine vulnerability of farmers and their adaptation strategies as well as the state of mainstreaming climate change adaptation to development policy in Ethiopia.

Dr. Seyoum Yunkura Hameso is Assistant Professor of Economics, at the Department of Economics, College of Social Sciences, Hawassa University, Ethiopia. Formerly, he taught at the University of East London and University of West London, UK.

Acknowledgements

In the course of preparing this book, and the research work it is based on, I received support from numerous people. I wish to thank a number of people who offered assistance of one sort or another. Among them are: Steffen Abele, Ayano Baraso, Trygve Berg, Allan Brimicombe, Matewos Dangiso, Andrew Dorward, Giorgia Dona, Argaw Fantu, Salvatore Di Falco, Tesfaye Gissilla, Atote Hameso, Bereket Kebede, Kathryn Kraft, Mauro Ghirotti, Maggie McPherson, Senait Solomon, Worku Tesemma, Meera Tiwari, Admasu Tsegaye, Julia Volz, Myles Wickstead, and Manfred Zeller. Moreover, I wish to thank the participants, in different focus group discussions, semi-structured interviews and surveys, who shared valuable time and thoughts. Nonetheless, errors of omission or commission remain mine.

Table of contents

List of abbreviations & acronyms

ADLI	Agriculture Development Led Industrialization (Ethiopia)
AEZ	Agroecological Zone
AfDB	African Development Bank
ASAP	Adaptation for Smallholder Agriculture Programme, IFAD
ATA	Agricultural Transformation Agency (Ethiopia)
Birr	Ethiopian Birr, also ETB
CAQDAS	Computer Assisted Qualitative Data Analysis Software
CDM	Clean Development Mechanism, Kyoto Protocol
CO_2	Carbon dioxide, the most important greenhouse gas
CoP	Conference of the Parties, annual summit of UNFCCC
CRGE	Climate Resilient Green Economy (Ethiopia)
CSA	Central Statistical Authority (Ethiopia)
DCG	Drylands Coordination Group (Africa)
DFID	Department for International Development (UK)
EEA	Ethiopian Economics Association
EIAR	Ethiopian Institute of Agricultural Research
ENSO	El Niño Southern Oscillation
EPA	Environmental Protection Agency (Ethiopia)
EPRDF	Ethiopian People's Revolutionary Democratic Front
ESRC	Economic and Social Research Council (United Kingdom)
EU	European Union
FAO	Food and Agriculture Organization (United Nations)
FGD	Focus group discussion
GCMs	General Circulation Models
GDP	Gross Domestic Product
GEF	Global Environment Facility
GERD	Grand Ethiopian Renaissance Dam
GHGs	Greenhouse gases (mainly CO_2, N_2O, and methane)
GPS	Global Positioning System
GoE	Government of Ethiopia
GTP	Growth and Transformation Plan
HU	Hawassa University
HYVs	High Yield Varieties (crops), also hybrid seeds
IDS	Institute of Development Studies
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IIED	International Institute for Environment and Development
ILRI	International Livestock Research Institute
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-Tropical Convergence Zone
LDCs	Least Developed Countries
masl	Metres above sea level
MDGs	Millennium Development Goals
MFIs	Microfinance Institutions
MoARD	Ministry of Agriculture and Rural Development (Ethiopia)
MoEF	Ministry of Environment and Forests (Ethiopia)
MoFED	Ministry of Finance and Economic Development (Ethiopia)
MoH	Ministry of Health (Ethiopia)
MoWE	Ministry of Water and Energy (Ethiopia)

N_2O	Nitrous oxide, a greenhouse gas
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Programme of Action
NGO	Non-governmental organisation
NMA	National Metrological Agency (Ethiopia)
NORAD	Norwegian Agency for Development Cooperation
OECD	Organisation for Economic Co-operation and Development
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PSNP	Productive Safety Net Programme
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SHFs	Smallholder farmers
SIDA	Swedish International Development Agency
SLF	Sustainable Livelihood Framework
SLUF	Sustainable Land Use Forum (Ethiopia)
SNNPRS	Southern Nations & Nationalities Peoples Regional State
SPSS	Statistical Package for the Social Sciences
SOS Sahel	'Save Our Souls' Sahel (Ethiopia)
SSA	Sub-Saharan Africa
TNAs	Technology Needs Assessments
UEL	University of East London
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	United States Dollars
WB	World Bank
WHO	World Health Organisation
WMO	World Meteorological Organization
WVE	World Vision Ethiopia

List of figures

List of tables

Chapter 1: Background

1.1 Introduction

Climate change[1] is one of the most urgent and complex challenge for societies and economies (Corner *et al.,* 2012; Giddens, 2009; UNDP, 2007). For developing countries, climate change complicates existing challenges of poverty eradication (Hassan, 2010; Hope, 2009; Adger *et al.,* 2003) and the realization of Millennium Development Goals (Sachs, 2007; Sumner and Tiwari, 2009). Left unaddressed climate change contains the potential to reverse progress on development and to compromise the wellbeing of the current and future generations (World Bank, 2010b, p.37). While adaptation to climate change is necessary for all countries that seek to reduce the current impacts of climate change and increase resilience to future impacts, it is highly relevant for developing countries whose societies are already struggling to meet the challenges posed by existing climate variability (Yamin *et al.* 2005; Adger *et al.*, 2003). For these countries, adaptation has grown from a minor environmental concern to a major challenge for human development and a crucial element in eradicating poverty (Davies *et al.,* 2008).

The IPCC made a case for more extensive adaptation by expressing the need for deep understanding of options and barriers to adaptation which are not fully understood (IPCC, 2007c, p.14). Other scholars recommended in-depth studies into farmers' adaptation noting that existing studies on adaptation in Africa produce very general results at a highly aggregated level and consider few adaptation options (Dinar *et al.,* 2008). Moreover, the dominant discourse of adaptation is top-down managerialist approach starting with international bodies cascaded to national authorities through negotiations and financial transfers whereby national and international climate policy regimes fail to reach the poor and vulnerable or they tend to plan interventions for communities instead of supporting initiatives led by communities (Yamin *et al.*, 2005). To be effective, global efforts need to be aligned with local realities and focused 'on how policy can support the adaptive capacity and resilience of vulnerable communities' (Adger, 2003a, p.192). In other words, successful adaptation requires synergy at different

[1] Key terms related to climate change such as vulnerability, adaptation an adaptive capacity are explained in detail in chapter 2, section 2.1.

levels (BASIC, 2007) starting at the grass roots level, in this case, smallholder farmers.[1]

Smallholder farmers make significant contribution towards food in security sub-Saharan Africa producing up to 80 per cent of the food (IFAD, 2013; AGRA, 2014). In Kenya, Ethiopia, Uganda and Tanzania, for example, smallholder agriculture accounts for about 75 per cent of agricultural production and over 75 per cent of employment (Salami *et al.*, 2010). Other studies note the importance of smallholder agricultural growth for poverty reduction through its impacts on labour and grain markets (Dorward *et al.,* 2004). On the other hand, smallholder farmers and poor farmers in particular lack assets, social networks, mobility, and political power, commonly cited as being critical for adaptation (Tanner and Mitchell, 2008; AfDB *et al.*, 2003). These conditions are compounded by limited information available for adaptation decision-making (including poor climate information from meteorological records, limited dissemination, and low scientific understanding of climate change and its impacts on development), weak institutions and governance (including unclear mandates, weak planning systems, un-inclusive service delivery, and a lack of accountability or participation in decision-making), and lower resources with which to respond (Tanner and Horn-Phathanothai, 2014).

These deficiencies, in turn, translate to low adaptive capacity. While this characterisation is broadly acceptable, there is a counter argument that farmers exhibit elements of resilience through unique factors including family labour, a store of indigenous knowledge[2] and possible diversification away from agriculture (Leonard *et al.,* 2013). Moreover, the traditional agroecosystems inhibited by smallholder farmers are noted to be less vulnerable to *catastrophic loss* because they grow a wide range of crop varieties in various spatial and temporal arrangements (Altieri and Koohafkan, 2008). Home gardening agroforestry that

[1] Smallholder farmers are understood as 'farmers using predominantly family labor and for whom the farm provides their main source of income and livelihood' (Johansen *et al.,* 2012, p. 19).
[2] Being the custodians of local knowledge, farmers are said to have detailed understanding of soils, relief, vegetation and water movements, and recommended policy makers to draw on knowledge and experience from local communities (Altieri and Koohafkan, 2008). Admassie et al (2008) intimate that farmers' knowledge of the environment passed down through generations offer invaluable information regarding adaptation to changing climatic conditions that would not likely be acquired through other means.

combines crops, trees and livestock is cited as an example that provides multiple services for households. Similarly, conservation agriculture is described as 'an antidote to non-viable agricultural production and continual land degradation' (Mavunganidze *et al.,* 2013). A study from Uganda, for example, indicated that conservation agriculture reduced the cost of preparing land for agriculture. In addition to growing more food, this approach decreased the use of chemical fertiliser and pesticides, saving farmers money, reducing pollution and allowing depleted soils to recover (Munang and Nke, 2011, p.1515). Thus, the landscape approach where farming is integrated with forestry and other land uses is recommended as a means to cope with environmental degradation while expanding agricultural production.

In spite of in-built resilience factors, there is no denying that smallholder farmers are among the most affected since their livelihoods are directly dependent on climate sensitive economic sector, namely, agriculture. In the case of Ethiopia, 95% of agricultural activity (which is primarily smallholder farming) is dependent on rainfall to the extent that the country's GDP growth rate is closely associated with the pattern of rainfall distribution and agricultural production. Studies link annual rainfall with crop yield and GDP growth (World Bank, 2006). However, later studies found such a link to be weaker than originally thought (Conway and Schipper, 2011). Nonetheless the link persists in less diversified agricultural systems dominated by few crops such as coffee and maize. Agricultural production in these systems is generally affected by climatic variables such as temperature, precipitation, wind conditions and water availability. According to Intergovernmental Panel on Climate Change (IPCC), rising temperature and changing precipitation patterns affect crop growth, livestock performance, water availability and the functioning of eco-system services (IPCC, 2007a). The World Bank (2010b, p.41) reckons that due to rising temperature, people's exposure to malaria, dengue and cardiovascular illnesses increase especially in the tropics. It expects diarrheal diseases to increase up to 5% by 2020 in countries with per capita incomes below $6,000, while declining agricultural yields in some regions would increase malnutrition, thus reducing people's resistance to illness. The World Health Organisation as well predicted that the above diseases would worsen as the climate changes (WHO, 2013).

In agrarian economies such as Ethiopia, smallholder farmers are subjected not only to health and related impacts of climate change but also to forces of globalisation – hence 'double exposure' (Leichenko and O'Brien, 2008; Morton, 2007; Adger, 2004). Thus it is imperative to explore responses to environmental change in the context of wider socio-economic change brought on by economic transformation and globalisation (Kent & Dorward, 2015). Globally, smallholder farmers form a vital part of the wider agricultural community, yet their role is often ignored and they are hard hit by climate change impacts that are locally specific and hard to predict (IFAD & UNEP, 2013). Hence it is particularly essential to examine how they develop worldviews and cultural values, how they generate and share knowledge on climate change.

In the case of coffee, studies on Central America predicted that climate change will shift the altitude range to higher elevations over time, with the optimal altitude shifting from 1200 metres above sea level (masl) at present to 1400 masl in 2020 and 1600 masl in 2050 (Laderach *et al.,* 2008). Furthermore, the IPCC predicted a reduction in areas suitable for coffee production by 2050 with increases of temperature of 2.0-2.5°C. In Brazil, the world's biggest coffee producer, a temperature rise of 3°C would reduce the area suitable for coffee production by two-thirds in the main growing states of Minas Gerais and Sao Paulo (IPCC, 2014).

In the case of Africa, a study in Uganda (Ben, 2005) predicted that an increase in temperature by an average of 2°C would drastically reduce the production of Robusta Coffee, Uganda's major export crop, therefore limiting it to highlands. Similar conclusion is drawn for tea in Kenya (OECD, 2003) where the total area suitable for growing tea may be dramatically reduced with a temperature increase of 2°C, with only higher-elevation areas to remain suitable for tea growing while other areas would become too hot to grow tea. Given the proximity and similarity of the Ugandan and Kenyan cases to Ethiopia, it is extremely useful to understand the implications of climate change on the production of the country's Arabica coffee.

Given the impacts of climate change on livelihoods, response efforts to address them contain two vital steps.[1] The first is to perceive the risks of climate change; the second is to decide on adaptation measures and both steps involve risk management and decision-making (Maddison, 2007). Peoples' perceptions are contextual, grounded on complex set of social, political and environmental settings. Perceptions about climate change and especially about its causes are filtered through local knowledge, values and moral norms. The IPCC (2007c, p.14) recognised that perception about climate change is about human behaviour, which is one of the least understood components of the climate system. Therefore it is important to understand how differently situated communities perceive, interpret and act on climate change (Litre *et al.*, 2014). The importance is magnified in the face of the claim that climate vulnerability studies ignore local perceptions and contexts that define quality of life and wellbeing (O'Brien *et al.,* 2004a). Improving understanding of perception about climate change calls for a thorough exploration.

Whilst Ethiopia remains the least studied (Deressa *et al.,* 2009), the case of Sidama, a region with a population of over 3.6 million, is even more wanting. Sidama's smallholder farmers are heavily vulnerable to shocks, yet their perceptions and vulnerability are largely undocumented and least studied (Hameso, 2014b). The paucity of studies on Sidama is in contrast to growing literature in other parts of the world, for example, Roncoli et al (2002) on Burkina Faso, Taylor et al (2014) on UK, Crate and Nuttall (2009) on northern hemisphere, Mortreux and Barnett (2009) on Tuvalu, Petheram et al (2010) on Australia, and Abid et al (2014) on Punjab, and Juana et al (2013) on Sub-Sahara Africa. Apart from perception of climate change, there is a lack of comparative assessment of vulnerability of different social groups and ecosystems resulting in poor understanding of vulnerability to climate change. This study aims to deepen understanding of smallholder farmers' vulnerability and adaptation to climate change by comparing three agroecological zones AEZs) of Sidama, namely the highlands, midlands and lowlands.

In broader sense, vulnerability is generated by multiple factors and processes, geography and climate variability being important elements that impinge on 'social

[1] Adaptation in particular requires people to notice the change in climate (Maddison, 2007) followed by identification of adaptation measures and implementation.

relations of resource access, political and economic marginalization, loss of employment opportunities, and weakening of social networks' (Eriksen *et al.*, 2007, p.3; Quinn *et al.,* 2011). In the context of Africa, economies and communities face two-fold impacts of climate change. The first is direct impact linked to projected increase in extreme weather events,[1] and the second is indirect impact linked to declining productivity of the natural resource base due to 'watershed erosion, loss of soil productivity, loss of woodlands and forests, desertification, coastal erosion, and loss of aquatic and terrestrial biodiversity' (World Bank, 2009, p.xviii). The more dramatic explanation of the scope of the challenge is described as the earth entering 'the sixth mass extinction of species' resulting from the loss of biodiversity threatening valuable ecosystem services and human well- being (Ceballos, et al., 2015).

Given the magnitude of the challenges of direct and indirect impacts of climate change, business-as-usual approaches fall short of dealing with existing climate vulnerabilities let alone increased levels of risks or the emergence of new risks in the future (Yamin *et al.,* 2005, p.2). In order to reduce vulnerabilities of smallholder farmers to climate change, the application of appropriate coping and adaptation strategies is indispensable. These strategies need to tune to complex adaptation needs of smallholder farmers due to the variety of crop and livestock species involved compared to commercial farms with more restricted range of crops that have access to irrigation and mechanization. Further empirical research is needed on the circumstances under which current strategies to cope with extreme events foster or constrain farmers' longer-term adaptation (Morton, 2007).

Existing studies identified a number of adaptation measures at different levels, both micro and macro. Focusing on the case of the Nile Basin of Ethiopia, Deressa et al (2009) identified micro or household level strategies such as crop and livestock diversification, the use of drought-tolerant crop varieties and livestock species, mixing crop and livestock production, and membership in rotating credit

[1] The results of direct impacts of climate change include reduced crop yields and livestock productivity, drinking water shortages, reduced potential for hydroelectricity, spread of diseases such as malaria, potential migration and social strife, increased cost of infrastructure maintenance and development, and increased pressure on service delivery and fiscal resources (World Bank, 2009).

groups locally known as *Equb.* Other studies identified migration and diversification as strategies to reduce vulnerability by spreading risks (Ellis, 2000a).

At the macro level, national adaptive capacity is dependent on social infrastructure and the accountability of institutions (Adger *et al.*, 2004). Since both micro and macro level adaptation strategies are context specific, the above studies do not offer comprehensive account of the available options in the local context. Building on the work of Agrawal (2010), this study offers comprehensive exploration of various adaptation options in Sidama. As part of such explanation, the next sections present the scope of the study, background to Sidama and the policy framework of climate change in Ethiopia.

1.2 Scope & significance of the study

The scope of this work is delimited by geography, livelihood system, and response measures to climate change. With regards to *geography*, this study is framed within the context of developing countries. Among them, Sub-Saharan Africa is the region with special vulnerabilities including poorly developed infrastructure and transport, energy, information, and communication systems (World Bank, 2009; Hassan & Nhemachena, 2008). Within SSA, Ethiopia is one the most affected by climate change due to its low level of economic development, heavy dependence on rain-fed agriculture and high population growth (Conway and Schipper, 2011; Eshetu *et al.,* 2014); yet research on the impacts of climate change has remained remarkably fragmentary (Conway *et al.*, 2007).

Historical climate data show that average temperature in Ethiopia has increased by 0.37 °C in every ten years for the last fifty years (1951-2006). The country's National Adaptation Programme of Action (NAPA) recognised that adaptive capacity varies between sectors and geographic locations within the country (NMA, 2007). Accordingly, a number of climate change related analysis focused on the Nile Basin region of Ethiopia while other areas tended to be neglected. For example, there are no studies on climate change in Sidama. Yet there are strong signals that the landscape is changing so much so that the highlands are gradually

converting to midland conditions. Like comparable cases around the world, these changes are altering not only the way smallholder farmers live, but also their strategies to secure basic living standards, including the opportunity to earn income and meet material needs, preserve health and basic education, and maintain a sense of social and cultural affiliation (Eriksen *et al.*, 2007).

In terms of livelihood systems, the study focuses on a livelihood system of a Coffee-Enset[1] culture – a system of production for market and subsistence. The focus is justified by the recognition that future ability to cope with climate change is supported by specific knowledge about where, when, and how much climate change will affect human communities (Wheeler, 2011, p.4). As climate change is expected to increase in the coming decades, there is a growing realisation that vulnerable communities will face disproportionate and adverse consequences. While abundant literature explored vulnerability and adaptation to climate change worldwide, the case of rain-fed agricultural livelihoods of Ethiopia is scarce (Deressa *et al.,* 2010; Conway *et al.*, 2011; Ching *et al.*, 2011; Admassie *et al.,* 2008). Within Ethiopia, the case of smallholder farmers largely dependent on coffee and Enset is the least studied and merits attention.

Coffee, as the main cash crop and crucial to livelihood in Sidama, is under threat from increasingly irregular rainfall pattern and rising temperature. *Enset* or *Weese*, also described as a 'tree against hunger' (Brandt *et al.*, 1997), remains an important and highly nutritious plant with valuable traits of nutritional, cultural or economic value. Yet its growers are said to 'have undergone a gradual process of impoverishment over the past three decades' (Dougherty, 2002). These contrasting findings beg a question as to what is going on in reality and why vulnerability persists in a visibly green landscape. Therefore, the presumption of a 'tree against hunger' needs to be investigated in the face of vulnerability of the population to climate change and other stressors. The choice of Enset and coffee livelihoods provides interesting insights to explore the need for particular policy options not only in the face of vulnerability to climate change, but also for food

[1] Known as *Weese* in Sidamuaffo*,* enset, also spelt *ensete,* is a plant similar to banana, thus sometimes called false banana due to its striking similarity to the banana plant. It furnishes the main staple food, fibre for handicrafts, ropes, leaves for shelter, by-products for animal feed (Ghirotti, 1998).

security and poverty reduction. Even though the work is limited to a specific livelihood system and region, its findings offer useful understanding of similar contexts in Africa and beyond.

In terms of response measures to climate change, the scope of the book is confined to adaptation rather than mitigation of climate change. The reason to prioritise adaptation as important and urgent policy imperative and research agenda rests with the fact that mitigation efforts to reduce greenhouse gases will take time and are often fraught with complicated and protracted international negotiations (Burton *et al.,* 2003; Pielke *et al.,* 2007; Fankhauser, 2009; Heuson *et al.,* 2014). The lack of progress on reducing emissions through policy has frustrated policy makers in developing countries (Schipper, 2004, p.11).

The challenges in international climate policy have their roots in divergent views among the countries of the global North and South about how best to tackle the challenges of climate change. In the North, the issue is articulated as environmental imperative of emissions reduction, implying that mitigation is more relevant to advanced industrial economies that contributed most of the GHG emissions (Pettit, 2004). In the global South,[1] the issue is closely linked to the development of the countries whose contribution to global warming is relatively small, and yet need to adapt to reduce their current and future vulnerability to climate change (Pettit, 2004; Shalizi and Lecocq, 2009). For these countries, an intuitively appealing approach is to enhance the flexibility and resilience of systems to react to and cope with climate change (Fankhauser *et al.*, 1999, p.67). Subsequently, several countries have initiated a process of adaptation by designing strategies and action plans for public adaptation measures (Heuson *et al.,* 2014, p.27). Ethiopia submitted a National Adaptation Programme of Action (NAPA) in 2007. Thus assessing adaptation policies at different scales makes substantive contribution to policy and research.

The other reason to prioritise adaptation is the fact that the climate is changing and adaptation is a matter of necessity by all countries (Shalizi and Lecocq, 2009). In recent decades, anomalous and extreme weather events have increased in ways

[1] The disparity in views between the two groups of countries contributed to slow and protracted negotiations on international climate policy.

consistent with modelling projections, indicating that climate change is already happening (Tanner and Mitchell, 2008). Thus, even if stabilisation or reduction in GHG emissions were to be achieved, the climate system is already changing and the damage will be large unless investment is made on adaptation to develop adaptive capacity and reduce future vulnerability to climate change (Parry *et al.*, 2008, p.69; IPCC, 2007b). The result of such investment – both in adaptation research and practice – is to enhance the flexibility and resilience of systems to cope with climate shocks and extremes (Fankhauser *et al.*, 1999, p.67). In the spirit of contribution toward adaptation research, this book confines itself to adaptation rather than mitigation.

The last reason to prioritise adaptation is linked to the benefits of adaptation. The benefits of successful adaptation include sustained or increased agricultural production, higher household incomes, enhanced environmental services, protection of the asset base, and less vulnerability to extreme weather events (IFAD, 2013). Adaptation links well with development imperative to the extent that it is equated to good development (Agrawal, 2010), and, if properly handled, helps farmers boost food security and gain sustainable livelihoods. Thus adaptation needs more attention than was previously the case (Huq and Reid, 2004, p.15). Moser and Ekstrom (2010) rightly noted that adaptation is a topic of scientific inquiry in the 21st century in local and international policy and planning.

The justifications for prioritising adaptation are not intended to discount the importance of research into mitigation of climate change. Quite the contrary, mitigation is a vital response to avoid dangerous climate change. In this regard, some progress is made to treat both mitigation and adaptation supplementary to each other rather than trade-offs (e.g. van Vuuren, 2011). Thus the question is no longer of whether to mitigate or adapt; both are essential in reducing the risks of climate change (Eriksen *et al.,* 2007, p.3). Such is the case for agricultural sector, which, rather than being portrayed as victim, also possesses the potential to address climate change. Some studies exist indicating the mitigation options in agriculture (Robbins, 2011; Sumi *et al.,* 2010). Robbins (2011), in particular, explored practical and ethical grounds to pay farmers to combat climate change. Others proposed reducing meat consumption as a valuable climate change

mitigation strategy (Laestadius *et al.,* 2014; Westhoek e*t al,* 2014). Indeed there are a plethora of mitigation actions that are not part of this book. Prominent among them is the new mechanism of Nationally Appropriate Mitigation Actions (NAMAs)[1] expected to enable large-scale emission reductions in developing countries. It is a signal that, by pursuing less carbon-intensive growth, developing countries can decouple development from GHG emissions. As a practicable policy tool and as a matter of priority, however, this area is at early stage of development (Wang-Helmreich *et al.*, 2011) and it is not the focus of this book.

The significance of this book lies in its topicality and relevance. The contemporary world is experiencing social, technological and environmental change at unprecedented pace, across a variety of scales and possible pathways of change (Leach *et al.,* 2007, p.1). Moreover, the climate change processes under study are dynamic and interact in complex ways. Within the context of changes, studying perceptions, vulnerability and adaptation to climate change is current and important as global warming poses significant challenge to already existing problems of poverty and development (Adger *et al.*, 2003; Davies *et al.,* 2009). For as long as climate change is occurring and more change is anticipated with significant vulnerability of societies and systems to its impacts, gaining deeper understanding of the subject is timely and critical across communities, space, and disciplines.

For developing countries such as Ethiopia, climate related research is crucial for practical and theoretical reasons. In practice, knowledge emerging from empirical research and specifically from agroecology-based research would inform policy by pointing to relevant appropriate adaptation technologies (Deressa *et al.,* 2009). Consequently, this book engages with the critical phases in climate change starting with perception, vulnerability and adaptation to climate change. Previous works examined each phase separately, for instance perceptions (Litre *et al.,* 2014; Mengistu, 2011; Mubaya *et al.,* 2012), adaptation (Adger *et al.,* 2003; Agrawal,

[1] According to the Cancun Agreement, NAMAs initiate the following actions: a) developing country Parties will take nationally appropriate mitigation actions in the context of sustainable development, supported and enabled by technology, financing and capacity-building, aimed at achieving a deviation in emissions relative to 'business as usual' emissions in 2020; and b) that internationally supported mitigation actions will be measured, reported and verified domestically and will be subject to international measurement, reporting and verification in accordance with guidelines to be developed under the Convention (UNFCCC, 2011).

2010; Bryan *et al.,* 2009; Conway, 2011; Hassan & Nhemachena, 2008) or both (Abid *et al*., 2014; Admassie *et al.,* 2008; Hameso, 2014a; Juana *et al.,* 2013). This book explores all of the above aspects of climate change in holistic manner by focusing on a view from the bottom starting with a survey of rural people's knowledge and experience of climate change.

One of the main purposes of adaptation research is exploring relative vulnerability of countries, regions or communities (Adams *et al.*, 1998, p.283). This work seeks to gain deep understanding of relative vulnerability of farmers within the context of multiple stressors including climate change. It offers first hand insight into who is vulnerable, to what stress, in what way, and what capacity exists to adapt to changing risks (Ford and Smit, 2004; Conway *et al.*, 2011). In addition to identifying vulnerability, the book contributes to practical initiatives by investigating adaptive capacity and needs in a particular region or community (Smit and Wandel, 2006), Sidama in this case.

Theoretically, the study deploys sustainable livelihood framework which was initially applied in poverty reduction, wellbeing and development contexts, but only rarely and sparsely used in climate change studies. The framework is recommended as a useful approach to understand household and community resilience and analysing vulnerability in the context of developing countries (Lautze *et al.,* 2003). By deploying the framework under climate change, this study offers deeper insight into the relationship between vulnerability and adaptive capacity of cash crops and staple food livelihood system under environmental risk, thus contributing to on-going debate on a topical and important problem of the time.

Finally, this study addresses some of the concerns raised in recent research on climate change. A previous study that reviewed the literature[1] on human dimensions of climate change using qualitative method drew attention to the following drawbacks:

> [T]he period and length of fieldwork and the number and types of interviews conducted are … not always clear. Information on crucial aspects of qualitative

[1] Articles published in *Global Environmental Change* journal between 2000 and 2012

> research like researcher positionality, social positions of key informants, the use of field assistants, language issues and post-fieldwork treatment of data is also lacking in many articles. We argue that this lack of methodological information and reflections is particularly problematic in an interdisciplinary field such as climate change research and journals such as Global Environmental Change and that clearer communication is key to facilitate truly interdisciplinary dialogue (Nielsen and D'haen, 2014, p.402).

This study addresses, in different parts and sections dealing with methodology, all aspects of these concerns including researcher positionality, as discussed in the prologue to this book. Moreover, the study's objectives and questions are explicitly stated in the next section.

Main objectives

The aim of this study is to explore perceptions, vulnerability and adaptation of smallholder farmers to climate change in the context of sustainable livelihoods. The specific objectives are:

- to find out how people in Ethiopia and particularly smallholder farmers of Sidama perceive climate change,
- to examine comparative vulnerability of different rural households to climate change,
- to analyse response strategies pursued by smallholder farmers to adapt to climatic change,
- to investigate barriers and institutional changes required for greater resilience and increased adaptive capacity,
- to assess policy and institutional measures undertaken to mainstream climate change in development policy, and
- to recommend measures that contribute toward sustainable livelihoods.

Based on the above-mentioned objectives, the study poses the following questions with a view to answer them:

- How do people in Ethiopia in general and smallholder farmers of Sidama in particular perceive climate change?
- Which categories of farmers are more vulnerable to climate change?
- What strategies are pursued to adapt to climate change?
- What are the factors that support farmers' adaptation to climate change?
- What are the barriers and institutional changes required for greater resilience to climate change?
- What is the state of mainstreaming climate change adaptation to development policy in Ethiopia?

- Are there any positive opportunities for smallholder farmers from climate change?

The attainment of these research objectives involves in-depth exploration of the background to Sidama, policy dimension of climate change in Ethiopia and the selection of suitable methods and analytical tools to study perceptions, vulnerability and adaptation to climate change.

The implications of the research include, among others, a better understanding of the perception of smallholder farmers and the pursuit of bottom-up approach in assessing who/what is vulnerable to climate change in order to support national and international efforts in adapting to climate change. Besides the research intends to make a contribution toward conceptual approach integrating perceptions, vulnerability and adaptation to climate change via sustainable livelihoods framework. The study also explores possible opportunities and benefits from climate change in Sidama context. Finally, the study creates and develops information base for policy on vulnerability, adaptive capacity and resilience.

1.3 Background to Sidama

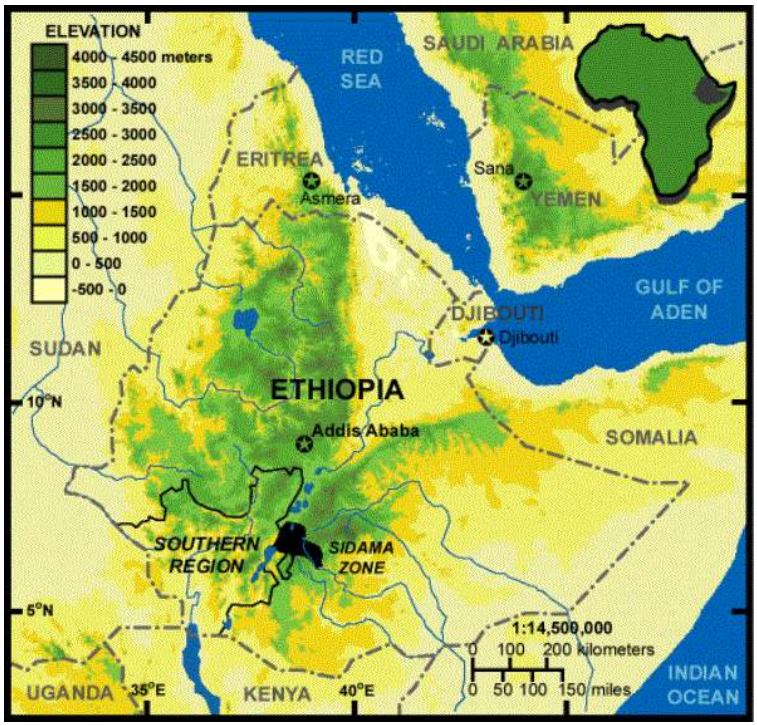
Sidama is located in Southern Ethiopia[1] (Fig 1). It has a total population of over 3.6 million[2] (CSA, 2007) and total land size of 6972 square kilometres. Its population density of 506 people per square km makes it one of the highly dense parts of the country with the average for Ethiopia[3] being 83 persons (CSA, 2011).

[1] Sidama is bounded by Oromiya region in the north, east and south east, with Gedeo zone in the south and Wolayta zone in the west. It lies between $6^0$14' and $7^0$18' North latitude and 37^0 92' and 39^0 14' East longitude.

[2] These numbers are imputed from the 2007 Population and Housing Census of Ethiopia using annual population growth of 2.9%. In 2007, Sidama zone, has a total population of 2,954,136 of which 2791504 (94%) were rural inhabitants. Note that the statistical figures exclude Hawassa town for unknown reasons. If Sidama population residing in Hawassa is included, the total population would be larger than 3.6 million.

[3] Ethiopia's population in 2011 was 85 million and it is expected to be 92 million in 2014.

Figure 1: Location of Sidama in Ethiopia



The elevation of Sidama ranges between 501 and 3000 meters above sea level having three agroecological zones (AEZs) with annual mean temperature of 10°C to 27°C and annual mean rainfall ranges between 801 mm and 1600 mm.

Altitude is the key influence on livelihood systems, farming practices, human settlement, temperature and rainfall distribution. Accordingly, the highlands (locally known as *Alichoo*) lie at the altitude of over 2000 masl; they are often characterised by rugged mountainous terrain. Their average annual rainfall is 1800 mm and the mean annual temperature is 16°C. About 28% of Sidamaland is highlands. The midlands (*Gamoojje*) lie between 1600 to 2000 masl in elevation and an average annual rainfall of about 1500 mm and 17°C average annual temperature. This temperate zone covers 45% of Sidama. The lowlands (*Qolla*) range between 500 and 1600 masl in altitude, with mean annual rainfall of 600 mm, and the mean annual temperature of 23°C. Largely located in the Rift Valley, these lowlands cover 27% of Sidama.

In each of the above ecozones, farmers engage in a range of agricultural activities. In the highlands, the dominant activity is the production of Enset and livestock rearing. The midlands are known for coffee production and animal husbandry

where a typical garden contains a combination of different food and cash crop species (Ghirotti, 1998). Besides coffee, a stimulant plant called Khat[1] (also known as *chat* and *cat*) (*Catha edulis*) is also grown here as a cash crop. The lowlands specialise mainly in maize production and animal husbandry. Most of the lowlands are located in the Rift Valley, the deep volcanic rift that extends from the Red Sea through the Eastern Africa and Mozambique to Indian Ocean. Large lakes in and around Sidama, including Lake Abaya and Lake Hawassa, are part of the Great Rift Valley. Yet, irrigation agriculture which would otherwise have decoupled water availability from rain dependency, is undeveloped. The same applies to basic infrastructure. For example, there are only 879 kilometres of all-weather roads (including 95 km of asphalt road) and 213 km of dry-weather roads with an average road density of 161 km per 1,000.[2] The economy is predominantly agrarian where rural residents account for over 94% of the population. Smallholder farming is the dominant activity for the majority of the people (over 90%) like elsewhere in rural Ethiopia (Devereux and Guenther, 2007).

Sidama's rural livelihoods are at risk due to several factors, an important one being climate change. Weather conditions in the highlands have gradually converted to midland conditions while the lowlands are transforming into semi-desert conditions. Paradoxically, increased aridity and drought occur amid erratic rain and heavy flooding. For instance, in April 2013, heavy rainfall in the midland and highland areas caused localized flooding in Lokka Abayya as the Bilaate River overflowed. This has affected more than 3,500 people leading to livestock deaths, damaged houses and infrastructure, as well as damage to over 600 hectares[3] of crops in Sidama and its surrounding areas (WFP, 2013).

Difficulties have also been reported in the areas that grow crops, mainly maize, hence known as the Maize Belt, due to 'population growth, declining landholding sizes, deforestation, land degradation, declining soil fertility, erratic and insufficient rainfall, and dependency on relatively expensive agricultural inputs

[1] From 24 June 2014, Khat is banned in the UK classified as a class C drug.
http://www.bbc.co.uk/news/uk-wales-south-east-wales-27991393 (Accessed: 20 July 2014)
[2] SNNPR Bureau of Finance and Economic Development
http:// www.snnprbofed.gov.et/Reports/Roads.xls (Accessed: 10 May 2014)
[3] 1 hectare = 10,000 m or 100 m^2 In some areas farmers refer to *timad*, which is the quarter of a hectare.

that require regular and adequate rainfall for production' (USAID, 2005). Moreover, common to some other areas in Ethiopia (Kebede and Adane, 2011), Sidama has experienced food insecurity, diminishing water resources, erratic and torrential rainfall causing floods and inundation of crop fields near riverbanks and lakesides, flooding of crop fields, and the spread of malaria. What makes the Sidama case unique is the constellation of marginality and socio-economic inequity that extends for over a century. Despite tumultuous political changes of one sort or another, a kind of 'infrastructure of inequality' persisted in modern Ethiopia, which feeds from two sources, namely, the nationality and the land question. Historically, Sidama had been incorporated into the Ethiopian empire in 1896 (Hamer, 2009; Aadland, 2002; Hameso, 2006). The outcome of the conquest subjected the Sidama people to serfdom locally known as the *gabbar* system that compelled subjects to surrender their labour and a portion of their produce to settlers from the North. John Hamer, an American social anthropologist aptly described this historical inequity in the following way:

> By the 1920s the northern Amhara conquerors had largely completed their mission of *protecting* [emphasis added] the Ethiopian south. Those who did not return north were given land in the far south of Sidamaland as a reward for their service and Sidama who remained on this land were forced to give one third of their harvests as rent. The 1974 Revolution brought this practice to an end (Hamer, 1987, pp.41-42).

While the notion of mission to protect is debatable, it is widely acknowledged that the 1974 revolution enthroned the military dictatorship that terminated some aspects of empire polity and its exactions; yet it maintained and consolidated other aspects of inequity. For example, the ownership of land was transferred from individual *gabbar* owners to state domain via the act of nationalisation of the rural and urban land in 1975. The accompanying land reform provided a partial, and by no means a full, answer to the land question. The 'Land to the Tiller' motto, enthusiastically embraced by progressive student movement of the late 1960s, was particularly popular among peoples who had borne the brunt of the *gabbar* system. However, the popularity of the revolution was short lived for as long as the communist experiment by the Derg meant that farmers were left with reduced control over their labour or the produce from land. Besides the state monopoly policies of grain boards and marketing restrictions arrested the potential of farmers to improve their livelihoods. Eventually, severe repression and

concomitant violent conflicts within the country and with neighbouring states created perpetual sense of emergency and eventually beckoned the demise of the Derg regime.

In 1991, with the collapse of the Derg, Ethiopia was set for yet another, equally pervasive social engineering of the polity, economy and society. Amid tumultuous changes, a constant feature is the historical legacy of neglect and economic and political marginalisation. Moreover, land (the most critical element in any agrarian economy as a livelihood asset), is rendered the prerogative of state, serving as the source of patronage and political leverage – having important implications on the organisation of livelihoods. Politically, since 1994 until the present, Sidama has been administered in one of the 9 regions known as Southern Nations, Nationalities and Peoples Region (SNNPR). Within this administrative framework, the Sidama Zone is divided into 19 rural districts (*Woredas*) with 527 rural villages (Kebele*s*) and two administrative towns.[1]

By outer appearances, Sidama is visibly lush green and fertile. Writers described the Sidama landscape as characterised by mosaic clusters of homesteads consisting of round huts that are interspersed by patches of farm fields and open land for grazing cattle and surrounded by gardens of coffee and Enset plants (Aadland, 2002). The wider use of agroforestry by farmers as a land use system integrating trees and shrubs with crops and/or livestock production plays part in maintaining resilience but it also conceals important aspects of vulnerability. Beneath appearances lies deeper susceptibility to combined environmental and socio-economic shocks. The state of vulnerability varied according to the prevailing political context. For instance, in response to field research conducted in the 1980s that asked farmers in Sidama about the problems faced in crop production, the majority (60%) mentioned land shortage followed by problems of too much time spent on government initiated peasant association work, sickness, lack of inputs and land erosion as factors negatively impacting on production

[1]The names of these districts are: Hawassa Zuria, Malga, Wondo-Genet, Gorche, Wonsho, Chuko, Loka-Abaya, Bursa, Bona-zuria, Chire, Shebedino, Dalle, Alata-Wondo, Dara, Hula, Aroresa, Bansa, Arbagona and Boricha woredas. The two towns are Alatta Wondo and Yirgalem Town Administrations excluding Hawassa town.

(Ghirotti, 1998)[1]. Some of these problems, as manifested in food insecurity and poverty, are still prevalent today.

Food insecurity is rampant among segments of population suffering from 'hidden hunger' or what can euphemistically be referred to as 'green famine' associated with micronutrient deficiencies. As the result, some households barely meet their food needs and therefore rely on food assistance even during average rainfall years. A recent research involving households from highland and midland zones of Sidama found that about 75% respondents were moderately to severely food insecure (Regassa and Stoecker, 2011, p.1276).

Amid food insecurity, farmers live and respond to multiple stressors of poverty, low agricultural productivity, price volatility and climate change by growing plants and crops, the most frequent ones being Enset, coffee and maize in the highlands, midlands and lowlands, respectively. Due to their importance on livelihoods, further explanation of these plants and crops is in order.

Enset or Ensete *ventricosum* is a long-lived, banana-like perennial plant used as main staple food in Sidama and its surroundings. Additionally, its multiple benefits include fibre for handicrafts, ropes and leaves for shelter, as well as by-products for animal feed (Dougherty, 2002; Ghirotti, 1998). Variously called as a tree, a crop or a plant,[2] it is grown at elevations ranging from 1,100 to more than 3,000 masl. Enset is known as *Weese* in Sidama, *Weessee* in Gedeo, *Weessii* among Gujii Oromo, *Weise* in Kambata and *Asat* in Gurage. It is widely grown in the southern and south western regions of Ethiopia where it supports the livelihoods of 20 million farmers (Brandt *et al.,* 1997). For the Sidama, it plays a central and multi-purpose role in the life of the people where it remains the most essential plant with vital nutritional worth and food security.

[1] Ghirotti's original research was carried out in 1998 and his MSc dissertation was entitled: Farming systems, household economics and child malnutrition in Sidama: an international course for primary health care managers at district level in developing countries. Rome, Istituto Superiore di Sanità.

[2] Enset is also described as a perennial herb that grows to a height of about 4-8 m tall (sometimes even up to 11 m) consisting of an adventitious root system, an underground stem structure known as a corm, a pseudostem, which is distinctly dilated at the base by leaf sheaths that extend from the base of the plant, leaves and inflorescence (Tsegaye, 2007). In this study, it is referred as a plant and Weese in Sidamuafo.

Enset has multiple benefits. Apart from ensuring food security, it has environmental value. In their extensive study, Brandt et al (1997) described it as drought resistant tree instrumental for food security. In his outstanding study, Ghirotti (1998) underscored environmental value of Enset whose higher canopy and humidity maintains other plants including coffee, kale, yam, and other vegetables. Its functions are summarised as follows:

> Enset furnishes the main staple food which is potentially available throughout the year, fibre for handicrafts, ropes, leaves for shelter, by-products for animal feed. Preferably when the plant is 6-8 years old, the pseudostem is scraped in order to obtain 'bula,' [*sic*] the most valuable food made from the juice, and 'wasa,' [*sic*] which is obtained from fermentation of the solid residue and can easily be stored in the ground for over two years. Production per plant is about 30 kg though an eight years old plant can produce up to 40 kg of wasa [*sic*] (Ghirotti, 1998)

The food produced from Enset take the form of *Waasa* (kocho), *Bulla* (the starchy product separated from *Waasa* during initial processing), and *Hamiicho* (fleshy inner part of the corm). While *Waasa* is a dietary staple for Sidamas, nearly all parts of Enset are put to use to the extent that daily life is functionally inseparable from some or all parts of Enset. The pseudostem and the corm are processed to form food products. Its leaves are used in the process of baking bread, for wrapping, lining the fermentation pit, protection from heat and rain, the production of string and rope, making mats, and even for making women's skirt while and the remaining fibre is used for making strong ropes, twine and sacks (Negash and Niehof, 2004, p.62).

The processing of *Waasa* (food) is linked to anther important dimension, namely, gender and associated roles. The Sidama society is reported to be patrilineal and women do not inherit land in either their own or their husband's clan (Hamer, 1987). Yet women are said to be the custodians of Enset to the extent that it is called 'the crop of women' among the neighbouring Gedeo people (Kanshie, 2002). Similarly, an interesting connection could be made with findings of studies in West Africa which noted that 'although women have relatively less access to and control over resources, their command over food and the care of children gives them indirect leverage in decisions concerning the allocation of resources' (Adams *et al.*, 1998). In recent times, minor changes took place in the form of land certification programme which assigns farmers written user-rights to demarcated pieces of

land having a greater emphasis on gender equity by issuing certificates in the name of both spouses (Bezabih *et al.,* 2012). Overall, however, rural women here as elsewhere in Africa are particularly affected by climate change because of their role in natural resource management and nutrition (World Bank, 2009). In the case of Sidama, the technology used for the plantation or harvesting of Enset, and the production or storage of *Waasa* is undeveloped and remained largely traditional with little or no application of modern technology. Effective innovation or research on the plant is hardly applied. One reason for this is the localisation of Enset whereas grains such as maize, wheat, barley and *teff* take priority for research and innovation.

Coffee is one of basic cash crops in Sidama and one of the most important export items for Ethiopia. Except for some dry lowlands and cool highland areas of Sidama, most midland districts produce coffee for sale and for domestic consumption. As the prime cash crop, coffee is crucial to social and economic wellbeing but its sustainability is under threat from increasingly irregular rainfall pattern and rising temperature as well as coffee berry disease. Thus coffee is highly weather dependent where and too little water sucks the tree dry and too much fuels a fungus. For example, a fungus commonly known n Central America as rust is reported to kill coffee trees in the past six years, and scientists speculated that the region could lose up to 40 percent of its coffee crop (Stone, 2014).

In addition to coffee and Enset, farmers in Sidama grow maize and a number of other crops and fruit bearing trees. Khat, sugar cane and eucalyptus trees are also grown to generate income and complement cash requirements. The ubiquitous eucalyptus tree is spread throughout Sidama having both positive and negative impacts.[1]

Livestock is reared in nearly all AEZs lending to the credence of mixed crop-livestock livelihood systems. Livestock play an important role by serving as a store of value and by providing traction and manure required for soil fertility maintenance (Deressa *et al*., 2008). The Sidama attach high social value to livestock. Cows in particular are held with special regard in cultural and economic

[1] It serves as a source of income on the one hand and as an agent of soil degradation on the other.

life. Culturally, ownership of cows determined one's social status. Economically, they provide income and important dietary supplements of meat, butter and milk. Under agricultural intensification observed in many parts of Sidamaland, maintaining livestock and planting Enset and other crops compete for limited landholding. As the result, livestock in all AEZs face threat by shortage of pastureland and near depletion of communal grazing fields. This meant many smallholder farmers are unable to maintain even one or two dairy cows that provide their families with milk and income from milk sales with direct link to nutrients deficiencies and malnutrition (see also Ghirotti, 1998). Therefore livestock and other livelihood assets of smallholder farmers in face intense stress emanating from economic, social, political and environmental challenges. These challenges do not only start and end at the local level, but they also link up with broader, national, regional and global factors, climate change being one.

In summary, the above sections illuminated the background to Sidama. This context is inextricably linked with the boarder policy and institutional setting in Ethiopia. Consequently, the following section offers brief explanation of the background of Ethiopia's climate change related policies and institutions.

1.4 Background to Ethiopia and climate change policies

Ethiopia is an East African country with immense geographical diversity and topographical variation. It has a population of 92 million. The economy is based on agriculture which contributes 42-45% of the country's GDP, 80% of employment, and 90% of foreign exchange earnings (Zenebe *et al*., 2011). Among important crops, coffee accounts for over 35% of export earnings and more than 25% of the population depend on coffee production and trade. Ethiopia is the third largest producer of coffee in Africa, and the tenth largest in the world (McCarthy, 2007). According to AfDB (2010), more than 95% of total coffee was produced by smallholder farmers.

The physical climate of Ethiopia is characterised by tropical monsoons. Elevation is the main determinant of local microclimate and due to its diverse terrain Ethiopia has different seasonal rainfall patterns. On the basis of altitude, three key AEZs are

identified: *Dega* (2300-3200 masl), *Woyna Dega* (1500-2500 masl) and *Kolla* (500-1500 masl), representing highlands, midlands and lowlands, respectively (IFPRI, 2006).[1] These zones are then characterized by three main seasonal rainfall patterns. The seasons are *Bega* (October-February), *Belg* (March-May) and *Kiremt* (June-September). *Bega* is a dry season during which the entire country is dry, with the exception of occasional rainfall that is received in some parts. *Belg* season exhibits light rainy season and it is the main source of rainfall for water-deficient southern parts of Ethiopia. *Kiremt* season is the main rainy season and covers most of Ethiopia. During this time, Ethiopia is subject to oscillatory Inter-Topical Convergence Zone (ITCZ) whose movements are sensitive to variations in the Indian Ocean's sea-surface temperatures[2] (Seleshi and Zanke, 2004, p.975; McSweeney *et al.,* 2010). This means that the onset and duration of rainfall seasons vary inter-annually resulting in frequent droughts. The cause of this variability is known as El Niño[3] Southern Oscillation (ENSO) which is a complex interaction of the tropical, Pacific Ocean and the global atmosphere that results in irregularly occurring episodes of changed ocean and weather patterns in many parts of the world. The impacts include altered marine habitats, rainfall changes, floods, droughts and changes in storm patterns (UNISDR, 2009).

On the basis of the abovementioned economic and environmental background, the broader policy framework in the context of development and climate change in Ethiopia is determined by overarching institutional and governance set up. Ethiopia is located in strategically important part of East Africa and is a host to the African Union. The current ruling polity emerged from the coalition of ethno-

[1] The Atlas of the Ethiopian Rural Economy (IFPRI, 2006) goes further and divides AEZs in Ethiopia into six. *Bereha* refers to hot lowlands of less than 500 masl. *Kolla* refers to lowlands between 500 and 1,500 masl. *Woyna Dega* refers to highland between 1,500 and 2,300 meters. Dega refers to highland between 2,300 and 3,200 masl. *Wurch* refers to highland between 3,200 and 3,700 masl. *Kur* refers to highland areas above 3,700 meters. For practical reasons and due to their relevance, the first divisions are adopted in this study.

[2] Climate change may increase the strength and frequency of the oscillation.

[3] El Niño and La Niña refer to sustained sea surface temperature anomalies of magnitude greater than 0.5°C across the central tropical Pacific Ocean, El Niño being a warming and La Niña is a cooling event. El Niño is associated with reduced rainfall in the main wet season, July to September, causing severe drought and famine in north and central Ethiopia while it increases rainfall in February to April season in southern Ethiopia (McSweeney *et al.*, 2010). On the other and, the cool phase events (La Niña) are associated with increased Atlantic cyclones, and they have the cooling effect on the surface of the central and eastern Pacific Ocean. La Niña occurs every two to five years and keeps East Africa drier than usual and sparks food security concerns in areas lacking irrigation and therefore dependent on rainfall (IRIN, 2011) 'East Africa: La Niña-induced drought "to affect millions"' http://www.irinnews.org/report/91966/ east-africa-la-ni%C3%B1a-induced-drought-to-affect-millions. (Accessed 18 February 2014).

national political forces called Ethiopian Peoples' Revolutionary Democratic Front (EPRDF) with the Tigrayan People's Liberation Front (TPLF)[1] as dominant element. The TPLF is one of the groups that conducted armed rebellion in the 1980s and secured victory over the Derg and formed Transitional Government in 1991.[2] In 1995, Ethiopia was declared to be a Federal Democratic Republic with 9 regions.[3] Although most of the country is constitutionally structured along ethno-linguistic federalism, forming ostensibly ethnically homogeneous regions. The Sothern Nations Nationalities and Peoples' Region (SNNPR) is an exception with over 56 'nations, nationalities and peoples' sheathed as a single region. This arrangement is the cause of trepidation most notably for Sidamas to whom the region is but a tool to restrict local autonomy and socio-economic development. The associated issue of land is the source of additional consternation. It is not the first time the question of land became critical; indeed, the history of Ethiopian polity is littered with the problem.[4]

Politics in Ethiopia is an overly complicated business. In theory, the country is a multi-party democracy. Periodic elections were held in 1995, 2000, 2005 and 2010 with the next election slated for 2015. The election in 2005 marked an important milestone when opposition parties demonstrated strong performance. Yet the results were marred by violence and vote irregularity and the incumbent assumed victory. After evaluating and reflecting on 2005 electoral debacle, the EPRDF approached subsequent elections with restricted political space and it easily won the 2010 election with 99.6% of parliamentary seats. The resulting dominant single party rule made it easy to pass laws without opposition input or critical

[1] The TPLF emerged from the Tigray region (which has the population of 6 million). The EPRDF comprises four political entities, namely, the Tigrayan People's Liberation Front (TPLF), Amhara National Democratic Movement (ANDEM), Oromo People's Democratic Organisation (OPDO), and Southern People's Democratic Movement (SPDM).

[2] The Transitional Government lasted until 1994. It was guided by a Charter signed by the parties that convened the June 1991 Conference.

[3] Initially there were 14 regions from 1991-1994. In 1994 the regions were reduced to 9 regions after five regions in the South were amalgamated to become the SNNPR where Sidama was subsumed as a part. The merger had wider socio-political and economic ramifications for constituent peoples and nations.

[4] Farmers hold the land but the right to legal ownership of land is currently vested in the State According to the 1995 Ethiopian Constitution Article 40 (3) the 'right to ownership of rural and urban land, as well as of all natural resources, is exclusively vested in the State and in the peoples 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 transfer.' Article 89 (5) adds that 'Government has the duty to hold, on behalf of the People, land and other natural resources and to deploy them for their common benefit and development.' (Constitution of the Federal Democratic Republic of Ethiopia Proclamation No. 1/1995. Addis Ababa. 21 August 1995).

oversight. For example, the most controversial laws were passed during the tenure of the post-2005 parliament. They include laws that relate to civil society or NGOs, security related laws (anti-terrorism legislation), media laws (e.g. press freedom), and land lease laws. Subsequently, a situation has developed that clashes with freedoms and entitlements enshrined in the Constitution of 1995 including the right to freedom of assembly, association and speech. The dominant single party rule meant grey areas for separation of powers and accountability of the legislative, executive and the judiciary resulting in concentration of power among the few elite or interest groups who exercise unconstrained power. It also meant that highly centralised governance imposed itself to consolidate control in a multi-ethnic country fraught with historical inequity, quite in contrast to the formally announced federal and decentralised political architecture. Michael Halderman (2004) captured the legacy of centralisation by arguing that policy-making and implementation in Ethiopia are strongly influenced by a long history of centralised, hierarchical systems of control under Imperial rule and nearly two decades of military rule by the Derg. According to the same author, although the EPRDF has successfully met many of the challenges through political, administrative and financial decentralisation, the centralised and controlling legacy remains an important factor.

The political apparatus that the EPRDF established is suspended on conflicting paradigms – with rhetoric diverging from reality – seeking legitimacy from two sources: involvement with external sources and internal delivery of fast economic growth. An example of the former is the geo-political condition of a country with a large population and relative stability in a conflict-ridden region. Geo-political imperative and security considerations, especially the 'War on Terror', by key Western donors made Ethiopia the major recipient of development assistance involving a wide-range of efforts by multilateral and international organisations, bilateral development agencies and NGOs in support of the government (Halderman, 2004).

The economic growth imperative rests on the country's GDP growth rate, which has run into double digits in the last decade enabling it to foster international partnerships on development and regional security. The ruling EPRDF party

pursues 'Revolutionary Democracy' ideological policy framework to guide a 'developmental' state, presumably along the lines of East Asian countries of the 1970s and 1980s. It maintains a heavy-handed approach on the economy tightly regulating banking, telecommunications, power and shipping. The government asserts that its policies have significantly reduced headcount poverty in Ethiopia from 59% in 1992 to 29.5% in 2011 (MoFED, 2012).[1] Independent studies, for example, Oxford Poverty and Human Development Initiative (OPHI, 2014)[2] contest that the percentage of total population in severe poverty in Ethiopia stands at 71% of which 82% are rural and 21% are urban. The results of such studies bear credence in the face of growing inequality amid a highly inflated role of state in the economy – a situation that renders the gates wide open for rent seeking opportunities linked to land administration and crowding out private sector investment through government's direct ownership and regulation of the financial sector.

The claims of the government about progress and contested realities notwithstanding, the social, economic and environmental challenges facing Ethiopia are enormous. If Africa is said to be highly vulnerable to future climate change, Ethiopia is often cited as one of the most extreme examples (Conway and Schipper, 2011). For a long time, Ethiopia remained a country with deep experience of famine and it continues to be haunted by the spectre of food insecurity. Recurrent drought, famine and recourse to food aid became the most pronounced features. In their recent study, Viste et al (2013), listed the following drought episodes in Ethiopia: 1972-75, 1984, 1987, 1990-92, 1999-2000, 2002-03, and 2008-11. The year 2009 was the second driest year, surpassed only by 1984. In the last four decades alone, the country has suffered from serious droughts, some resulting in starvation and/or death of millions of people.

Apart from drought, soil erosion and land degradation are among the most critical and far ranging environmental issues affecting Ethiopia due to increased crop

[1] Despite the assertion and possible efforts to reduce poverty, rural poverty remains severe and deep in the rural areas including the study area.
[2] Oxford Poverty and Human Development Initiative (OPHI) is based on multidimensional poverty index, which involves three dimensions and 10 indicators: Education (years of schooling, child school attendance), Health (child mortality, nutrition) and Living standard (electricity, improved sanitation, safe drinking water, flooring, cooking fuel, assets).

cultivation in marginal areas and livestock grazing pressure (Mckee, 2007). As the most recent studies indicate agricultural landscapes in parts of Ethiopia have undergone unprecedented changes along unsustainable direction as manifested in land degradation, biodiversity loss, and low agricultural productivity (Assefa and Bork, 2014).

Addressing climatic risks and socio-economic problems had remained an important policy challenge. The two recent governments (the Derg and EPRDF) adopted different policy measures to deal with the long-standing problems. In his critical assessment of the environmental policy of Ethiopia in the 1980s, Hoben (1995) noted that in the wake of the 1985 famine, the Derg government launched an ambitious programme of environmental reclamation claimed to be the largest food-for-work programme in Africa. Supported by donors and NGOs, the programme involved peasants constructing soil and stone bunds on agricultural land and building hillside terrace as well as enclosure to plant trees in community woodlots. Yet the programme performed poorly due to a number of reasons. First, it was based on inadequate scientific and technical knowledge. Second, it was implemented with a standardized approach with little regard to regional or local agroecological conditions. Third, the views and interests of the rural men and women it was intended to benefit were not solicited or heeded. Its implementation was rather top-down, authoritarian and politicized. The Derg regime was weak or authoritarian or both without institutional capacity to hear and learn from the rural people (*ibid.,* p.1019). Finally, the discourse and environmental policy were driven by neo-Malthusian narrative.

As if history repeats itself, the same argument can be had about the EPRDF regime. Just as it has been in the past, rural development policies and programmes represent what Adams et al (1998) call 'a hasty response to crisis and political exigency.' Another author laments the continuation of 'top-down and centrist approach in the planning and management of development schemes … [as] the features of the current regime' (Debelo, 2011, p.49). It has to be said, however, that there are some differences between the policies of the Derg and its successor.

Unlike the Derg, the EPRDF government recognises drought as the most threatening climate-related hazard posing significant threat to the livelihood systems in the country (NMA, 2007). Indeed the government had no shortage of policies although the real challenge lies in the speed and scope of implementation. In the last two decades, it devised a number of agricultural policy measures to deal with the natural and socio-economic exigencies. Examples include Agricultural Development Led Industrialisation (ADLI), the Sustainable Development and Poverty Reduction Programme (SDPRP), the Plan for Accelerated and Sustained Development to End Poverty (PASDEP), Household Extension Packages (HEP), Voluntary Resettlement Programme (VRP) and other social protection interventions such as disaster prevention and risk management, the Productive Safety Net Programme (PSNP), weather-indexed drought insurance and commodity exchange (Teshome, 2006; MoFED, 2006; Devereux and Gruenther, 2007; Dorosh and Rashid, 2012).

The safety net programme in particular merits attention as a coping mechanism linking short-term emergency and long-term development. The PSNP[1] started in February 2005 as a multi-donor initiative to protect chronically food insecure individuals' assets and livelihoods through predictable transfers of cash. Its purpose was to smooth household consumption, to prevent household asset depletion, to encourage households to engage in production and investment, and to promote market development by increasing household purchasing power (MoARD, 2006). The programme was an extension of the food for work scheme of the Derg era, and later modified to encompass two components: public work and direct support accounting for 85% and 15% of beneficiaries, respectively. In terms of public work,[2] individuals receive money after participating in community development work such as road construction, soil and water conservation and other development activities – elements that address climate change adaptation. Direct support was given to children, disabled people and old people without any need to work (Senbeta, 2009). The programme turned mixed results. As a coping

[1] The two main objectives of the programme are a) to provide farmers a platform to maintain their asset and create or multiply the existing assets and b) to ensure food security.
[2] The work involves five working days per month for six consecutive months a year and, in return, a receipt of 180 birr per person per year (Senbeta, 2009).

mechanism, it benefited large population.[1] Yet it was fraught with problems of implementation, targeting and dependency (Conway and Schipper, 2011). In the report for IRIN[2] Network , Kindra (2014) stated that both the government and donors became increasingly aware that PSNP does not really help secure those who have very limited or no assets against shocks (targeting problem), nor does it help them 'graduate' from a chronic situation to a state of food security (dependency conundrum). As a result a complementary scheme known as Household Asset Building Program (HABP) was introduced in 2010, still as part of PSNP, to help people build their livelihoods and create assets by offering credit, agricultural extension, micro-enterprise advice and linkages to markets. Large sum of money, mainly donor funded, has been spent, yet the success of this scheme is yet to be assessed and determined.

Apart from PSNP and related mechanisms, the government set up coordinating agencies for climate change negotiations and management. Examples include the submission of NAPA in 2007, the enhancement of the role of the Environmental Protection Authority (EPA) in 2009, the voluntary submission of Nationally Appropriate Mitigation Action (NAMA) plan[3] as well as the Climate Resilient Green Economy (CRGE) strategy in 2011.

The NAPA and NAMA policy documents assessed key underlying causes of the country's vulnerability to climate change as dependence on rain-fed agriculture, poor water resource development and a high population growth rate (NMA, 2007). The impacts of climate change were assessed as food insecurity due to drought and flood events, outbreak of diseases such as malaria and water-borne and respiratory diseases and land degradation from heavy rainfall (Gebreegziabher *et*

[1] Launching PSNP4, The World Bank's Country Director for Ethiopia, Guang Chen, reportedly claimed that the productive safety net programme has made unparalleled contributions not only to food security and Ethiopia's progress in meeting many of the MDG goals, but to reversing land degradation. See, Jemal, N. (2014) Ethiopia to benefit From WB's Support for PSNP. October 3. [Online] Available at: http://allafrica.com/stories/201410030924.html (Accessed: 6 October 2014).

[2] IRIN is the humanitarian news and analysis service of the UN Office for the Coordination of Humanitarian Affairs.

[3] The NAMA prioritized the following projects for mitigation: Electricity Generation from Renewable (Energy for the Grid System, Hydro power (including such projects as Gibbe and Genale excluding GERD); Hydro Power Projects under study, Wind projects, Geothermal projects; Bio-fuel development for road transport and for household use, Electricity generation from renewable energy for off-grid use and direct use of renewable energy, Transport, Forestry/forests, Agriculture and Waste management.

al., 2011), More recently, the government identified agriculture, health, transport, natural resources, energy and industry sectors as most vulnerable to climate change (FDRE, 2012).

In addition to identifying the impacts and assessing vulnerability, NAPA took into account of climatic trend presented in Table 1. Accordingly, the mean annual temperature in Ethiopia, for the last fifty years (1951 and 2006) has risen by 1.3°C (Conway and Schipper, 2011; McSweeney *et al.*, 2010; NMA, 2007; FDRE, 2011) which translates to an average rate of 0.28°C per decade. The corresponding figure for SNNPR is 0.4°C which exceeds the countrywide average indicating the significance of rising temperature in this region (NREPA, 2012). However, there was no significant trend in rainfall.

Based on General Circulation Models (CGMs), future climate predictions for Ethiopia are equally grim. Countrywide temperature is projected to rise on average by 1.2°C, 2.2°C and 3.3°C in 1920s, 1950s and 2090s, respectively. On the other hand, rainfall is expected to increase creating wetter conditions, which is counterbalanced by significant uncertainty and higher evaporation (FDRE, 2011).

Table 1: Climate change projections for Ethiopia

Time	Temperature	Rainfall	Extreme weather events
1960-2006	Mean temperature increased by 1.3°C. More hot days and nights; fewer cold days and nights	Highly variable from year to year, season to season, decade to decade. No significant trend.	Regular drought and severe flood events. No evidence of changes in frequency or intensity of extremes
2020s	+1.2°C (0.7 - 2.3°C)	+0.4% increase in rainfall	Greater increases in rainfall in October to December, especially in the south and east
2050s	+2.2°C (1.4 - 2.9°C)	+0.4% increase in rainfall	Heavier rainfall events, uncertain future El Niño behaviours brings large uncertainties.
2090s	+3.3°C (1.5 - 5.1°C)	Wetter Conditions	Flood and drought events likely to increase, heat wave and higher evaporation

Source: Adapted from FDRE, *crgevision: Ethiopia's vision for a climate resilient green economy, 2011.*

To address the projected climate change, the government initiated the CRGE strategy in 2011. The strategy envisioned carbon neutral growth based on energy-efficient development trajectory with a view to address both climate change

adaptation (climate resilience) and mitigation (green economy) objectives (CRGE, 2011). The goal of low carbon or carbon-neutral growth pathway is to achieve middle-income status by 2025, which initials raising GDP per capital level from the current $380 USD to $1000 USD. The CRGE is an overly ambitious agenda and it is informed by equally ambitious plan known as the Growth and Transformation Plan (2010-2015) embarked by the government in 2010. The plan underpinned agricultural growth. At the same time, Agricultural Transformation Agency (ATI) was formed in 2010 with the mission to transform agricultural sector into a driving force for economic growth and development. The agency combines research with practical implementation and its formation followed insights from Asian counties such as Malaysia, South Korea and Taiwan in the 1950s and 1960s.[1]

A closer scrutiny of the CRGE shows that climate change adaptation and mitigation strategies in Ethiopia are driven by local and global policy imperatives. Locally, national policy makers seem to understand the importance and urgency of addressing climate-related disasters that beset the country for decades. They also seem to realise that the recurrence of such disasters signal the failure to adapt successfully to the lived environment in a sustainable way.

Internationally, global pressure and, more importantly, incentives in the form of climate change funding guided the formulation of national climate change policies (See Table 1a for the list of laws relating to environmental protection and climate change in Ethiopia). Subsequently, most of the relevant policy instruments date back to the 1990s.[2] For instance, Ethiopia had ratified the United Nations Framework Convention on Climate Change (UNFCCC) treaty in April 1994 and the Kyoto Protocol in 1997. In return, it receives financial support from bilateral donors (e.g. Norway, UK-DFID, Japan) and multilateral donors (e.g. UNDP, World Bank).

[1] ATI is supported by several public and private donors that include USAID, UNDP, The World Bank, IFPRI, the Bill & Melinda Gates Foundation, Rockefeller Foundation, and The Nike Foundation.
[2] The Environmental Policy of Ethiopia of 1997 set the policy context for environment protection whereas the Environmental Protection Authority (EPA) was established in 2002 as the lead agency to provide strategic leadership and coordinate responses to climate change. Ethiopia is also party to a number of environmental international agreements including: Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes and Ozone Layer Protection (CIA Factbook, 2014).

Table 2a: Relevant legislation on environmental protection in Ethiopia

Laws, regulations and treaties	Adopted
Ethiopia signed the UNFCCC signed 1992, ratified 1994	1994
The Convention on Biological Diversity	1994
The Conservation, Development and Utilization of Forests	1994
Environmental Policy of Ethiopia and Conservation Strategy of Ethiopia	1997
The UN Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa, signed 1994, ratified 1997	1997
Proclamation to establish Institute of Biodiversity Conservation and Research	1998
The Basal Convention on the Control of Trans boundary Movements of Hazardous Wastes	1998
Rural and Agricultural Development Policies and Strategies of Ethiopia	2002
Proclamation for the Establishment of Environmental Organs	2002
Environmental Impact Assessment Proclamation	2002
Pollution Control Proclamation	2002
The Stockholm Convention on Persistent Organic Pollutants	2004
Ethiopia ratifies the Kyoto Protocol (and becomes a party)	2005
Proclamation to establish National Metrology Institute	2010

Among climate change mitigation projects, the Humbo project[1] was supported by World Vision, the World Bank and the Ethiopian government. Given the above background, it is worthwhile to investigate if the existing governance and institutional frameworks are able to ensure the mainstreaming of climate change to development policy.

1.5 Organisation of the book

The book is organised into eight chapters. Chapter 1 presented the general background by setting out the context, the scope and significance of the study, research objective and questions as well as brief overview of Sidama and climate change related policy framework of Ethiopia. The scope of the study is delimited by geography, livelihood system, and response measures to climate change.

Chapter 2 reviews the literature on the topic under study. The review is thematic covering perceptions, vulnerability and adaptation to climate change, and development-climate change nexus. The literature on perceptions produce

[1] Known as the Humbo Ethiopia Assisted Natural Regeneration Project, this is part of the UNFCCC's Clean Development Mechanism. [Online] http://cdm.unfccc.int/Projects/DB/JACO1245724331.7/view (Accessed: 20 May 2014).

contested debate, which is the subject of exploration in the study. The literature on vulnerability is rich and varied, examining three approaches, namely hazards, political-economic and integrated approaches. The literature on adaptation covers coping as short-term mechanism, adaptation options and strategies, the benefits and barriers to adaptation to climate change. The literature on environment and development nexus examines intellectual debates in their historical context. The last section explores debates on mainstreaming climate change adaptation to development.

Chapter 3 presents the methodology adopted. Comparative case study research design is used to compare and analyse livelihood systems. Both qualitative and quantitative methods are deployed as complementary tools for data collection and analysis. Three research sites are selected on the basis of spatial representation of agroecological sites and the availability of meteorological stations with relevant data. Fieldwork research took place from January to May 2012. Data collection targeted farmers, policy makers, weather stations, field observation and documents. Data are collected through quantitative survey and focus group discussion with farmers as well as semi-structured interviews with farmers and policy makers. Data collection and fieldwork presented ethical issues and practical challenges, thus a separate section is devoted to the discussion of these challenges. Data analysis is informed by sustainable livelihoods framework. The framework holds multiple possibilities for cross-sectional and in-depth analysis and by adapting it to fit the specific needs of climate change research, it helps to investigate vulnerability context, livelihood assets, how assets are utilised for adaptation as well as institutions enabling or hindering adaptation to climate change. Initially, the framework was applied in poverty reduction, wellbeing and development contexts, but only rarely used in climate change studies.

Chapter 4 presents the results of data and discussion of socio-economic characteristics of survey respondents and their vulnerability context. The characteristics under consideration include household head's age, gender, education, wealth status, farm size and location. This is followed by presentation of data on livelihood options and institutions and structures relevant to climate change in Sidama and Ethiopia is presented. Results are discussed using different

analytical tools such as descriptive statistics. Chi square test is used to explore the significance of association between household's livelihood assets across the AEZs. Frequency tables, pie charts, bars, graphs, pictures and boxes are also used to visualise results.

Chapter 5 presents and discusses the results of historical climate data based on observed climatic information. Climate data are compared with perceptions of climate change and its causes and impacts among smallholder farmers and policy makers.

Chapter 6 presents and discusses the results of the study on vulnerability to climate change. The main sections here include discussions of impacts, vulnerability and highly vulnerable groups. Impacts of climate change are categorised under the themes of socio-economic conditions, water and soil, crops and plants, and livestock.

Chapter 7 covers adaptation strategies by farmers as well as barriers for successful adaptation and the factors that support adaptation to climate change. It also discusses the framework on mainstreaming climate change to development policy.

Chapter 8 concludes the book by summarising the key findings and making recommendations. It also points out the limitations of the study and areas for future research.

Chapter 2: Perception, vulnerability and adaptation to climate

2.1 Introduction

This chapter reviews the literature on perception, vulnerability and adaptation to climate change and the environment – development nexus. The aim of the literature review is to deepen understanding and provide critical appraisal of existing literature, highlight gaps in research and identify areas for further research. The literature review is thematic involving perceptions, vulnerability, adaptation and development-climate change nexus. The following section defines frequently used key terms with the aim of enhancing conceptual clarity.[1]

Definition of key terms

Climate is the average weather pattern over many years expressed through variables such as temperature, precipitation and wind. It differs from weather, which represents short-term atmospheric conditions expressed in the mix of events such as temperature, rainfall and humidity that occur each day or week.

Climate change refers to significant and persistent change in the mean state of the climate system attributed directly or indirectly to human activities (for example, anthropogenic greenhouse gas emissions) that alter the composition of the global atmosphere observed over long time periods. It includes such changes as average temperatures, precipitation, humidity, wind conditions, and all other aspects of the earth's climate. A related term *climate variability* refers to short-term fluctuation of weather that can occur without interference from human activities. For example, some of the drivers of climate variability include the El Niño Southern Oscillation. Following on the IPCC's definition of climate change as any change in climate over time, whether due to *natural variability* or as a result of *human activity* (IPCC, 2007b) and for the purpose of this book, both notions are considered as climate change.

[1] The list draws from a very good explanation of key terms covered in the Drylands Coordination Group report (Kebede and Adane, 2011, pp. 2-5).

Global warming is observed increase in average temperature near the Earth's surface and in the lowest layer of the atmosphere due to increased emissions of greenhouse gases from human activities. Global warming is a type of climate change; it can also lead to other changes in climate conditions, such as changes in precipitation patterns (McCaffrey, 2012).

Green House Gases (GHGs) are gasses that trap long-wave radiation in the upper atmosphere, raise atmospheric temperatures and produce other changes in the climate system. In particular, three GHGs had increased in the atmosphere, namely carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). From around 1750 to 2011, CO_2 increased by 40% from 278 part per million (ppm) to 390.5 ppm while methane increased by 150% from 722 ppb to 1803 ppb and nitrous oxide by 20% from 271 ppb to 324.2 ppb (IPCC, 2013, p.467). And this increase is the main driving cause of climate change. When ranked by their direct input to greenhouse effect, the most significant gasses are CO_2 accounting for 77%, methane for 14% and nitrous oxide for 8% of GHGs. The production of these gasses varies with the type of economic activity. For example, energy supply is reported to account for 26%, industry for 19%, land use, land-use change and forestry for 17%, agriculture for 14%, transportation for 13% and waste and wastewater for 3% (IPCC, 2007a). Thus agriculture causes approximately one-third of global GHGs when direct energy use, emissions from livestock, the production of fertiliser, pesticides, machinery and equipment as well as soil degradation and land-use change for feed production are taken into account (FAO (2011, p.viii; Hameso, 2013).

Vulnerability to climate change refers to the degree to which a system is likely to experience harm as the result of exposure to climatic hazard. It depends on the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2001, p.995). In other words, it is a function of exposure, sensitivity and adaptability. Exposure relates to the nature and degree to which a system is exposed to climate change, while sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli (Brooks, 2003, p.8). Adaptability refers to the degree to which adjustments are possible in practices, processes, or structures of systems to climate change.

Adaptation to climate change refers to the process of responding and adjusting to actual or potential impacts of changing climate conditions in ways that moderate harm or take advantage of any positive opportunities from climate change. In other words, adaptation represents a process through which people reduce the adverse effects of climate variability on their health and wellbeing, and take advantage of the opportunities that their climatic environment provides (Burton, 1992 quoted in Smit *et al.,* 2000). Adaptation takes different forms: reactive versus anticipatory (timing), autonomous versus planned (spontaneity) and private versus public (scale) (Fankhauser *et al.,* 1999; Smit *et al.,* 2000). Reactive or spontaneous adaptation takes place in response to climate change while anticipatory adaptation is undertaken in anticipation or in reaction to climate change (IPCC, 1996). Autonomous adaptation is triggered by ecological changes in natural systems and by market or welfare changes in human systems (IPCC, 2007a). Another term often used as opposed to adaptation is maladaptation, which refers a situation where a strategy inadvertently increases vulnerability.

Adaptive capacity refers to the ability of a system to adjust to climate change to moderate potential damage, to take advantage of opportunities, or to cope with the consequences (McCarthy *et al.,* 2001, p.982). The IPCC defined it as the ability of people or a system to modify or change its characteristics to cope better with existing or anticipated external stresses (IPCC, 2001; Smit and Wandell, 2006). A system or a community is said to have enhanced adaptive capacity if it is able to modify its characteristics or behaviours so as to cope better with changes in external conditions. A related term, *resilience* represents 'the capacity of a system, community or society potentially exposed to hazards to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure (UNISDR, 2005).

Mitigation of *climate change* represents interventions to reduce anthropogenic forcing of the climate system. It includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks. A carbon sink accumulates and stores carbon-containing chemical compounds. On the other

hand, carbon sequestration is the processes that remove carbon from the atmosphere.

Livelihood is the sum of ways in which households make ends meet. It also refers to the means of securing the basic necessities of life such as food, water, shelter and clothing.

Poverty is a widely used term in development discourse; it encompasses both income and non-income dimensions of deprivation, including lack of income and other material means, lack of access to basic social services such as education, health, and safe water, lack of personal security, and lack of empowerment to participate in the political process and in decisions that influence someone's life (OECD, 2003).

Sustainable livelihood pertains to livelihood that can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, without undermining the natural resource base.

Sustainable livelihood framework is a tool for analysis of livelihoods. It consists of the vulnerability context, livelihood assets, and transforming structures that in combination influence livelihood strategies, which in turn generate outcomes related to income, wellbeing, vulnerability, food security, and sustainability.

Smallholder farmers are farmers who own small plots of land on which they grow subsistence crops and one or two cash crops relying largely on family labour. In different countries, they are variously described as family farmers, subsistence farmers, poor farmers and peasant farmers. Smallholder farming is characterised by small farm size, low technology and low capitalization.

Agroecological zones (AEZs) are areas with relatively homogenous agricultural land use options that are primarily determined by geographic elevation which in turn influences temperature and rainfall. In this book, three zones are broadly defined: a) highland, *Aliicho* or *Dega*, b) midland, *Gamooje* or *Woyna Dega* and c)

lowland = *Qolla, or Kolla*.[1] Terms like zones, sites and areas are interchangeably used to express the abovementioned physical agroecological locations.

Kebele is the lowest administrative unit in Ethiopia similar to a ward, a neighbourhood or a localized group of people. Each Kebele consists of about 500 families or households – the equivalent of 3,500-4,000 persons. In terms of administration, a Kebele is part of a district (Woreda) which in turn is part of a Zone. Zones are grouped under Region. There are 9 regions that comprise the Federal Democratic Republic of Ethiopia (FDRE).

2.2 Perceptions about climate change

Perception is the process of attaining awareness or understanding of a phenomenon including climate change. Change, as King Whitney (quoted in Hartel and Pearman, 2010) noted, has a considerable psychological impact on the human mind. 'To the fearful,' he argued, 'it is threatening because it means that things may get worse. To the hopeful it is encouraging because things may get better. To the confident it is inspiring because the challenge exists to make things better.' Arguably, the sentiments of fear, hope and confidence play part in climate change and the risks thereof. Like other changes, climate change invokes uncertainty. In their attempts to make sense of changes, people give meaning to lived reality based on their experiences. Accordingly, the exploration of perceptions of climate change involves two vital steps: the detection of climate change and determining its significance versus other stressors.

Recent studies from Western India into rural people's belief and understanding of climate change suggested that most respondents detected changes in the climate but they did not hear about the scientific concept of climate change (Moghariya and Smardon, 2012). Similarly, a study of East Tibetan villages found that people were not aware of the global phenomenon of climate change and assumed that the changes were local (Byg and Salick, 2009). It is worthwhile to probe the

[1] Throughout this study, Sidamuafo terms are used to reflect the language of the study sites, except when the terms in use are of wider use in research and policy arena.

local/indigenous versus the global/scientific understanding about perceptions of climate change.

The other aspect of perceptions of climate change relates to significance people attach to climatic shocks versus other stressors. Studies with coffee producing communities of Mexico (Eakin *et al.,* 2005) and Nicaragua (Bacon, 2005) attached lesser significance to the impacts of climate change on their coffee trees compared to impacts of coffee price changes. In other words, according to South American studies, market forces attracted higher significance over climate change. However, studies on Africa noted that farmers were acutely aware of warmer temperatures and decline in precipitation (Maddison, 2007; Juana *et al.,* 2013). For example, Mubaya et al (2012) found that climate variability was the most critical factor that exacerbated livelihood insecurity for farmers in Zimbabwe and Zambia. The fact that the above studies presented mixed results invites the need for further exploration.

Closer to the Sidama context, existing research on farmers' perception and knowledge of climate change from central Tigray, Northern Ethiopia, farmers reported untimely rain and frequent drought (Mengistu, 2011). Another research on Ethiopia's Nile Basin reported differential perceptions among farmers living in the highlands and in the lowlands (Deressa *et al.*, 2010, p.28). The latter finding requires closer examination, as it appears counter-intuitive to expect temperature or precipitation variability to be felt at the higher rather than the lower altitudes that are known for water stress. Other studies on Western India noted that 'residents of drought prone areas possess significantly more understanding about causes and mitigation measures of climate change' (Moghariya and Smardon, 2012, p.6). These mixed findings are examined in the context of Sidama.

Once, climate change is properly perceived, initiatives to improve adaptive capacity and identification of adaptation measures commence with assessment of vulnerability (Ford and Smit, 2004; Conway *et al.*, 2011). Consequently, the next section surveys the review of literature on vulnerability.

2.3 Vulnerability to climate change

Research into vulnerability of human and natural systems to climate change is relatively nascent drawing on a wide range of subjects. Vulnerability studies involve different disciplines[1] with many conceptual approaches to vulnerability analysis (Deressa *et al.*, 2008; Brooks, 2003; Alwang *et al.*, 2001). The diversity of disciplines and knowledge domains gave rise to issues of interpretation of vulnerability.

In their examination of research on vulnerability to climate change, O'Brien et al (2004a) distinguished two interpretations of vulnerability: as starting point and end point. Vulnerability as a starting point is a state generated by multiple environmental and social processes, but exacerbated by climate change (Kelly and Adger, 2000). Here, importance is attached to understanding the biophysical, social, political and cultural factors that contribute to vulnerability to climate change. Vulnerability as an end point, on the other hand, signifies a present inability to cope with changes. Here, vulnerability is treated as a residual of climate change impacts minus adaptation or the net impacts of climate change (Gbetibouo and Ringler, 2009). This approach is used to determine the extent of the climate problem and to provide input into policy making regarding the cost of climate change versus costs related to greenhouse gas mitigation efforts (Kelly and Adger, 2000).

While both interpretations are widely used in vulnerability studies, this study uses the former interpretation, i.e., vulnerability as a starting point. The reason for doing so lies in the fact that vulnerability starts with socio-economic and political arrangement people found themselves and exacerbated by climate change.

Regardless of interpretive divergence, a number of studies admit that vulnerability is a notion of broader currency applicable to a wide range of communities, both rich and poor (Wheeler, 2011). As Kirby (2006, p.169) rightly argued vulnerability is the most essential feature of the human condition and anyone could be vulnerable to climate change. Complete insulation from climate risk is not feasible;

[1]The list of relevant disciplines comprise of development studies, sociology, anthropology, disaster management, environmental/climate science, health and nutrition (Brooks, 2003)

yet, some communities or sectors are more vulnerable than others, as are smallholder farmers. Even among smallholder farmers, vulnerability takes into account individual characteristics, farm size, resource distribution, scope of production (food staples and cash crops), and livestock and off-farm activities (Co-operative and Enterprise Development Directorate, 2012). For instance, field studies from rural West Africa distinguished between small, vulnerable households whose productive capacity is frequently weak or whose asset reserves are rarely sufficient to cope with crises of any duration and relatively wealthy and resilient large household possessed ability to avert or cope with crisis through labour substitution and livelihood diversification (Adams *et al.,* 1998). In Ethiopia, a stakeholder analysis of vulnerability to climate change identified the most vulnerable groups to include people marginalized due to their economic status, ethnicity, sex, age, and education. It argued that people with low levels of education are more vulnerable to the adverse effects of climate change because they are less likely to be aware of long-term climate change and tend to be more averse to the risks associated with some adaptation measures (Admassie *et al.*, 2008).

The diversity of societies, resources and economies also meant that no one approach to vulnerability assessment fits every need (Downing and Patwardhan, 2003). Neither is there a single 'correct' or 'best' conceptualization of vulnerability that would fit all assessment contexts (Füssel, 2007). Given such understanding, most vulnerability studies owe their historical origin to two research traditions – hazard research and political-economic perspectives – later to be complemented by integrated approaches (Eakin, 2008).

Natural hazards or biophysical approaches emerged in the 1980s (Füssel and Klein, 2006) and viewed vulnerability as the outcome for a population (e.g. lives lost, area flooded or decline in yield). The main concern centred around the physical impacts of climate change on different attributes such as income or crop yield. Accordingly, vulnerability is expressed in terms of impacts or the amount of damage experienced by a system as a result of an encounter with a hazard. The focus therefore lies with the climatic hazard.

The logic of the hazard paradigm was based on the premise that the mixture of hazards and vulnerability produce risk. That is, the potential threat to humans (hazards) and the exposure and susceptibility to losses (vulnerability) result in probability of hazard occurrence (risk). Under conditions of low adaptive capacity and where proper adaptation is lacking, a disaster (realization of a risk) would occur. In short, vulnerability to climate change contains the risk (risky events), the options for managing risk (risk responses), and, the outcome in terms of welfare loss (Siegel and Alwang, 1999).

In their exploration of vulnerability form different disciplines, Alwang et al (2001) noted that households respond to, or manage, risks in several ways. They may use formal (e.g. insurance) and informal (e.g. borrowing from relatives) risk management tools. By the same token, risk management involves ex ante and ex post actions by households. Ex ante risk reduction measures reduce risk (e.g., eradication of malaria-bearing mosquitos in the higher altitudes when they become warmer and drier as the result of climate change) or lower exposure to risks (for example, using malaria pills or insecticide treated mosquito nets). Households also to take ex ante risk mitigation actions[1] that compensate for losses, for example, by purchasing insurance. Ex post risk coping refers to responses that take place after a risky event is realized. It involves activities dealing with losses such as selling assets, removing children from school, migration of selected family members, and seeking temporary employment. A study of central Tigray, in Ethiopia, by Mengistu (2011, p.142) produced a list of coping mechanisms such as food for work scheme, credit, petty businesses (such as firewood and charcoal selling), reduction of daily meal (in amount and frequency) and migration. Elsewhere in Africa, farmers were reported to engage in risk spreading strategies 'designed to mitigate the negative impacts of poor seasons and usually fail to exploit the positive opportunities of average and better than average seasons' (Cooper *et al.* 2008, p.27).

In a nutshell, the focus of the natural hazards or biophysical approaches is on hazards and the exposure of affected communities. The strength of this approach is

[1] Alwang et al (2001) lists risk mitigation actions to include formal and informal responses to expected losses such as self–insurance (e.g. precautionary savings), building social networks, and formal insurance based on expansion of the risk pool.

the clear significance it attaches to extreme events and hazard-specific vulnerabilities (Yamin *et al.*, 2005). Yet it pays less attention to the role of socio-economic conditions, power relations and existing vulnerabilities that are equally important.

The socioeconomic or social vulnerability approaches to vulnerability developed in the 1990s when the hazard paradigm came under criticism for its inadequacy to explain the causes and consequences of disasters such as the famines in the Sahel region. A number of studies were conducted along these lines (World Bank, 2010a; Sen, 1981; Blaike *et al.*, 1994; Adger, 1999; Drèze and Sen, 1989; Brooks, 2003; O'Brein *et al.*, 2004a; Yamin *et al.*, 2005; Eakin, 2008; Scalet and Schmidtz, 2009; Davies *et al.,* 2009). Some of the studies, for example World Bank (2010a), implied that the risks people face and the reasons for their vulnerability to hazards go beyond natural causes or that natural hazards may lead to disasters only if unmediated by positive human agency. Sen (1981) in particular had explicitly demonstrated that drought does not necessarily lead to famine and starvation (for Ethiopia see Woldemariam, 1984; de Waal 1991; and Keller, 1992). In the case of Ethiopia, Conway and Schipper (2011) stated that the 'social construction of emergencies is reinforced by the frequent recurrence of socio-economic drought even when there is no meteorological drought.' Arguably, the statement could shed light on the paradox of green famine whereby famished people are surrounded by green lush gardens. In Ethiopia or elsewhere in the world, famines occur when there is a sharp decline in average food availability per head implying that there is a difference between a people not having enough food and there being not enough food. As Massimo De Angelis (2000) rightly argues, a person may have few means of commanding food if he or she has no job, no other sources of income, and no social security. The resultant hunger can coexist with a plentiful supply of food in the economy and the markets. Therefore, famine occurs by failure of people to establish command over an adequate amount of food and other necessities – hence it is entitlement problem. People starve when they are unable to convert what they own into a bundle that includes enough food to sustain them (Sen, 1981, p.118). What is more important is not food supply but food entitlement system (Scalet and Schmidtz, 2009) and what is to blame is 'massive social failure' rather than

'nature,' although those in power find blaming nature consoling and comforting (Drèze and Sen, 1989, p.4).

Thus the main focus of socioeconomic approaches to vulnerability rests with the social, economic, and political aspects of society rather than with natural hazards (Adger, 1999). The starting point is assessing vulnerabilities already embedded in the social and political order that exist prior to and independently of hazards (Yamin *et al.*, 2005). Central to this approach are people's coping mechanisms and socio-economic structures while hazards only perpetuate vulnerabilities. Instead of linking vulnerability solely to environmental hazards, the socioeconomic approach viewed vulnerability as a characteristic of a place or population, associated with historical patterns of resource allocation, relationships of social privilege and economic marginality and the political disempowerment of particular social groups (Eakin, 2008). According to Davies et al (2009), climate change deepens the risks faced by poor and vulnerable people in rural areas, particularly those involved in agriculture and other ecosystem-dependent livelihoods.

Moreover, while biophysical vulnerability is a function of the frequency and severity of a hazard, social vulnerability is determined by internal characteristics of a system in relation to external hazards (Brooks, 2003). Some of the internal characteristics include poverty in inequality, health, and access to resources such as food entitlements, access to insurance, and housing quality, and social status (Blaikie *et al.,* 1994; Adger and Kelly, 1999). Group-related character-istics of social vulnerability involve class, caste, ethnicity, gender, disability, age, or seniority. At the household level, diet, shelter, sanitation, and water supply combine to determine vulnerability to biological disaster (Blaike *et al.*, 1994, p.9, 106).

Unlike the hazard paradigm, what is important for socioeconomic perspective is not hazard *per se* but the attributes of the exposure unit (a particular population, place, or system), its resources and assets, and the institutional framework that circumscribe its capacities, sensitivities and exposure to climatic risks (Eakin, 2012). Supporting this position, Drèze and Sen (2007) argued that vulnerability of

populations depends on their endowments (set of goods and resources) and entitlements (the institutions that govern what the population can do with its endowments). In this regard Amartya Sen stands out by shifting focus away from income as the sole indicator of wellbeing and by stating the purpose of development as reducing deprivation and broadening choice. Development, for Sen, represented the removal of various types of *unfreedoms* that leave people with little opportunity to exercise their agency, and more importantly, a process of expanding the real freedoms and capabilities to lead the kind of lives they value – and have reason to value (Sen, 1999, pp.xii, 1, 18). Hence people, their freedoms and capabilities hold centre stage in the meaning of development.

Within socioeconomic framework, people's vulnerability is linked to their asset-base and food security (Brooks, 2003). While low asset base and higher food insecurity exacerbate vulnerability, poverty[1] and economic marginalization work to reduce peoples' adaptive capacity (O'Brien *et al.*, 2004a). Linking vulnerability to climate change with poverty is amplified by the fact that the livelihood systems of the poor are closely tied to climate-sensitive conditions be it flooding, droughts, frosts, pests or diseases (Nordhaus, 2007) that are likely to destroy their livelihoods while deepening their poverty (Nyong, 2009; Hope, 2009). Even in the absence of climate change, the rural poor suffer from insufficient income to fulfil basic needs. Apart from income poverty, disadvantaged people suffer from other dimensions of ill-being such as social exclusion, physical weakness, vulnerability, deprivation, and powerlessness (Chambers, 1995). Climate change imposes additional layers of vulnerability.

The strength of this approach lies in highlighting the social dimensions of vulnerability. However, by placing heavy emphasis on the internal character-istics of the exposure unit (household, community, region), it pays less attention to hazards themselves including climate change. This problem is addressed by integrated approaches.

[1]Sumner and Tiwari (2009, p. 59) describe vulnerability and poverty as overlapping but different concepts. They note that poverty is about deprivation in various dimensions while vulnerability is about the risk or probability of an individual, household or community moving in or out of poverty in response to shocks and fluctuations.

Integrated approaches to vulnerability emerged in the late 1990s and the early 2000s, making use of the insights of earlier developments: resilience ecology and sustainable livelihoods (Scoones, 1998; DFID, 1999; IISD, 2003; Eakin, 2008; Eakin, 2012) as well sustainable adaptation (Moser and Boykoff, 2013; Erikson *et al.*, 2011). They viewed vulnerability not as static internal condition but rather a dynamic property emerging from the structure of human relations, the internal attributes of specific populations and places, and the nature of social-environmental interaction (Eakin, 2012). The extent to which individuals or groups become vulnerable to climatic hazards depends on livelihood assets at their disposal. Hence, vulnerability is partly linked to lack of assets (financial, human, natural, physical, and social capital) and capabilities (institutions and policies) for adaptation.

Integrated approaches combine both the socioeconomic and the biophysical attributes in vulnerability analysis (Füssel, 2007). The socioeconomic factors include the level of technological development, infrastructure, institutions, and political setups (Kelly and Adger, 2000; McCarthy *et al.* 2001). The environ-mental attributes include climatic conditions, quality of soil, and availability of water for irrigation (O'Brien *et al.,* 2004b). This approach acknowledges that vulnerability to climate change is multi-dimensional and it is a function of biophysical outcomes related to variations and changes in temperature, precipitation, topography, and soils as well as socio-political, institutional factors and a country's level of economic development (Agrawal, 2010; Adger, 2006). For example, the occurrence of climatic or even natural hazard imposes varying degree vulnerability for communities in Bangladesh or Pakistan compared to Japan or the USA. In both cases, rapidly changing economic, social, institutional, and technological conditions impinge on vulnerability to climate hazards. For example, a series of droughts may have similar impacts on crop yields in two regions, but differing economic and institutional arrangements in these regions may well result in quite different impacts on farmers (Smit *et al*., 2000). It is thus important to incorporate economic, social, and environmental dimensions of vulnerability.

Theoretically, this approach is holistic and comprehensive; it also links well with the interpretation of vulnerability as a starting point. It serves as a useful analytical

tool since climate change is a crosscutting issue affecting human welfare, food security, environmental quality, and other development goals. The problem with integrative approach lies in practical application. The number of factors needed to measure vulnerability present methodological challenge in constructing a composite measurement of vulnerability. However the very idea of having a single index of vulnerability is inappropriate (Admassie and Adnew, 2008) since climate change is a multi-dimensional phenomenon incorporating economic, social, and environmental dimensions. This study uses integrated approach without resorting to vulnerability index with the aim to complement the debate on coping mechanisms of smallholder farmers (Legesse, 2006) to multiple stressors (Reid and Voger, 2006). By so doing it explores the social and biophysical vulnerability of smallholder farmers in Sidama.

2.4 Adaptation to climate change

Adaptation, like vulnerability, is a universal condition of humanity. Adaptability of human systems to changes is as old as human societies and it is a vital characteristic that ensured the survival of cultures through times. However, adaptation to climate change presents newer, unique and complex challenges to societies. The problem is complex because the changes are occurring in the context of failure in addressing the causes of poverty (Schipper, 2004).

Indicative of the significance of the problem, the literature on adaptation of human communities to climate change is fast evolving (IPCC, 1996; Fankhauser *et al.,* 1999; Smit *et al.*, 2000; Smit and Pilifosova, 2001; Adger *et al.*, 2003; Smit and Wandel, 2006; Maddison 2007; Hassan & Nhemachena, 2008; Agrawal, 2010; IFAD, 2013). Earlier studies defined adaptation as any adjustment to ameliorate the anticipated adverse consequences associated with climate change (Stakhi quoted in Smit *et al.*, 2000). Smit and Wandel (2006, p.282) defined adaptation as a process, action or outcome in a system (household, community, group, sector, region, country) that enables the system to better cope with, manage or adjust to changing condition. Adaptation can be undertaken at individual, household level or at the level of community or beyond. At the household or farm level, adaptation actions tend to be autonomous whereas government agencies are disposed to

anticipatory[1] and planned adaptation (Maddison 2007; Smit and Pilifosova, 2001). Planned adaptation is the result of a deliberate policy decision, based on awareness that conditions have changed or are about to change and that action is required to achieve a desired state (Smit *et al.*, 2000; Adger *et al.*, 2003; UNDP, 2012). It involves governments evaluating different social and economic goals, and making decisions to manage the impact of climate change (Filho and Mannke, 2014, p.95). The process of decision-making takes account of information about climate change to develop appropriate responses based on current individual, community and institutional behaviour. This renders adaptation to climate change as a dynamic social process where 'the ability of societies to adapt is determined, in part, by the ability to act collectively' (Adger, 2003b). Consequently, the ability to act collectively manifests itself in policies and measures undertaken by public agencies (community, governmental and non-governmental).

On the other hand, most adaptation efforts are realised at the local level, hence their effectiveness depends on local 'institutions through which incentives for individual and collective action are structured' (Agrawal, 2010, pp.173-174). For example, in the study dealing with farmers' innovation and local approaches in marginal environments, it is argued that successful examples of key strategies to improve rural livelihoods are initiatives led by farmers' organizations and by NGOs emphasizing reforestation, soil conservation and efficient water harvesting and use of rainwater (Altieri and Koohafkan, 2008, p.48). To be effective, however, adaptation efforts at the local level need to be synchronised and supported by national frameworks with resources and policy direction. Nyong and Niang-Diop (2006, p.239) opined that recognizing the local and national domains of adaptation activities is the first step towards successful and sustainable adaptation. Thus the recognition of domains and synchronisation of efforts between the local and beyond requires understanding of local conditions for coping or adaptation actions both of which contain important distinction.

Coping refers to human responses to external shocks expressed as an array of short-term actions in response to crisis (Davies, 1993, p.60). According to Adger (1996) and Eriksen et al (2005) coping actions take place within existing

[1] Anticipatory adaptation represents proactive actions taken well before the impacts of climate change are realised.

structures, while adaptation underpins changing the framework within which coping takes place through, for example, learning from the past (Yamin *et al.,* 2005). Sociologists criticised the use of the term 'strategy' alongside coping since the former implies 'the presence of conscious and rational decisions involving a long-term perspective' (Crow, 1989, p.19) linked to choice, power and interaction (Schindler, 2009). In reality, however, coping refers to mainly short-term actions and the related decisions lack deliberation and thought as can be imagined to prevail in a strategy. The issue remains debatable as some writers maintain that coping involves 'rational and calculated response to minimise the intensity or duration of crisis' (Adams *et al.,* 2008, p.264). In order to avoid conceptual mislabelling, 'strategy' is used with adaptation and terms like actions, measures or mechanisms are used with coping. Issues of terminology notwithstanding, Cooper et al (2008) adopted sequential approach considering coping as an essential first step to adaptation. The assumption is that short-term coping mechanisms could develop through time into long-term adaptive strategies (Berkes and Jolly, 2001). Others (for example Yamin *et al.,* 2005) linked coping to temporary measures designed to maintain or return to the status quo. Arguing in the context of Sahel region, Adams et al (1998) noted that the chief aim of coping is to maintain the various objectives of the household and ensuring individual and/or collective wellbeing. The same authors note the existence of some trade-offs and strategies that may appear destructive or unsustainable, they however maintain that coping is a rational and calculated response to minimise the intensity or duration of crisis, to maximise limited resources, and to preserve long-term livelihood security. Thus flexibility in mobilising and managing resources is critical to coping success as rural Sahelians negotiate an array of concurrent or successive needs and demands.' (Adams *et al.,* 2008, p.264)

Accordingly, farmers engage in the process of balancing competing needs and limited resources in the interest of preserving their livelihood, consumption, health and social status. Rahmato (1988; 1987) listed concrete examples of coping measures in Ethiopia during the 1984 famine in Wollo involving five sequential stages: austerity measures, reduced consumption, temporary migration, divestment or asset disposal, and crisis migration. Devereux (1992) argued that coping is a function of the type, timing and intensity of the crisis faced and ones'

resilience. A household is said to cope successfully when it can summon sufficient resources to overcome adversity without endangering long-term objectives such as a livelihood security (Adams *et al.,* 1998). On the contrary, when coping fails, it means key productive assets are sold, illness symptoms are ignored, marriages and funerals are postponed, or health and nutrition needs are compromised (Devereux, 1992).

In times of crisis, the ways through which households and communities mobilise and allocate resources varies from context to context that require better understanding. This is particularly the case given growing realisation that development efforts might be sustainable and constructive if they were sensitive 'to the origins, dynamics and differential experience of rural adversity, and supportive of what communities and households do themselves to minimise risk and cope with crisis' (Adams *et al.*, 1998, p.263). Therefore, it is vital to assess smallholder farmers' adaptation needs and adaptive capacity.

In their informative work into the factors that determine adaptive capacity, Yohe and Tol (2002) listed a range of factors such as available technological options for adaptation, the availability of resources and their distribution across the population, the structure of critical institutions and decision-making, human capital, social capital, the system's access to risk spreading processes, the ability of decision-makers to manage information, and the public's perceived attribution of the source of stress. Smit et al (2001) summarised these factors as economic wealth, technology, infrastructure, information and skills, as well as equity and institutions.[1] The latter can facilitate or impede adaptation to climate change to the extent that institutions and governance related issues are described as dominant barriers to adaptation to climate change (Ekstrom and Moser, 2013, p.97). While the role of most of the above factors is well recognised, the role of networks and institutions needs further exploration.

Climate modelling studies are criticised for underestimating the role of social and institutional networks as determinants of adaptive capacity (Adger *et al*., 2003b; Jaja and Dawson, 2014). Recent studies abound, however, that recognise the

[1] Institutions consist of formal and informal rules as well as clusters of rights and decision-making procedures (North, 1990).

crucial role of formal and informal institutions and social relationships in facilitating or even hindering adaptation to climate change (Agarwal, 2010). Nyong and Niang-Diop (2006) cited facilitation and implementation roles – the former includes 'developing information and raising awareness, removing barriers to adaptation, making available financial and other resources for adaptation and otherwise enhancing adaptive capacity. On the other hand, examples of implementation role include making the actual changes in operational practices and behaviour, and installing and operating new technologies. While facilitation is done by external agencies, adaptation could be implemented by the local people, from the scale of the household to the national/regional levels.[1] National level facilitation can be done through mainstreaming adaptation into national developmental policies and programmes (*ibid.*, p.239).

Other studies reported that social and institutional networks embody strength and resilience through which a 'social system is capable of organising itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures' (UNISD, 2005) Thus, in the world of multiple hazards, increasing resilience or the ability of a system to deal with different types of hazards is the basis for sustainable growth (Heltberg *et al.*, 2009; UNDP, 2010). This requires advancing from short-term measures of coping to long-term strategies of adaptation.

Adaptation strategies are influenced by current socio-cultural and economic considerations, climate experience, the policy environment and the perception of the risks posed by climate change (Adger and Kelly, 1999). Based on these factors, roughly three approaches to adaptation are identified: livelihoods, sectoral and generational.

Considering livelihoods approach to adaptation, IFAD[2] (2013, p.6) noted that adaptation options available to smallholder farmers depend on contextual climate

[1] The terms national and regional in this context differ from those in the literature where regional frameworks are above the national ones; for instance, regional groupings of East or West Africa involve different countries. In Ethiopia, regions are subsumed under national framework.
[2] In 2012, IFAD launched its *Adaptation for Smallholder Agriculture Programme* (ASAP) initiative as 'a unique instrument that directs resources to smallholder farmers so that they can increase their climate resilience' (IFAD, 2013).

risks, geographic location, asset base and livelihood strategies. For example, having access to better technical assistance on climate risk analysis, including tools such as satellite-based monitoring and Geographic Information Systems (GIS), can support farmers to supplement traditional adaptation practices with innovative know-how. Advances in computing technology support climate data modelling which is in turn expected to gradually advance knowledge of climate trends and impacts. There is a possibility, therefore, for remote localities to benefit from these advances in the form of accurate modelling and subsequent support to the process of adaptation to climate change.

Considering sectoral approach to adaptation, Clements et al (2011) listed technologies and practices in climate change adaptation for agriculture to include water use and management, soil management, crop management, livestock management and farming systems. Similarly, Altieri and Koohafkan, (2008) underlined multiple cropping or poly-culture systems, wild plant gathering, mulching, use of local genetic diversity and soil organic matter enhancement as adaptive strategies of smallholders farmers. Moreover, in their consideration of adaptation options and constraints in Ethiopia and South Africa, Bryan et al (2009) identified the use of different crops or crop varieties, planting trees, soil conservation, changing planting dates, and irrigation as the most common adaptation strategies. In both countries, farmers were more likely to adapt if they had access to extension, credit and land. Among the poorest farmers, food aid, extension services and climate change information were found to facilitate adaptation.

Considering generational approach to adaptation, Kelly and Adger (2000) classified adaptation strategies into two generations. The first generation studies focused on hazards and impacts based on end point analysis of vulnerability (see vulnerability review above). Examples of adaptation actions in this category include: irrigation, drainage systems, coastal setbacks, or relocation of settlements, to be achieved through economic assistance and enhancement of institutional capacities. These approaches focus on biophysical impacts, and they were ‘used in combination with an array of climate change scenarios, biophysical models,

economic models, integrated systems models, empirical studies, and expert judgments to identify impacts and adaptation options' (O'Brien *et al.*, 2004a).

Second generation adaptation studies focus on social vulnerability to climatic risks as exemplified in studies by Adger et al (2001), Eakin (2003) and O'Brien *et al* (2004a). Adaptation policies associated with these studies are more social rather than technical in nature. Examples include poverty reduction, diversification of livelihoods, protection of common property resources, and strengthening of collective action. In this regard, a very good contribution on adaptation strategies is contained in a book by Agrawal (2010), which is further explored in this work. He listed the strategies in five risk management categories.[1] They are diversification (the distribution of risk across asset classes), communal pooling (the distribution of risk across households), storage (the distribution of risk across time), mobility (the distribution of risk across space), and market exchange (the purchase and sale of risk via contracts), which may substitute for any of the other four categories when households have access to markets (Agrawal, 2010, p. 182).

Among these strategies, diversification is described as the most noticeable and widely applied option so much so that it is recognised as a distinguishing characteristic of environmental change and policy (Mitchell and Hulme, 1999; Lempert *et al.,* 2000). Ellis (1998, p.1) described the notion of livelihood diversification[2] as 'the process by which rural families construct a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living.' Other studies (for example Mitchell and Hulme, 1999; Lempert *et al.*, 2000) associated livelihood strategies with principles of risk management whose purpose is to strengthen the ability to respond to stressors and secure livelihoods under present conditions, which would then increase the capacity to adapt to changes in the future.

[1] A possible drawback in Agrawal's categorisation is the focus on market based economic dimensions that seem to discount some forms of responses to climatic risks. The spiritual dimensions could have beeen added as additional dimension of coping. In support of the latter position, Moser and Boycoff (2013, p.2) argued that successful adaptation is not simply decided on scientific, rational, objective, or procedural grounds, but in normative, historically contingent, and context-specific.

[2] Ellis (1998) observed that diversification could have conflicting consequences that require attention. It could, for example, be a conduit to diminish or accentuate rural inequality; it can act both as a safety valve for the rural poor and as a means of accumulation for the rural rich; it can benefit farm investment and productivity or impoverish agriculture by withdrawing critical resources.

The literature on adaptation to climate change poses another important question as to whether adaptation should remain protective option or rather an 'opportunity for social reform, for the questioning of values that drive inequalities in development and our unsustainable relationship with the environment' (Pelling, 2011). In order to enrich the latter proposition, this work explores how adapting to climate change can present opportunities to challenge existing social contracts and unequal relationships. One such opportunity lies in *no-regrets* adaptation that generate net social benefits under future scenarios of climate change (Heltberg *et al*., 2009). *No-regrets* adaptation actions increase resilience and produce economic, social and environmental benefits whether climate change materialise or not (UNDP, 2010).

IFAD (2013, p.33) offers examples of clear benefits adaptation including net incremental income through sustainable intensification or diversification for smallholder farmers, wider development goals such as poverty reduction and the growth of the economy, functioning environmental services and reduced carbon emissions. To secure these benefits, it is necessary to survey good practices in climate change adaptation processes. Existing studies list some examples of these practices to include effective stakeholder involvement, consideration of both biophysical and social dimensions of the problem, and adequate funding (Moser and Ekstrom, 2010). However, the list is not exhaustive and it needs further exploration in specific contexts of smallholder farmers and their experience.

Apart from benefits of adaptation, the literature on adaptation explores factors that hamper adaptation. Barriers to adaptation are impediments that can stop, delay, or divert adaptation process (Moser and Ekstrom, 2010). They act as a hindrance to take action on climate change. Examples of some barriers to adaptation in the context of developed countries include leadership, resources, communication and information as well as values and beliefs (Moser and Ekstrom, 2010). According to another study that focused on cross-country adaptation in Europe, Asia and Africa barriers to adaptation are identified as 'spatial and temporal uncertainties in climate projections, lack of adequate financial resources, and lack of horizontal co-operation' (Krysanova *et al.*, 2010, p.4122).

In the context of developing countries, studies on Ethiopia (Deressa *et al*., 2009) and Pakistan (Abid *et al.,* 2014) identified lack of information, lack of money, shortage of labour, shortage of land, and poor potential for irrigation as barriers to adaptation. Similarly, a comparative study of Ethiopia and South Africa identified the lack of access to credit in the latter and lack of access to land, information as barriers to adaptation (Bryan *et al.,* 2009).

Similarly, lack of coordination and communication between researchers and policy makers is also a challenge. An example of this is limited integration between researchers and those government agencies who play a central role in everyday management of development and natural resources (Diaz and Hurlbert, 2014). Institutional and cultural barriers between researchers and policy makers could hinder the transformation of scientific knowledge into plans and actions capable of strengthening adaptive capacity. Another research-policy related barrier to adaptation is the debate that pits environmental protection against development goals. The following section explores the historical context of this debate.

2.5 Climate change and development

Environment – development nexus: Emphasis of the post-World War II development studies rested on achieving increase in economic wellbeing[1] -- typically higher per capita income. The focus is understandable given the imperative of recovery for war-torn economies of the West and the proposed development pathways for newly emerging countries from colonial rule.

In the decades that followed, views shifted towards multidimensional understanding of development. The shift paralleled scholarly debate about environment and development that grew in the 1950s and 1960s when environmental crises related to industrial activities caught the world's attention. Examples included the London's toxic smog of 1952, oil spill, acid rain and air pollution crises of the 1960s in industrial economies.

[1] Other elements of wellbeing, apart from economic performance, include food security, sense of belonging, respect, social and cultural heritage, equality and distribution of wealth, dispersed settlement, access to nature-based outdoor activities and control over one's own destiny (O'Brien *et al.*, 2004a).

The debate intensified in the 1960s with the publication of Rachel Carson's *Silent Spring* conveying her concern about the wider use of pesticide on birds and other species (Carson, 1962) and Garrett Hardin's *The Tragedy of the Commons* (Hardin, 1968) pointing to the degradation or depletion of shared resources under conditions of uncontrolled access. Hardin's argument centred on the use of communal pastureland where an individual herdsman reaps the benefit of each additional animal's grazing, while the whole village shares the cost of reduction in available grass. As each villager pursues his own personal gain, by keeping more and more cattle, the actions would eventually risk exceeding the carrying capacity of the commons. In the case of farming, this would mean that practices of enhancing crop production beyond ecological limits cause soil degradation. The implication is that individuals acting rationally to serve their self-interest will ultimately degrade shared limited resources. In other words, individuals are trapped in exploiting natural or communal resources to a point where the latter will become extinct. The intention of people to exploit natural resources may not be to undermine natural resource base, but their actions can lead to resource depletion and the collapse of the ecosystem.

However, the view envisaged in the 'tragedy of the commons' is later challenged by the proponents of the 'commons' approach (for example, Ostrom, 1990) who pointed to institutional arrangements for managing natural resources to help avoid ecosystem collapse, short of privatising or nationalising common pool resources. In particular, Elinor Ostrom indicated the importance of common property regimes for livelihoods and demonstrated through numerous case studies that communities can successfully govern commons resources (Ostrom, 1990; Ostrom et al, 1999). The commons approach centres on the opportunities embedded in communally owned resources. It posits that individuals, communities and group members are able to design a livelihood that enables them to interact with their environment while ensuring sustainability (Agrawal and Gupta, 2005). In this context, communities are viewed as sets of commoners who share resources and define for themselves the rules according to which the resources are accessed and used (e-flux, 2010).[1] The rules, in turn, are noted to be crucial for life enhancement and attaining sustainability within the commons. Moreover, at the

[1] On the Commons: A public interview with Massimo De Angelis and Stavros Stavrides [Online] http://www.e-flux.com/journal/view/150

local level, social institutions, norms of reciprocity, myths, mores, kinship and community ties can enable development and sustainably managed commons through shared, local decision-making (Campbell and Wiesen, 2009; Ostrom 1990).

The possibility of sustainable management of the commons notwithstanding, concern about the exploitation of natural resources for economic growth remained ever apparent in scholarly debate about the links between environment and development. Prominent among them was the landmark study from The Club of Rome entitled *The Limits of Growth* (Meadow *et al.*, 1972), which highlighted the potential dangers of human activity on the planet (Kanninen, 2013). The key concern was on the consequences of unrestrained, rapid economic growth in interconnected and shared world. The concern remains to build sustainable economy in a world of finite resources (Dietz and O'Neill, 2013).

These and related concerns extended the notion of human wellbeing beyond minimalist measurements of economic wellbeing and well into the realm of the social and political indicators. Besides, the persistence of poverty despite economic growth altered the focus of research and policy to basic needs and poverty alleviation. Questions were also raised about the meaning of development and how to measure it (Seers, 1969; 1972; 1979). In particular, the works of Amartya Sen on development and capability approach expanded the scope of development discourse (Sen, 1981; Sen, 1989; Nussbaum, 2011; Ibrahim and Tiwari, 2014). Subsequently, the concepts of capability, equity and sustainability came to be seen as both good in themselves and an end (Chambers and Conway, 1991). As the result, in some parts of the world at least, research efforts, farmer education and training, advice and information were said to shift towards balancing economic efficiency with environmental and social sustainability replacing the previous focus to increase production, productivity and profits (OECD, 2001, p.7). The contributions of these and other scholars on the nature of contemporary development had impacted policy not only at local levels but also globally. Table 2 summarises global environment-development discourse and policy of the last four decades.

Table 3: Timeline in global environment-development discourse & policy

Time	Event	Aim/goal
1987	The Brundtland Commission Report *Our Common Future* (United Nations) [1]	Reconciling traditional development objectives with environmental ones: promoting harmony among human beings and between humanity and nature
1988	Intergovernmental Panel on Climate Change (IPCC) was formed	Provide governments with a clear scientific view of what is happening to the world's climate.
1992	UN Conference on Environment and Development (UNCED) negotiated UNFCCC	Agreement reached on the need for serious action to reduce man-made greenhouse-gas emissions. Over 180 countries signed UNFCCC treaty
2000	Millennium Development Goals	Goal 7. Ensure environmental sustainability. Aims to reverse current trends in environmental degradation in order to sustain the health and productivity of the world's ecosystems.
2004	UNDP's Climate Change Adaptation Policy Framework	Help developing country governments to prepare their National Adaptation Programmes of Action (NAPAs).
2007	Developing countries produced their NAPAs	Specific adaptation options or measures identified.
2009	Copenhagen UN climate summit	Deadline for binding global agreement on climate change missed. A new climate change treaty was not reached.
2011	Durban Summit	Formation of Durban Platform for Enhanced Action to negotiate legally binding emissions reduction by 2015. Any reductions take effect after 2020.
2012	Rio+20 Earth Summit	The United Nations Conference on Sustainable Development
2013	Warsaw Climate Change Conference	Governments took decisions to stay on track towards securing a universal climate change agreement in 2015.
2014	The Global Commission on the Economy and Climate report	The New Climate Economy is the Commission's project set up to provide independent and authoritative evidence on the relationship between actions which can strengthen economic performance and those which reduce the risk of dangerous climate change.

[Source: Adopted from Hameso, 2012]

Brundtland Commission report (WCED, 1987) defined sustainable development as development that meets the needs of the present without compromising the ability of the future. The goals of sustainable development included economic growth, environmental protection and equity. The achievement of these goals without presenting zero-sum choices remained a policy challenge for governments leading to the formation of IPCC in 1988. Research, too, focused on the challenges of

[1]The Brundtland Commission Report entitled 'Report of the World Commission on Environment and Development: Our Common Future' highlighted the concept of sustainable development. It stated that 'the "environment" is where we live; and development is what we all do in attempting to improve our lot within that abode. The two are inseparable.' (Our Common Future, WCED, 1987)

intergenerational justice – the use of natural resources in ways that produce positive outcomes for future generations (Lundahl and Ndulu, 1996). A comprehensive strategy to address development and environment nexus through global partnership awaited the UN's Earth Summit in Rio de Janeiro that agreed the Framework Convention on Climate Change (UNFCCC) in June 1992. Later the Kyoto conference of 1997 committed Parties to set internationally binding emission reduction targets. Subsequently, the UNDP published Climate Change Adaptation Policy Framework in 2004 which recognised that adaptation occurs at different levels: international, national and local levels. The Framework, initially focused on the national and international levels, was particularly instrumental for developing country governments to prepare their National Adaptation Programmes of Action (NAPAs)[1] (Adger *et al.,* 2003; UNDP, 2004).

Following the framework and supported by UNDP, many developing countries, including Ethiopia,[2] prepared their NAPAs. And after two decades of the Rio conference, the UN convened the Earth Summit (also known as Rio+2) in Rio de Janeiro, Brazil.[3] The Summit took place at a time when concerns persist about the globalisation of economic growth and consumer life styles placing unsustainable demands on environmental and natural resources. The wider economic crises of 2007-08 also served as a reminder that business as usual approach is not sustainable. According to Dorward (2009) 'both the scale and the externalities of these problems are too large, consumer and multinational interests too entrenched, and the costs of environmental change too heavily borne by poorer tropical economies for these processes to be anything but too little too late' so much so that 'the nature and role of growth in development, and indeed of the nature and goals of development itself' need a radical rethink. The Earth Summit appears to heed this line of argument and focused on a green economy and institutional framework for sustainable development as a way to deal with what Bidwai, (2012, p.150) dubbed as a great dilemma facing the South; namely, 'in the absence of affordable and adequate low-carbon alternatives, much of the South can

[1] The process of drawing up NAPAs began in 2001 coordinated by the UNFCCC. They were financed by a GEF-managed LDC Fund established in 2002.
[2] Ethiopia published and submitted its NAPA in 2007.
[3] Climate negotiations and meetings take place annually among the Conference of the Parties (COP), which is the supreme body of the UNFCCC.

only pursue its development goals by relying on fossil fuels, which will raise emissions in the short run.'

The solution to the dilemma lies in creating an environment where low-carbon growth is possible along with adaptation to climate change. Working in that direction, the Global Commission on the Economy and Climate (GCEC)[1] was set up in 2013 to analyse and communicate the economic benefits and costs of actions on climate change. The commission is founded on the assumption that one of the most critical and urgent challenges facing countries today is achieving economic prosperity and development while also combating climate change. The report admitted that it did not focus on adaptation, but it recognised that adaptation is essential since it is interwoven with the issues of growth and development (GCEC, 2014, p.12).

Mainstreaming adaptation: Interdependence between adaptation to climate change and development is well established (OECD, 2006; Tanner and Horn-Phathanothai, 2014) to the extent that adaptation to climate change is described as not 'only a valuable part of global climate efforts but an essential one, with benefits that contribute to many human development goals' (IFAD, 2013, p.6). Similarly a number of factors link adaptation and development. First, both are long-term processes. Second, climate change affects the building blocks of development such as food security, water availability and health. In other words, climate change does not only pose serious challenge to social and economic development, it can hamper development or even remove progress hitherto made on poverty reduction (OECD, 2006, p.1). Third, development incorporates wide-ranging change processes that would increase vulnerabilities through socio-economic, cultural and environmental factors. For example, fossil fuel-based, carbon-intensive development pathways contribute to GHG emissions and exacerbate human induced climate change. In acknowledgement of this fact, the Word Bank (2010b) noted that some growth strategies can 'add to vulnerability such as when they are heavily dependent on one activity, such as tourism, or entail the large-scale depletion and degradation of the natural resource base on which the poor depend

[1] GCEC is an independent initiative commissioned by seven countries – Colombia, Ethiopia, Indonesia, Norway, South Korea, Sweden and the United Kingdom. The Commission's flagship *New Climate Economy* was launched in March 2014 and reported in September 2014.

disproportionately for their livelihoods.' Thus how development occurs has implications for climate change and for the vulnerability of societies to its impacts. At the same time addressing contemporary socioeconomic and environmental challenges are critical to confront future climate change (O'Brien *et al.*, 2004a). For these reasons, the need for mainstreaming climate change into development policy is urgent.

According to Hassan (2010) development and adaptation challenges are inseparable and the question is how African countries can accelerate economic growth and social development necessary to cope with the consequences of predicted unfavourable future climate. Thus, in order 'to achieve faster growth and development … SSA requires more aggressive efforts and major investments in many sectors that would require much higher levels of energy use and emissions and increase the pressures on the already stressed land, water and other natural resources of the region' (Hassan, 2010, p.661).

The challenge can be addressed through 'major investments and policy reforms to induce a needed radical transformation of the way development is conventionally pursued to a more climate-sensitive path of low carbon growth' (*ibid*). The point is reinforced by IPCC (2014) that some low-carbon development options may be less costly in the long run and could offer new economic opportunities for Africa to sidestep inefficient, fossil fuel-dependent infrastructure that more developed countries are locked into. The challenge could also be addressed by incorporating adaptation options into a wide range of policies; for example, agricultural, water resources, and public health policies rather than having a separate climate policy (Burton *et al.*, 2002). The essence of mainstreaming is 'the integration of climate change concerns into existing or planned policies and institutions at national level, including [sic] the mainstreaming of activities to reduce climate change impacts, exposure and sensitivity into policies and projects of multilateral organisations, donor agencies and other relevant bodies.' (Conway and Schipper, 2011, p.228)

The rationale for public policy in the realm of climate change adaptation stems from the fact that global warming presents 'the greatest and widest-ranging market failure ever seen' (Stern, 2007). The reasons for this relate to limited

information on climate change, limited access to resources and the costs involved in adaptation which market mechanism would rather not choose to pay (Smit & Pilifosova, 2001). From the point of view of economic theory, climate is a global public good and as such climate change is an externality.[1] It presents fundamental problems for it takes many firms, people and decisions about consumption, investment, and innovation. Moreover, dealing with market failings involves proactive management of climate change risk, or planned adaptation as opposed to reactive, autonomous adaptation (Smith *et al.*, 1996; Fankhauser *et al.*, 1999). Hence, the need for coordination and interventions involving both market and non-market forces (Nordhaus, 2007). The role of coordination among relevant stakeholders is already noted in economic development literature that equated underdevelopment with coordination failure where the success or failure of economic development policies can be explained by the 'principal-agent' model.[2] According to the model, coordination failure occurs when the principal fails to induce agents to coordinate their actions, which leads to an outcome that makes all agents worse-off (Todaro and Smith, 2009).

Coordination of efforts for and mainstreaming climate change to development requires assessing vulnerability and adaptation measures in the context of general development policy objectives (Halsnæs and Trærup, 2009). It is based on the premise that the 'current variability and additional climate risks on development is so large and pervasive, [that] mainstreaming current and future climate vulnerabilities into development is an urgent prerequisite for sustainable development for developing and developed countries alike' (Yamin *et al.*, 2005). In the post-MDG era, sustainable development goals are bound lo include environmental sustainability and climate change as important themes to be addressed (UN, 2013).

In the context of sustainability, mainstreaming adaptation to climate change implies pursuing 'climate-proof' development not simply by identifying responses

[1] Externalities represent inadvertent impacts on the wellbeing of one person caused by the activity of another. Many aspects of environmental degradation such as air pollution, global warming, loss of wilderness and contamination of water bodies are examples of externalities (Toman, 2001).
[2] The 'principal' refers to the government while 'agents' consist of households, private-sector firms, public agencies, government-owned enterprises and international companies. The model stipulates that an effective principal is needed to coordinate actions taken by agents and achieve an optimal outcome, making all agents better-off.

to the impacts but also reducing vulnerability to climate change (Schipper, 2007). In recent years, Ethiopia envisioned carbon neutral development trajectory. Yet research into mainstreaming climate change adaptation to development policy in the country is scanty and only emerging of late (for example, Eshetu *et al.,* 2014). This book examines signs of synergy of planning for development in the age of climate change.

2.6 Summary

This section reviewed the literature on key facets of climate change. It is noted that perceptions of climate change among farmers and policy makers varied. In some countries (for example in Mexico and Nicaragua) the impact of market forces was felt more deeply than the impacts of climate change. In other areas (for example in African countries such as Zimbabwe and Zambia) farmers felt climate variability as the most critical factor affecting their livelihoods. Moreover, studies in Ethiopia reported higher perception of climate change in the highlands than lowlands, which needs to be investigated further.

The literature on vulnerability to climate change point to rich tradition having its origin to hazard research, political-economic perspectives and integrated approaches. These approaches have their own strengths and weaknesses. The strength of the hazards approach lies in highlighting the frequency, intensity and nature of the climatic hazards and their impact on exposure units. Yet the exposure units (e.g. ecosystems and population groups) are not only susceptible to natural, climatic hazards but also to internal, social characteristics. The strength of social vulnerability approach highlighted hitherto neglected areas. The existence of both forms of vulnerability (biophysical and social) requires the use of integrated approach to study multiple stressors made worse by climate change. The limitation of this approach is the inclusion of multiple stressors, which adds layers of complexity to analyse vulnerability. Yet, it offers holistic means to capture key aspects of vulnerability to climate change.

Adaptation to climate change is viewed as a dynamic social process, which takes different forms. Its effectiveness depends on combined efforts at local level and

national frameworks of policies and institutions for the achievement of development goals and the management of climatic risks. The literature on environment and development nexus is rich in coverage. The link between the two is based on the principles of sustainability and sustainable livelihood framework presented in the next chapter.

Chapter 3: Methodology and analytical framework

This chapter presents the research design, site selection, methods used in data sampling and collection, analytic framework of the study as well as ethical and practical challenges in doing development fieldwork.

3.1 Research design and site selection

This work sought to locate its epistemological position in comparative case study research design with a view to compare and analyse livelihood systems in three agroecological sites. As one of the tools of empirical enquiry, a case study 'investigates a contemporary phenomenon within its real-life context', and it is particularly suitable for answering the 'how' and 'why' questions (Yin, 2003, p.110; Baxter and Jack, 2008).

The study used mixed methods (qualitative and quantitative) as complementary tools to provide different perspectives. The qualitative method took the form of focus group discussion and semi-structured interviews with open-ended questions intended to 'evoke responses that are meaningful and culturally salient to the participant unanticipated by the researcher as well as rich and explanatory in nature' (Mack *et al*., 2005). Fieldwork[1] followed institutional ethical clearance. Like other plans of field research, this phase involved site selection, sampling and data collection (Bailey, 2007).

The criteria to select research sites were predicated on two factors. The first rest on spatial difference, which links to the fact that vulnerability and impacts of climate change vary from place to place. The spatial difference dictates that different AEZs are selected, representing semi-arid lowlands, sub-humid midlands and alpine highlands. The spatial difference also accounts for variations in the livelihood systems, representing, enset, coffee, maize mixed with livestock. The second factor in site selection is predicated on availability of climatic data and by implication the existence of weather stations. The purpose is to compare farmers' perception of climate change with scientific data on climatic indicators such as

[1] This fieldwork was carried out a year after severe drought of 2011 affected parts of southern-most Ethiopia and the Horn of Africa region.

changes in temperature and precipitation. Despite a marked progress made in the field of climate science supported by improvements in information and communication technologies (ICTs), the availability of comprehensive, accurate and reliable climate data in Ethiopia is limited. Many weather stations[1] in remote rural areas are poorly equipped and served. This meant not all stations have complete data required for cross-site comparison. Based on the availability rainfall and temperature data for 20 years, three meteorological stations were selected.

Three Kebeles in close proximity (about 10-20 kilo metres) to these stations with similar altitude were systematically selected. They are Xexicha, Awaada, and Jara Galalcha (called Jara in short). In comparative terms, Hagereselam station has the highest elevation, milder temperature and higher rainfall. Both Yirgalem and Hawassa with relatively lower altitude, recorded higher temperature and lower precipitation while the low-lying areas are warmer and drier.

Apart from the two factors mentioned above (namely, spatial difference and weather stations), the decision on site selection was supported by initial fact-finding visit. The assessment trips covered nearly all districts of Sidama and they proved extremely useful to scan the physical environment and the context of the field research. Table 3 describes the physical and agroecological characteristics of the research sites.

Table 4: Agroecological characteristics of research sites

Features	**Xexicha**	**Awaada**	**Jara Galalcha**
Agroecological zone	Highland	Midland	Lowland
Nearest met station	Hagereselam	Yirgalem	Hawassa
Altitude (in masl)	2759 (2809)*	1700 (1768)*	1665 (1694)*
Temperature (minimum)	19°C	27°C	27°C
Temperature (maximum)	na	12°C	13°C

[1]Weather stations in Ethiopia are categorized into four classes depending on the instruments they use and weather elements they record. First Class Stations or Synoptic Stations record all weather elements and receive satellite data. Only 2 Synoptic Stations exist in the SNNP region, one in Hawassa and another in Arba Minch. Second Class or Principal or Indicative stations record temperature, rainfall, humidity, sunshine and some other weather elements. Third Class or Ordinary Stations record temperature and rainfall. Fourth Class Stations record rainfall only (SNNPR; NMA; http://www.ethiomet.gov.et/stations/regional_information/).

Rainfall (annual average)	111 mm	101 mm	81 mm
Main livelihood	Enset, livestock	Coffee, enset	Maize, livestock
Distance from Hawassa city	88 km	44 km	20 km

*Figures relate to the nearest weather stations in Hagerselam, Yirgalem and Hawassa
[Source: National Metrological Agency, 2012 and Survey data, 2012]

Xexicha (also called Teticha) Kebele is found in Hula (formerly Hagereselam) district – one of the 19 rural districts of Sidama (Fig 3). Hula district is bordered by Bona Zuria, Bursa, Alata Wondo, Dara districts and Oromia region. It has a population of 122,853 in 2007. Xexicha is a highland site found at elevation of 2759 metres above sea level (masl). Its average maximum temperature is 19°C and rainfall is 111 mm per year. The nearest weather station is located at Hagerselam town. Xexicha is located at 88 kilometres south-west of Hawassa city, and Hawassa city is located 275 kilometres south of Addis Ababa.

The dominant livelihood activities in Xexicha are farming and cattle rearing. Farming is exclusively rain-fed focused on enset and grains such as wheat, barley, and vegetables such as collard greens, onion, and garlic.

Most households engage in mixed farming and livestock. Livestock forms an important source of wealth having nutritional, symbolic and financial significance. Some people engage in producing and selling handicrafts (for example, bamboo and other wood products) and petty trade (for example, sale of grain, enset products, diary products as well as firewood. The later contains real possibility of fuelwood scarcity having a negative and significant impact on time spent on agriculture (Mekonen et al. 2015)

Modern infrastructure and economic activities are highly undeveloped in the area. Lack of cash crops adds to low monetary earning of households. However, due to changing climate, some adjacent localities are reported to start growing coffee trees.

Awaada (also called Awada) is found in Dale district, with Yirgalem as a district town (Fig 4). Dale district is bordered by Wonsho, Shabadino, Loka Abayya and Cuko and Alata Wondo districts. The district's total population is 212,310. Awaada is a mid-altitude site with an elevation of 1700 masl. It has an average maximum temperature of 27°C and rainfall of 101 mm per year.

Livelihoods in Awaada and its surroundings are diverse; the dominant ones are coffee and enset. Perennial fruits such as avocadoes, banana and papaya are widely grown with useful impact on livelihood (both for diet and for income from sales).

Mild weather conditions support mixed farming with limited cattle rearing. High population density, shortage of land and cultivation or marginal lands characterise the vulnerability of inhabitants. Awaada is in close proximity to Yirgalem town and a long-dated hospital in the outskirts of the town. There are also hot springs along the edges of Woyma and Gidawo rivers.

Jara Galalcha (Jara for short) is found in Hawassa Zuria district with Dore Bafano as its district town (Fig 5). The district is bordered by Boricha and Shabadino districts and the Oromia region, and it covers a significant portion of Lake Hawassa. The district has a population of 124, 472, and 23 Kebeles of which 5 can be termed as midland and eighteen are dry or semi-dry lowlands. Jara is characterised by semi-lowland features with an elevation of 1665 masl, and it has an average maximum temperature of 27°C and rainfall of 81 mm per year.

Historically, the population of this area endured direct impact of different political regimes of Ethiopia starting with the expansionist war of Menelik II, dispossession during imperial regime, and repression during the Derg regime and neglect during the EPRDF regime. The area appears to be marginalised lacking basic development infrastructure (e.g. roads, markets, and social services) although it is in close proximity to Hawassa town.

In ecological terms, much of Jara has semi-arid conditions. Temperature is usually high for most part of the year with annual average temperature around 27 °C.

Maize is the principal crop in Jara and nearby villages. Households engage in mixed farming, producing mainly maize using animal traction or oxen power. Farmers provide food for themselves and for a growing population of Hawassa and beyond. Livestock serve diverse purposes such as milk, meat, by-products, draught power and manure. Soil erosion is the key problem in the area, which is also characterised by aridity and erratic rainfall. The population is therefore highly vulnerable to land

degradation, severe water stress and water insecurity during dry months, as well as lack of basic services and infrastructure. Moreover, uncertain and variable rainfall exposed people to water insecurity in manner very similar to situations of semiarid regions of South Africa (Quinn *et al.,* 2011).

Farmers who live on the edges of Lake Hawassa use small-scale irrigation to grow vegetables including onion, red papers, cabbage, mustard, collard greens, carrot, and sugar cane. Fishing from the lake is also practiced but it is almost exclusively based on wild fish catch. Aquaculture is not developed.

The area is also characterised by tension with neighbourhood ethnic groups mainly associated with competition for access to grazing lands. Violent conflict is understood to erupt from time to time claiming life and property, pointing to additional vulnerability of resource stressed areas. In such cases, studies (for example by Costantinos and Mohammed, 1999; Bekele *et al.,* 2013) noted that the survival of peasant farmers is inextricably dependant upon their access to agricultural natural resources such as arable land, water, pasture, forest and forest products.

Studies also note that water scarcity, food shortages or extreme weather events cause or exacerbate conflicts (Tanzler *et al.* 2013; Stern, 2007; Scheffran and Battaglini, 2010). More specifically, strong historical linkage is said to exist 'between civil war and temperature in Africa, with warmer years leading to significant increases in the likelihood of war' predicting that 'with a 1°C increase in temperature … leading to a 4.5% increase in civil war in the same year and a 0.9% increase in conflict incidence in the next year' (Burke *et al*., 2009, p.20670). The result of abovementioned tension and conflicts compound vulnerability.

The foregoing section presented the site selection alongside the background information of the sites. Once the sample sites were selected, data sampling and collection took place from February to May 2012 as presented below.

3.2 Sampling, data collection and analysis

The questions on perceptions and vulnerability were conveniently dealt with the help of qualitative data, whereas questions related to livelihoods, adaptive capacity and household characteristics were dealt with quantitative data, as illustrated in Table 4. The table summarises the research objective and the corresponding data needs, data sources and data collection methods.

In order to achieve the study's objectives, three data collection instruments were deployed: focus group discussion (FGD), semi-structured interviews and a survey. The first two methods aimed to generate qualitative data while the survey intended to produce quantitative data.

Table 5: Research objectives, questions and data sources

Research objectives	Critical questions	Data needs	Data sources & collection methods
Survey the perceptions of people about climate change	How do people in Ethiopia in general and smallholder farmers of Sidama in particular perceive climate change?	Socio-economic shocks Climate shocks Trends Seasonality	Qualitative (Semi-structured interviews with farmers, FGD) Quantitative (Climatological data)
Examine comparative vulnerability of different rural households to climate change	Which categories of farmers are more vulnerable to climate change? And why?	Vulnerability indicators Household characteristics	Quantitative (survey, Climatological data) Qualitative (FGD)
Analyse response strategies pursued by SHFs to adapt capacity	What strategies, if any, do farmers pursue to adapt to climate change?	Adaptation strategies Household characteristics	Qualitative (FGD, Semi-structured interviews) Quantitative (Survey)
Investigate barriers and institutional changes required for increased adaptive capacity	What are the barriers faced by farmers for successful adaptation?	Livelihood assets Household characteristics Institutions	Household survey Qualitative (Semi-structured interviews with farmers and policy makers)
	What are the factors that support farmers' adaptation to climate change?	Institutions	Qualitative (Semi-structured interviews with policy makers, FGD) Quantitative (Survey)
Assess policy and institutional measures undertaken to mainstream climate change in development policy	What is the state of mainstreaming climate change adaptation to development policy?	Development policies Adaptation strategies	Policy documents (Laws, policies) Qualitative (Semi-structured interviews with policy makers)

In addition to primary data collection, secondary data are collected from published documents on policies, laws and practical measures relating to climate change in the Ethiopia. Limited amount of data is also gathered in the form of direct participant and field observation which was recorded during the field visits.

In order to facilitate data collection from various sources, permission was sought from zonal government administration and approval was promptly granted. Subsequently, planning meetings were arranged with officials from target districts and Kebeles.

The selection of samples for data collection depended on the method. For qualitative data collection, 30 farmers were selected for focus group discussion while additional 15 farmers and 17 GO & NGO participants[1] were selected for interviews. Moreover, quantitative data involved 120 heads of households for household survey.

The selection of participants for FGDs was preceded by brief planning meetings to help identify key informants. In each of the three sites, 10 farmers were purposefully selected for FGD, consisting of 8 male and 2 female participants in each site. Participants were people who lived in the area for two or more decades and from different age ranges. The gender ratio is not accidental; it is rather reflective of the distribution of woman headed households in the respective communities.

The selection of participants for semi-structured interviews with farmers was based on purposive sampling of participants with knowledge of the area and specific demographics (gender or inclusion of female household heads) along the lines of selecting FGD participants (see above). Then a total of 15 household heads were selected – five persons each from Xexicha, Awaada and Jara Kebeles. According to Bulmer and Warwick (1993, p.128), adopting purposive sampling is justified in 'many subjects of enquiry where the variables concerned are difficult to locate and identify.' In this research, it enabled capturing required characteristics such as gender and other socio-economic determinants. The choice of 17 participants from GOs and NGO[2] for semi-structured interviews was predicated on the positions held by participants within their organisations and their relevance to climate change policy-making or implementation. Accordingly, participants with part or full responsibility for making and/or implementing climate change policy were selected.

Participants for quantitative survey data were selected through systematic random sampling technique. The total list of residents was obtained from Kebele managers/chairs and samples were drawn according to the above technique. A total of 120 household heads (40 individuals from each AEZ) were selected. The choice of

[1]Different terms are used to describe people providing information during data collection. They include subject, participant, respondents, interviewee, and stakeholders. The term participant recognizes the active role that human beings in the research process as contributors. Hence it is used in this study's qualitative data while respondent is used for the survey data.
[2] They are 4 Federal or Central government officials, 2 Regional Government officials, 1 Sidama Zone official, 3 District officials, 2 Development workers, and 4 NGO officials.

household-level research is predicated on the recognition that it yields important local-level insights into climate adaptation strategies in the agricultural sector (Wood *et al.*, 2014). Research has also established that the decision to adapt to climate change at the household-level is individual and based on subjective factors such as risk perception and other factors such age, gender, personal preferences and social status (Litre *et al.*, 2014; Di Falco *et al.*, 2011). Noting that households in the rural settings are basic economic units who make decisions on production and consumption, individual heads of households are assumed to form the unit of data collection and analysis.

Once the sample is determined and participants are selected, different data collection methods were used. Qualitative data collection took the form of FGDs and key informant interviews with farmers and expert opinion of policy makers. FGD were held with the aim of exploring farmers' views about climate change. The *focus* of the discussions was on perceptions, vulnerability and strategies of climate change adaptation. Since so little is known about farmers' perception of climate change in Sidama, the FGD method is chosen as a first step in generating empirical data. In operationalizing the FGD method, discussion sessions were preceded by consultative briefings to discuss the general purpose of the study, relevant local issues and the agenda for discussion. The meetings involved myself as the researcher, research assistants, extension worker[1] agricultural professionals, administrative officials and Kebele managers (the gate keepers who have close knowledge of participants). The research involved different stakeholders in appreciation of participatory approach that is recognised for its ability to identify the local cultural, historical, socio-economic, geographical and political factors that influence the behaviour and practices of a community (Beazley and Ennew, 2006).

Three focus group meetings were held on 13 March, 28 March and 2 April 2012, in Xexicha, Awaada and Jara, respectively. All of the FGD sessions were conducted at communal sites and offices. Sidamuafo, the working language in Sidama was used for discussion. My knowledge of the language and local customs was beneficial on a number of fronts. It facilitated the process of communication and importantly it helped observing cultural sensitivities and subtleties. Moreover, it helped build

[1] In different literature, extension workers are also referred to extension agents.

trust, and share information and knowledge. Apart from my own involvement, the participation of research assistants was valuable given their knowledge of the local conditions.

One of the initial insights into the research at the FGD phase was the realisation of lack of direct linguistic equivalent of the term climate change in Sidama language. The words '*dilallote soorro*' refer to change in wind or weather conditions. Literally, the word *dilallo* means wind and *soorro* means change. As Rudiak-Gould (2012) has noted respondents tended to conflate the concepts of weather and climate since cultures could have two distinct words that distinguish between western concepts of climate and weather. The process of translation of these and other terms entails 'transformation' of the climate change concept knowing full well that no translation is perfect (Hameso, 2014a). When ambiguity exists, it is the priority for the researcher to clarify the term climate change in all the meetings.

Questions for discussion were based in thematic areas such as perception of climate change (including causes and impacts), vulnerability, adaptation measures and institutional and policy support to adapt to climate change. All group members were given chance to air their views in support or contrary to the views of other members. However, in such settings, the group dynamics could dictate the direction of discussion in a certain way and the researcher, as a moderator, needs to be aware of such situations. Stewart et al (2007, p.116) argued that elements of 'desirability influences, pressures to conform to group thinking, or the persuasive effects of a dominant group member' should not be allowed to affect the outcome of the discussion. In other words, the moderator has to guide and veer the direction of the conversation to *focus* on eliciting relevant information.

Each focus group discussion meeting took about 1.5 hours on average. Responses from FGDs were taped with a digital recorder and later transcribed for analysis. Relevant tools used during these times included field notebooks, digital camera, a smartphone with GPS and compass, and field maps. The data output collected in this way resulted in voluminous audio recordings and digital pictures.

Apart from FGD, interviews with farmers and policy makers took place at different sites including villages, communal sites and offices. Face-to-face interview technique was adopted to allow ready clarification of interview questions and to respond to any queries participants would have. Participants were asked open-ended questions about their experience, attitude, beliefs and perception about climate change. Semi-structured interviews with 15 farmers took place on the same days when FGD and surveys were done. Questions included how farmers describe the climate of their area, the causes of the climate change, its impacts on livelihoods, coping or adaptation actions, and any external support.

Upon the completion of FGDs and semi-structured interviews with farmers, data was collected from participants from governmental institutions starting with Kebele*s*, district*s*, zonal administration, regional government, and sectoral federal government line ministries. In total, 17 interviews were held of which 4 were with participants from federal (central) government officials.[1] At the regional, zonal, and district levels,[2] interviewees include those involved in agriculture, natural resource management and environmental protection. Questions to government officials centred around their organisational role in relation to climate change in the country, assessment of vulnerability to climate change, government priorities and plans for adaptation to climate change, mainstreaming climate change and opportunities and benefits from climate change, if any.

The main aims of the interviews with policy making and implementing agencies were to establish the relevance and application of climate change discourse in the local context by probing the consistency with which farmers and policy makers perceive and act on climate change. Meanwhile, interviews with farmers and policy makers targeted to investigate gaps in understanding and addressing the challenges of climate change at local and national scale.

[1] The officials were from Ethiopian Environmental Protection Authority (EPA), National Metrological Agency (NMA), Ministry of Agriculture (MoA), and Ministry of Water and Energy (MoWE).
[2] These included the Regional Agriculture and meteorological officials, Zone agricultural office, District agricultural officials, and Development workers.

Semi-structured interviews were also held with participants from NGOs with a history of involvement in climate change related work in Ethiopia. Four NGO[1] participants were interviewed. Interview questions focused on organisational role in climate change interventions, respondent's perception of the causes and solutions of climate change, comparative vulnerability of districts and groups, adaptation responses of smallholder farmers, the challenges and constraints to adaptation, as well as institutional support to farmers.

The location of the interviews with policy makers and most NGO experts was in Addis Ababa, the capital city, where nearly all sector ministries have their head quarters. Interviews with extension workers, district, zone and region officials took place in their respective local offices. While devolution and decentralisation of powers to regions is central to the constitution of FDRE, the policy-making bodies, especially the sectoral ministries were based in the capital city, reflecting inherently centralised nature of both governmental and non-governmental operations in the country.

Quantitative data collection took the form of survey questions to heads of households from smallholder farmers. The survey was preceded by a pilot study that involved 8 household heads in Wonsho District. This phase of study enabled pre-testing survey questions for validity, veracity and consistency. Research process during the pilot study phase involved recruiting enumerators, meeting with key informants and the translation of questions to Sidamuafo (the language Sidama farmers speak). Some modifications to the questions were made on the basis of discussions and comments from participants. However, the results of the pilot trial are not included in this book. The revised questionnaire was divided into themes that include general household characteristics, demographic and social characteristics, farmers' perception of climate change, livelihood assets, agricultural production and vulnerability to climatic risks, adaptation, adaptive capacities and strategies, and institutions and markets. Questions such as access to livelihood assets into 5 capitals require respondents to give 'Yes' or 'No' responses whether respondents had access/use of the listed capital assets or not. The resulting categorical data is coded as '1' and '0' and analysed accordingly. On the other hand,

[1] They were SOS Sahel, World Vision, Forum for Environment, and Sustainable Land Use Management.

questions to solicit demographic information such as age, family size, aimed to produce numerical data.

Subsequently, research assistants, enumerators and extension workers were trained about the purpose of this study although some of them had prior fieldwork experience. They administered most of the survey questions whereas I run a few survey questionnaires focusing instead on FGD and semi-structured interviews. Survey data collection took place from 17-22 March in Xexicha, 26-29 March in Awaada and 2-4 April 2012 in Jara.

Other data collection methods included obtaining observed climate information from weather stations and data from secondary sources in the form of published documents on Ethiopian legislature, government policies, laws and practical measures relating to climate change. The main purpose is to explore the links between theoretical pronouncements and practical adaptation measures to quiz if climate change is mainstreamed into development policy. Moreover, limited amount of data were collected by way of participant and field observation to complement FGD and semi-structured interviews. Data from field observation was recorded in field notes during or soon after the visits. Where farming locations and landscape were deemed significant, pictures were taken to capture information about geographic features and people's livelihoods, land use and landscape to account for land degradation, soil erosion and population density as well as visual explanation of current vulnerability to climate change. Examples of such pictures included flooded crop farms, soil erosion, land degradation, local markets, and adaptation actions used by households.

In order to complement qualitative data with survey data, historical weather and rainfall data on local meteorological satiation was collected from National Metrological Agency.[1] The use of multiple sources helped data triangulation through interviews, field observations, and literature reviews to validate findings.

Analysis of qualitative data started with transcribing 35 (3 FGD and 32 semi-structured) interviews amounting to 28 hours of audio recording. When and

[1] Was formerly known as National Meteorological Services Agency

where interview audio output were in Sidamuafo and Amharic, they were translated to English for the purpose of transcription and coding. The transcription of audio records was done using computer word processing software. Transcripts were then printed to enable depth understanding and initial coding. Thus, as Graham Gibbs (2002, p.xxi) rightly noted, the use of 'traditional paraphernalia of pens, paper, photocopies, filing cards, coloured markers' was unavoidable.

After depth reading, the transcripts were loaded onto Nvivo 10 to develop codes (nodes).[1] At the time of committing data to Nvivo, and in line with research ethics and to maintain participant privacy, the names of participants were anonymized and a separate metadata file was created. Data is analysed through thematic approach. Key emerging themes, meanings and discourses of climate change were explored through the deployment of Grounded Theory (Glaser and Strauss, 1967; Fleming and Vanclay, 2011). It is argued that, while a researcher could have ideas based on literature review and empirical research, one would prefer to engage deeply with the data, read the transcribed text and tease out what is happening (Strauss and Corbin 1990, 1994). In this case, NVivo, like other computer applications, helped with the process of coding, but the role of the researcher is critical. As Gibbs (2002) rightly noted, software is no substitute to one's own 'close reading of and a thorough familiarity with the text'. Using both NVivo codes and relevant literature review, different themes emerged along the lines of perceptions of climate change, causes of climate change, impacts of climate change, adaptation to climate change and institutional framework of support to deal with impacts. On the other hand, survey data was cleaned and analysed through descriptive frequencies using Statistical Package for the Social Sciences (SPSS) to compute and analyse relationships and causations of factors by using descriptive statistics and chi-square test. Finally, the process of collecting and analysing both qualitative and quantitative data involved important ethical issues and practical challenges to be discussed in the next section.

3.3 Ethical issues and practical challenges

[1]NVivo is one of the Computer Assisted Qualitative Data Analysis Software (CAQDAS). For an example of a PhD work using this software, see O'Neill (2013).

In the course of the research process, ethical issues were considered in a number of ways. The first relates to the recognition that the position of the researcher (and of participants) has influence on social inquiry (Scheyvens and Storey, 2003; Sultana, 2007). So far as the researcher's position is concerned, as a researcher in the field and as a person with lived experience of the region, I shared my experience and knowledge on the challenges of development and climate change with participants. I also explained my professional background and motivation to undertake the study. For readers of this book, I also stated my research positionality at the beginning (see Prologue).

The second ethical issue is related to the appreciation of the fact that development research, which may entail 'a confrontation between the powerful and the powerless, a relationship fraught with possibilities of misunderstanding and exploitation' (Beazley and Ennew, 2006). Besides I heeded Sultana's (2007, p.375) advice that:

> Conducting international fieldwork involves being attentive to histories of colonialism, development, globalization and local realities, to avoid exploitative research or perpetuation of relations of domination and control. It is thus imperative that ethical concerns should permeate the entire process of the research, from conceptualization to dissemination, and that researchers are especially mindful of negotiated ethics in the field.

In the face the above and related criticism levelled against development fieldwork as one in which 'a relatively privileged Western researcher travelling to a Third World country to study people living in poverty' (Scheyvens and Storey, 2003, p.2), I maintained sensitive attitude toward marginality, equity and justice. I also applied these principle on matters dealing with people marginalised due to their economic status, gender and ethnicity. In the case of gender disadvantage, the World Health Organisation (WHO, 2013) recognised that the role of women in response to climate change has been undervalued or undermined. In the case of Africa, it is particularly stated that women make up the majority of the poorest marginal farmers (Kent and MacRae, 2010). This study makes conscious choice of purposeful sampling to include female-headed households.

Keenly aware of these and related issues, I adhered to key principles of research ethics including explaining the purpose of the research to participants, seeking and obtaining informed consent, ensuring voluntary participation and confidentiality and determining access and data storage. During the recruitment and interview phase, I provided participants with explanation about the project, its aims, and procedures while due diligence is made to the protection and the rights of participants.

The research process also ensured the consent of participants by rendering their involvement voluntary. Participants were interviewed only after they were asked and granted full willingness to take part. The fact that findings of the research might be presented to different stakeholders was also mentioned. In order to dispel doubt, participants' queries in relation to the research were answered openly and honestly. In a society that became prone to shocks (social, economic, political and ecological), people may develop expectations for immediate outcome such as aid. The message that the study may not directly and instantly benefit participants is clearly conveyed alongside the possibility of indirect benefits that its findings may help contribute to knowledge about the area and the people with the view to attract attention and policy redress.

Confidentiality of participants was another issue that required serious consideration, which is ensured by handling personal data in a sensitive manner. For example, people's real names were rendered anonymous or changed along with other identifiable information in the survey questions before committing response transcripts to NVivo.

The ethical dimension of research pertaining to principles of 'Do no harm' and 'Do good' is ensured by assuring participants that the information they provide would be used for the purpose of the study with proper access and storage, and without reporting personal information. Due regard was also given to the possibility of research posing risk to participants and to the researcher. This would specially be the case in situations where researchers face potential risks linked to personal health and safety (e.g. accommodation, weather and state of roads) and importantly political conditions that require thoughtful reconsideration and

possible resolutions. These risks needed recalibration and re-evaluation at all stages of fieldwork research. The researcher repeatedly informed participants that the study is an academic exercise.

All of the above considerations were governed and informed by a number of ethical frameworks including The Economic and Social Research Council's *Framework for Research Ethics* and the University of East London's *Code of Good Practice in Research*. In addition, basic regulatory frameworks such as Data Protection Act 1998 were also observed. Besides, approval of the UEL Research Ethics Committee was sought and secured before the commencement of the fieldwork, as part of the requirement of ethics clearance for field research involving human participants.

Apart from ethical issues, practical challenges are ever present in development field research (Desai and Potter, 2006). They start with translation of survey questions into different languages and extend to logistic and the recruitment of research assistants for they play useful role in the conduct of the research. In the fieldwork phase of this study, transport facilities and communication tools proved hugely important; and sometimes their lack presented difficulties. For instance, I needed to adjust my field visit dates depending on the availability of vehicles allocated for university researchers and fellow PhD researchers.

Equally important is negotiating access to data sources and maintaining relations and momentum to carry out what is needed of fieldwork. When different gatekeepers are involved access to data sources is a challenge. The issue of gatekeepers is highly relevant to research into marginalised communities as it attracts attention from authorities. In such cases, personal security of the researcher needs careful consideration. For example, a researcher could face difficulties to conduct critical research under watchful eye of authoritarian regimes that are unprepared to tolerate critical scrutiny. In this study, the existence of networks of neighbourhood civilian informers was reported. The networks regularly report to 'political cells' that belong to local level of the political organisation of the ruling regime, the EPRDF. The 'cells' are explicitly political entities and key informants confirmed their existence in the study areas. Farmers

were organised into units of five – known as '1 to 5' structures. The nature of these structures is corroborated by a recent report entitled '*Securing communities for development: community policing in Ethiopia's National Regional State'* from Overseas Development Institute (ODI).

A study funded by DFID revealed that 'every five households is represented by one individual at the local committee level, and similarly, every committee will be represented by a number of its members at the next highest committee using the 1:5 ratio, and so on up the hierarchy' thus simultaneously serving two purposes: ensuring representation in administrative processes while 'providing the government with grassroots reporting structures that can be utilised as a surveillance system' (Denney and Kassaye, 2013). The same report disclosed the establishment of a number of structures in the community including 'Advisory Councils, Conflict Resolving Committees, family police and the use of shoe shiner's and other trade associations as police informants' (*ibid.,* p.iv).

Similar surveillance systems, yet more stringent and explicit, were noted in a recent PhD research based on Iraqi refugees in Syria involving 'pervading atmosphere of fear, anxiety and suspicion for carrying out research within the constraints set by a repressive police state … [whereby] occasional praise of the government is indicative of the anxieties that vulnerable populations have' (Zaman, 2012). In such settings, the state has the power to refuse renewing or even to rescind food hand-outs and other necessities of life. 'The hospitality of the state is always conditional and temporary', adds Zaman. The political background is very much characterised by successive generations of authoritarian rule having 'pervasive impact on the structuring of the humanitarian field' resulting in 'a much-constrained environment for religious networks and NGOs' (Zaman, 2012, p.226).

While the context of farmers in this study differs in important ways from displaced people in Syria, the broader framework is relevant as the state in Ethiopia controls the supply of agricultural inputs, including seeds, fertiliser and, more importantly, land. For example, a recent study into agricultural extension policy in Ethiopia found tension between the objective of stimulating agricultural growth and

extensively penetrating society and winning elections which may reduce the returns to this investment on agricultural extension programme (Berhanu and Poulton, 2014). According to David Turton (2009, quoted in Debelo, 2011) the Ethiopian state uses the notion of 'wilderness' in peripheral south as a mechanism of state building, control of the people and territories, and for building legitimacy through so called development and conservation schemes. According to the same author 'Following the incorporation of the south into the Ethiopian empire in the late 19th century through military conquest, the state-society relationship has been paternalistic in which the state is perceived as predatory because of its policies of suppression and exploitation' (Debelo, 2011, p.49)

Given such scenarios, a researcher may encounter difficulty to function in fear inducing atmosphere that may in effect impact on authenticity of responses. In order to resolve such challenges one has to carefully negotiate the realms of politics and academic research. Yet the challenge remains an important one for similar cross boundary and cross-cultural research. I managed the problem by carefully observing any hint of political instability to minimise risk and harm to all people involved in the research. In the case of data authenticity, if one method of data collection is compromised, extra effort was exerted to elicit robust responses through FGD and semi-structured interviews. However, for a successful field research, an environment of co-operation and support between researchers and officials or policy makers is essential though not necessary. The rationale for supportive framework is based on mutual benefit from the findings of the research that inform different stakeholders including academic/research interest and policy-making community. Additionally one has to support smallholder farmers to reflect on their practices safe in the knowledge that the information they share is not used against them.

Finally, toward the completion of the fieldwork comes the task of sitting down and transcribing and translating interviews. This stage proved time consuming given that an interpretive act in three languages was involved. The researcher's passion and stamina to make sense of data and derive meanings and themes from the interviews is a factor that keeps the effort going. Repeated listening to interviews

is beneficial to clarify meanings and better understand the context of the interviews (Hameso, 2014b).

It has to be said that while the fieldwork proved an enriching experience, it was also undoubtedly a challenging one. At all times, it called for meticulous planning, regular flexibility and constant communication with stakeholders. Following on a word of advice from Brydon (2006), an ethical researcher has to be readily responsive to any situation that might come up. For there will always exist uncontrollable variables including the political environment for which little can be taken for granted, but to which one must be in constant guard, especially following the events of what is now known as the 'Arab Spring' of 2011. With unforeseen political events and especially in unstable regions, research plans can easily and quickly go awry. Some unforeseen circumstances did indeed unravel in this research too, but adhering to robust risk assessment regime and ethical guidelines as well as constant communication with key research team proved critically important and useful. It was also important to have a plan of action and a PhD journal to document progress and processes. Moreover, works that involve technology tools could suffer ever present mishaps. This includes the state or quality of audio and potential loss of data related to with computer glitches. Having frequent and regular data backup, preferably in different media, is a must; and it certainly helps avoid disappointment should disaster(s) strike. In sum, despite the abovementioned challenges impacting data collection, the analysis of data is supported by analytical framework which is presented in the next section.

3.4 Analytical framework: Sustainable livelihoods

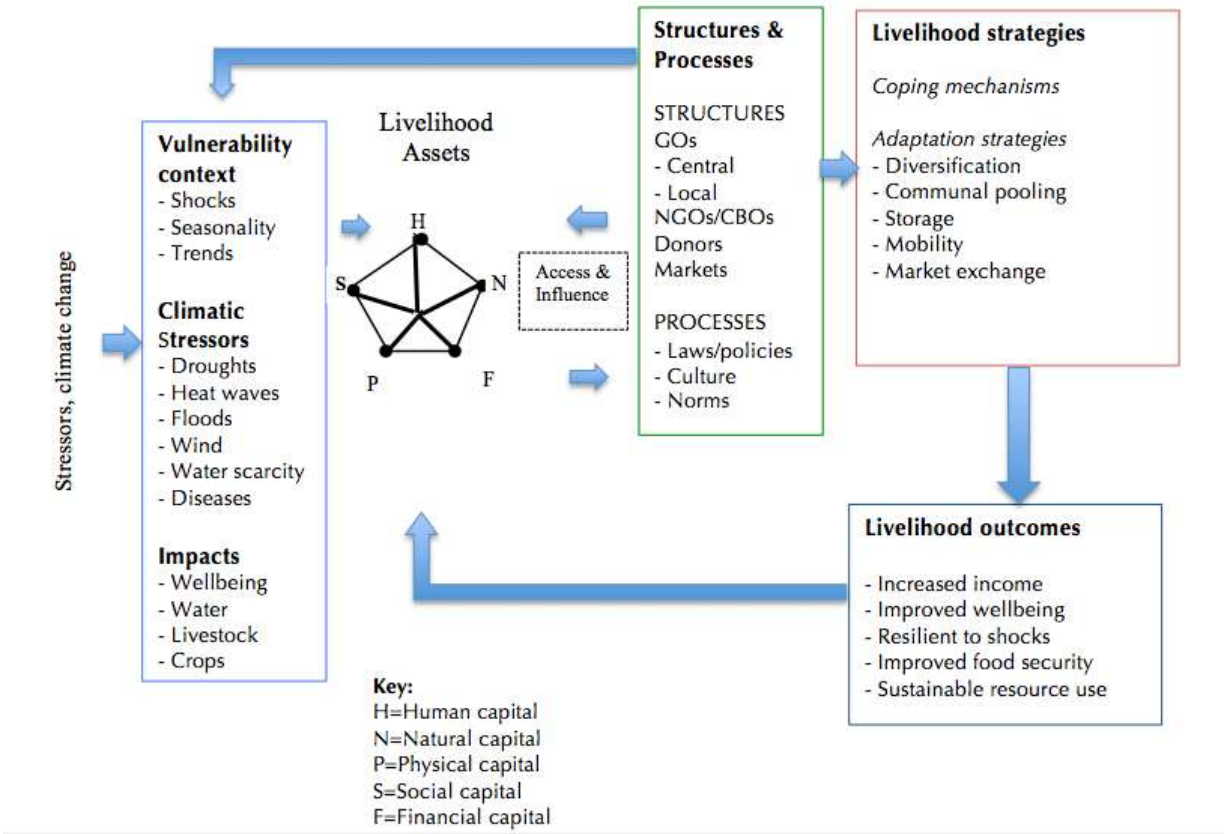
The study deploys sustainable livelihoods framework (SLF) as analytical tool. The framework emerged from the works of Chambers, Scoones, and Conway in the 1990s and moved beyond quantifiable monetary variables to incorporate assessments of vulnerabilities and social exclusion. It is rich in presenting the main factors that affect people's livelihoods and relationships between vulnerability context, livelihood assets, structures and processes, strategies and outcomes (DFID, 1999). Different aspects of the livelihoods approaches had been applied in developing countries in the context of poverty reduction, wellbeing and rural development (Chambers and Conway, 1992; Ellis and Freeman, 2004; Solesbury, 2003, Knutsson, 2006; Scoones, 2009). Later, bilateral and multilateral donor agencies such as DFID, CARE, Oxfam and UNDP upheld the principles of the framework for their international programmes (Carney *et al.,* 1999).

Central to SLF is the notion of sustainability which needs unpacking. *Sustainability* contrasts with *vulnerability* representing the opposite extreme of a continuum indicating the quality of livelihood systems (Niehof, 2004). A livelihood is said to be sustainable when it can cope with and recover from shocks and maintain or enhance its capabilities without undermining the natural resource base (Scoones, 1998; Carney *et al.,* 1999). The recovery and resilience of households or communities from climate shocks depends, as Tanner et al (2012) rightly stated, on access to assets such as land, labour, credit, social networks, health and education, infrastructure provision and access to natural resources. At the same time, access to assets is determined by the underlying political economy, the quality of governance and the possibilities for empowerment and voice.

The application of SLF in climate change studies is sparse and thinly spread despite the recognition that SLF serves as a useful tool to understand household and community resilience and vulnerability (Lautze *et al.*, 2003). Among studies that deployed livelihoods approaches on rural Africa are those that explored coping and adaptation to climate change (Burton *et al.,* 2003). Other studies examined the links between livelihoods and climate change without applying sustainable livelihoods framework (Erikson *et al.,* 2005). The studies that applied the framework (for example, Kebede and Adane, 2011; Mubaya, 2012) did not

encompass all the components of the framework to capture complexity through 'research that integrates different disciplinary perspectives and sources of data' (Carr *et al.,* 2014, p.110). This study approaches the subject from multi-dimensional perspective including economic, social and environmental aspects especially in relation to vulnerability. Moreover, it uses a modified sustainable livelihoods framework, as illustrated in Figure 6. The modification takes into account perceptions of climate change as part of human capital. Perception of climate change is embedded in knowledge and awareness of events, which in turn affect the strategies people choose to achieve their objectives. The framework starts by elucidating stressors and vulnerability context arising from external environment having impact on livelihoods. For smallholder farmers, the vulnerability context is associated with shocks, seasonality and trends and changes over which they have limited or no control (Ellis, 2000b).

Figure 2: Sustainable livelihood framework



Source: Adapted from IISD, 2003 and DFID, 1999, 2001, DCG report, 2013.
(The arrows in the framework do not imply direct causality save a certain level of influence).

Shocks emanate from environmental, social and economic factors. They include floods, droughts, earthquakes, illness of deaths in the family, harm to livestock or

crop health, ceremonial expenses, litigation, social crises, local or regional conflicts and violence, food shortage and inflation. Smallholder farmers are also vulnerable to *seasonality*. Agriculture in general and farming in particular is affected. The problem is pronounced for rain-fed farming where livelihoods depend on the amount and timing of rainfall. Similarly, livelihood outcomes for smallholder farmers are inextricably linked to seasonal-based production, prices and employment opportunities. Changed seasonal patterns introduce uncertainty, which in turn impacts on livelihood strategy and outcomes. Households are also affected by *trends* and *changes* in demography, resources, technology, markets and trade and governance conditions. While many of the trends and changes could be negative, not all them are as such. For example, trends in technology, especially those linked to ICT such as mobile phones and the Global Positioning System (GPS) can be used to empower farmers and support their livelihoods by providing information on markets, weather and landscapes.

SLF places considerable importance to *livelihood assets* represented in asset pentagon in Figure 6. They are also referred as capitals or livelihood building blocks that determine how people respond to the impacts of climate change. According to IISD (2003) the ways in which livelihoods work and how people respond to climate change depend on livelihood assets that form the basis of adaptation strategies. The stronger and more varied the asset base, the greater is the peoples' adaptive capacity and the level of security and sustainability of livelihoods (Cooper *et al.*, 2008).

The literature categorises livelihood assets into five capitals, namely, human, social, natural, physical and financial capital. Human capital takes the form of training, skills, and knowledge that translate into ability to labour and good health, nutrition, education, as well as capacity to work and adapt (DFID, 1999). Together they *enable* people to pursue different strategies and achieve their objectives. Human capital is particularly vital in perceiving climate change and taking adaptation actions. For instance, farmers with better education and skills are better placed to adopt new ideas and tools. Education in particular is shown to be an important factor in facilitating smooth introduction of new technologies (OECD, 2001) and this would apply to adaptation technologies.

Social capital denotes important category of assets consisting of networks[1] and norms that enable people to act collectively (Woolcock and Narayan, 2000; Adger, 2003b). Through networks, people share knowledge, spread risk and claims for reciprocity in times of crisis. In the context of climate change, the web of relationships, trust, reciprocity and exchange and the evolution of common rules play important role in determining adaptive capacity (Adger *et al.*, 2003b, Jaja and Dawson, 2014). This is particularly the case for rural communities where relationships and institutional access, rights and claims derived from group membership and village organisations play a vital role. Therefore, the role of social capital merits added emphasis and further exploration.

Among early works that offered insights on the subject, Bourdieu (1986, p.245) distinguished social capital from economic and cultural capital, as constituting a network of relationships which are 'the product of investment strategies, individual or collective, consciously or unconsciously aimed at establishing or reproducing social relationships that are directly usable in the short or long term.' Likewise, Coleman (1988) divided social capital into three forms: obligations and expectations, information channels, and social norms that provide access to social claims and transfers via kinship. Rural societies depend on these since formal institutions in the form of either markets or state intervention leave a gap in addressing their needs. Later studies, for example, Adger (2003b, pp. 389-90) made reference to 'social capital theory' that provides an explanation of how individuals use their relationships to other actors in societies for their own and for collective good – the latter having both material elements and wider spiritual and social dimensions. Indeed spiritual and social dimensions are often ignored on the grounds of rationality and the challenges they pose to scientific analysis.

[1] Based on social networks perspective, the Office for National Statistics of United Kingdom (http://www.ons.gov.uk/ons/index.html) divides social capital into three elements: bonding, bridging and linking. *Bonding social capital* is closer connections between people and is characterised by strong bonds, for example, among family members or among members of the same ethnic group. *Bridging social capital* describes more distant connections between people who differ in race or ethnicity, education, gender, age, or socio-economic status but with more cross-cutting ties (for example, relations between acquaintances, friends from different ethnic groups, friends of friends). *Linking social capital* describes connections with people in positions of power and is characterised by relations between those within a hierarchy where there are differing levels of power and enables access to support from formal institutions. It is different from bonding and bridging in that it is concerned with relations between people who are not on an equal footing (See also http://raggeduniversity.blogspot.co.uk/2011/06/crash-course-in-social-capital.html)

Nevertheless, the importance of social capital on adaptation to climate change is widely noted. For example, by building trust and co-operation between actors in the state and civil society, social capital and inclusive decision-making institutions are said to 'promote the sustainability and legitimacy of any adaptation strategy' (Adger, 2003b). Moreover, the process of adaptation based on social capital can alter the perceptions of climate change from global to local problem to the extent that 'when actors perceive adaptation to and the risks of climate change as being within their powers to alter, they will be more likely to make the connections to the causes of climate change, thereby enhancing their mitigative and, as well as adaptive capacity' (Adger, 2003b, p.401).

In the context of this research, co-operation and trust are manifest in three local institutions: *Debo, Ekub* and *Edir.* The first of these, *Debo* (*Dee*), is an informal system of co-operation for labour exchange during farming activities, based on equivalent labour or material contribution by each farmer (Ruben and Heras, 2012, 469). In many parts of Sidama, *Dee* remained pivotal to help carry out demanding tasks such as building huts (shelter), farming and sometimes crop harvesting.

Ekub (*Uquwe*) is a rotating credit group or a kind of saving association where members make regular contributions to a common fund. Every member stands to benefit from a lump-sum payment once in a pay-out cycle. For example, if a group consists of 20 members and each person contributes 100 birr a week or month, the same person is entitled to a lump sum of 2000 birr, which enables one to spend or invest on livelihood options of choice.

Edir is a funeral association that mainly deals with the organization of burial ceremonies, and offers financial assistance to the family of deceased. In their study into group-based funeral insurance in Ethiopia and Tanzania, Dercon et al (2006, p.685) noted the history of these institutions as characterized by resistance to attempts of political capture with apparent opposition to engage more broadly with NGOs and government agencies. While such is the historical background,

some institutions get into focus of prying eyes of authoritarian regimes, having compromised their independence in the process.

Natural capital is another component of livelihood assets. It refers to the natural resource base from which households engage in agricultural pursuits and resource collection for both sustenance and income generation (Ellis, 2000b). Examples include land, forest, air, water, fish, livestock, pasture, wild products and biodiversity. Depending on local contexts, some of these natural assets such as agricultural land, pasture land, forest and water are communally held hence common property resources (CPRs), often viewed as free whose consumption is hardly charged or regulated. Some of these assets such as forests, fishing grounds, pastures and water form vital livelihood and, if poorly managed, are subject to overuse, pollution, deterioration and potential destruction or depletion. On the other hand, well-managed natural capital can be used as critical assets to strengthen the adaptive capacity of the communities. Irrespective of communal or private proprietorship of natural capital, access to these assets is critical to rural livelihoods and to farmers who directly depend on natural resources for cultivation and livestock (Kebede and Adane, 2010).

In this study context, relevant natural capital assets are land, livestock, agroforestry (mainly trees), water, and pastures. In low-income countries, land is the most prominent natural capital as a key livelihood asset, followed by livestock (Dercon and Krishnan, 1996; Rahmato 1987). Moreover, agroforestry, plays an important role in mitigating adverse changes in traditional smallholder-farming systems (Gebretsadik, 2014, p.118). According to Altieri and Koohafkan (2008), the presence of trees in agroforestry designs stands out as a key strategy for mitigation of microclimate variability in smallholder farming systems, reducing atmospheric loads of greenhouse gases because of their high potential for sequestering carbon and buffering farmers against climate variability. Likewise, the availability of water and pasture plays an important role for rural livelihoods.

Physical capital or built capital refers to *infrastructure resources* and technology (e.g. tools and equipment for production, seed, fertiliser, pesticides, traditional technology, livestock used in animal traction). The components of infrastructure

essential for sustainable livelihoods include affordable transport, secure shelter and buildings, adequate water supply and sanitation, clean, affordable energy and access to information or communications (DFID, 1999).

Finance capital, expressed in the form of money or liquid assets (e.g. savings, credit/debt from formal, informal and NGO sources and remittances), plays an important role to build resilience against shocks. In developing countries, microfinance institutions (MFIs) provide access to financial credit for smallholder farmers as commercial banks hardly invest in small-scale agriculture (Jessop *et al.,* 2012, p.16). MFIs differ from banks by offering smaller loans, thereby making credit more accessible to farmers. Loans are typically made for the purchase of inputs (fertiliser), capital acquisition (livestock, machinery, buildings) or other improvements (IFPRI, 2006, p.29). In response to shocks, households resort to informal credit or usury which involves high transaction costs (Schindler, 2009) and therefore unsustainable in the long term.

The nature and combination of the above livelihood assets, to which households and communities have access, determines adaptation choices (Agrawal, 2010). However, the combination should not be construed as static; quite the contrary, it is dynamic in that some assets shrink or expand over time changing the shape of the 'asset pentagon'. Furthermore, some assets serve more than one function – for example, livestock is termed as natural asset, but in rural settings it also serves as physical capital (traction) and a boost to social capital in the form of social prestige, which its owners could draw down in times of need. This explains why smallholder farmers in Sidama value livestock as much as farming.

Livelihood assets are not the only determinants of the ability of smallholder farmers. *Transforming structures* or institutions that create and enforce legislation provide the necessary requirements to acquire assets, manage natural resources, and provide other services crucial for gaining access to assets, exchanging them, and benefiting from their use (ATHA, nd)[1] Transforming structures work at different scales starting at local (household, village/community, culture), private sector (markets), community-based associations, and NGOs. They extend to

[1] ATAHA offers critical examination of different elements of SLF.

government (central and local governments) and international structures. All of these have the capacity to 'structure' the risks and sensitivity to climate hazards, facilitate or impede individual and collective responses, and shape the outcomes of such responses (Agrawal, 2010). Viable and functioning institutions are required to coordinate activities of households for communal pooling or collective action.

Important too are *processes* in the form of policies, legislation, rule of law, and power relations that determine the interactions between the structures and individuals (Kollmair and Gamper, 2002). The effectiveness of adaptation practices in particular depends on the social and institutional contexts in which they are pursued. For example, land tenure or the system of rights and institutions that govern access and use of land are important for farmers to invest on land and take or spread risks. According to a study on Uganda, insecure land tenure rights led farmers to avoid long-term investments that could have helped them adapt to climate change and manage resources sustainably, and worse, they were a key driver behind some of the damaging practices, for example, deforestation, poor waste management and overuse of pesticides, and lack of involvement in the project activities on sustainable watershed management.[1] Thus, inappropriate policies and weak institutions may result in farmers adopting practices that are unsustainable or that actively degrade the environment. It is also the case that policy and institutional failures exacerbate market failures,[2] locking smallholder farmers into a low level equilibrium that perpetuates poverty and land degradation. On the other hand, robust institutions and policies play an important role in climate change adaptation. Agrawal (2010, pp.179-180) identified three ways by which the nature of access to institutions and institutionally allocated resources is a critical factor. First, they structure environmental risks, and thereby the nature of climate impacts and vulnerability. Secondly, they create the incentive framework within which outcomes of individual and collective action unfold. Thirdly, they act as the medium through which external interventions reinforce or undermine existing adaptation practices. However, the institutions that shape

[1] CCAFS (nd) 'Insecure land tenure rights in Uganda provides a stumbling block for climate adaptation and water management project' CCAFS: CGIAR research program on Climate Change, Agriculture and Food Security [Online] ccafs.cgiar.org /blog/how-land-tenure-insecurity-affects-climate-change-adaptation-work

[2] Yet researchers contended that the role of market, policy and institutional failures that shape farmer incentives and investment decisions are less understood (Shiferaw *et al*., 2009, p. 601).

farmers' decisions are not static; they are subject to change 'as a result of the changing calculations of advantage and the nature of political interactions among relevant decision makers' (*ibid*., p.174). For example, a change in political regimes and actors is bound to affect institutions especially in polities that depend on personalities and patronage rather than on solid, resilient institutions.

Livelihood strategies form another important component of sustainable livelihoods frameworks. Households or communities pursue different options for pursuing livelihood goals. For example, with rising temperature and erratic rainfall, farmers may change crop varieties or the planting time. They may diversify their income sources and livelihood options. Dorward et al (2005) distinguished livelihood strategies of poor people between 'hanging in', 'stepping up' and 'stepping out' representing coping, moving to new livelihood options and successfully graduating or exiting, respectively. Similarly, Agrawal (2010) classified adaptation strategies into diversification, communal pooling, storage, mobility and market exchange. The stronger and more diverse the adaptation strategies, the higher the resilience to shocks, trends, and seasonality changes, leading to successful adaptation.

Livelihood outcomes result from the application of livelihood strategies taking into account the assets that farmers have access and the vulnerability context and supported or obstructed by policies, institutions and processes. Examples of desirable outcomes include higher income and greater wellbeing in the sense of physical security, self-esteem, political empowerment, reduced vulnerability, increased resilience and adaptive capacity, reduced vulnerability, greater food security, and improved environmental sustainability. As IISD (2003, p.2) noted the SLF does not view adaptation to climate change as 'unfortunate necessity in the face of adversity' but embraces it as a positive opportunity for beneficial change, or no-regrets approach to adaptation.

Due its holistic nature, SLF has rapidly gained ground and support from different stakeholders including the UK government departments (e.g. DFID), non-governmental organisations (e.g. Oxfam, Care International) research establishments (e.g. Institute of Development Studies) (DFID, 1999; Solesbury, 2003) and international intergovernmental bodes (e.g. IFAD). The insights from

the application of the framework have helped draw lessons about its advantages and limitations.

One advantage of SLF in particular and livelihoods approaches in general is the concern with people, supporting them to build on their own strengths and realise their potential, while at the same time acknowledging the effects of policies and institutions, external shocks and trends (Carney, 1999). Other aspects of livelihood analysis include what Scoones (2009, p.173) applauded as 'integrative, locally-embedded, cross-sectoral and informed by a deep field engagement and a commitment to action.' Such analysis is prized to link the micro with the macro by connecting the local reality to broader policy and institutional set up, thus providing the basis for identifying the constraints to livelihood development that exist at the local level and in the broader economic and policy environment or those relating to economic sectors such as agriculture, health, education or rural infrastructure.

In this study, the rationale to apply sustainable livelihoods framework is that some of the key components such as vulnerability, institutions and policies and adaptation strategies are central to the framework. The strength of the framework lies in its focus on local, people-centred, and often non-sectoral vantage with preference to agency and entitlement as well as focus on livelihood assets (Bebbington, 1999; Leach *et al.,* 1999).

The approach is not without limitations, however. For example, IFAD[1] admitted that the framework was 'neither a model that aims to incorporate all the key elements of people's livelihoods, nor a universal solution.' It is evident that some aspects of the research, for example, perceptions of climate change, hardly fit the original framework although the modified version includes them as part of human capital (as education, skills and knowledge). Scoones (2009) highlighted the failures of sustainable livelihoods approaches including:

a) the lack of engagement with processes of economic globalisation,

[1] The International Fund for Agricultural Development (IFAD) *The sustainable livelihoods approach.* http://www.ifad.org/sla/

b) the lack of attention to power and politics and the failure to link livelihoods and governance debates in development,
c) the lack of rigorous attempts to deal with long-term change in environmental conditions, and
d) the lack of debates about long-term shifts in rural economies and wider questions about agrarian change.

These failings are summarised to questions of *knowledge*, *politics*, *scale* and *dynamics*. In terms of knowledge, SLA's focus on the local was at the expense of 'dealing with big shifts in the state of global markets and politics' (Scoones, 2009). In the age of globalisation, exclusive focus on the local misses the influences of global forces. In this study, the examination of coffee economy as a livelihood option for smallholder farmers enables exploration of the link between global market and local livelihoods. In effect, it addresses how global actions to raise or depress coffee prices impact on local livelihoods. Furthermore, the study involves the views of international agencies, mainly NGOs, who add their voice and efforts through local development intervention and global environmental advocacy. In terms of politics, a more explicit theorisation of power and social difference is suggested to bring politics back to 'inject a more thorough-going political analysis into the centre of livelihoods perspectives' (*ibid.,* p.171).

This study explores the local context in which structures and processes determine access to assets and support or hinder adaptation strategies and livelihood outcome. In terms of scale, the need for integration of livelihoods thinking and understanding of local contexts and responses with concerns for global environmental change is noted (*ibid.,* p.182). The study addresses this issue by exploring climate change impacts at the local level alongside institutional settings at the local, national context and beyond. In terms of dynamics, questions were raised if local level adaptation can 'address more fundamental transformations in livelihood pathways into the future' (*ibid.*). This study addresses the problem of dynamics and development pathways in Ethiopia through exploration of long-term adaptation options.

In sum, despite the limitations, SLF as a method is a useful analytical tool to help understand vulnerability and adaptation to climate change. It enables the deployment of different data sources to capture the complexity related to vulnerability and adaptation to climate change.

3.5 Summary

The research deployed comparative case study research design to compare and analyse livelihood systems in three agroecological sites in Sidama. The sites were selected on the basis of altitude and availability of weather stations. Primary data was collected through FGD, semi-structured interviews and a household survey. Data were analysed using computerised data analysis tools. The process of data collection and fieldwork involved ethical issues and practical challenges. The study deployed sustainable livelihoods framework as analytical tool to draft survey instruments and to analyse the results thereof. The following chapters (4-7) present the results and discussion of the findings.

Chapter 4: Results & discussion: Socioeconomic & institutional context

4.1 Introduction

The chapter presents and discusses the results of socio-economic characteristics and institutional context. Most of the results discussed in this chapter are derived from quantitative survey data, while the last section dealing with structures and processes derive from qualitative focus group discussion and interviews. The chapter is divided into thee main sections: socio-economic characteristics and vulnerability context, livelihood assets and options as well as structures and processes. The first section presents demographic characteristics including age, gender, education, wealth status, farm size and location. In terms of SLF (Fig 6), these characteristics form part of the social vulnerability context of the farmers. The second section presents data on livelihood options, institutions and structures relevant to climate change in Ethiopia. Survey results are analysed using different tools such as descriptive statistics. Chi square test[1] is deployed to investigate the significance of association between households' livelihood assets across AEZs. Frequency tables, pie charts, bars, graphs, pictures and boxes are also used to visualise the results.

4.2 Socio-economic characteristics and vulnerability context

Survey respondents exhibit diverse demographic and socioeconomic characteristics (Table 5). The average age of survey household head is 46 years with the standard deviation of 17.6. The minimum age[2] is 20 and the maximum is 90 years. More than half of the survey respondents (54%) were relatively young (between 20 and 40 years of age). Middle to older age groups accounted for the remaining 46%. Jara Galalcha has more young age respondents compared to Xexicha and Awaada.

[1] Chi square statistic is used to investigate whether distributions of categorical variables (e.g. agroecological zones) differ from one another.

[2] It has to be noted that age in rural Sidama is an estimate since it is not recorded as most of births take place at homes outside hospital or clinic settings. People use historical timeframe to tell one's age by reference to some time markers, for example, the year of Italian invasion, times of terror, fall of the Emperor and so on. However, in recent decades the introduction of modern education and health services meant that more accurate age measurement is possible.

Table 6: Socioeconomic summary of household survey (statistics)

Variable/Household characteristics	**Mean (SD)**		**Min – Max**	
Age of household head	46 (17.6)		20 - 90	
Family Size	7.13 (2.26)		1 - 14	
Variable/Household characteristics	**Frequency (%) N = 120**	**Survey sites**		
	All	Xexicha	Awaada	Jara
Age group				
Young (20-40)	61 (53.5)	29.7%	56.8%	72.5%
Middle (41-60)	25 (21.9)	29.7%	18.9%	17.5%
Old (61-80)	25 (21.9)	35.1%	21.6%	10.0%
Elderly (81-100)	3 (2.6)	5.4%	2.7%	0.0%
Family size (group)				
Small (1-5)	33 (27.7)	27.5%	20.5%	35.0%
Medium (6-8)	34 (28.6)	15.0%	38.5%	32.5%
Large (8-10)	42 (35.3)	40.0%	33.3%	32.5%
Very large (11-15)	10 (8.4)	17.5%	7.7%	0.0%
Gender				
Male	109 (90.8)	95.0%	85.0%	92.2%
Female	11 (9.2)	5.0%	15.0%	7.0%
Marital status				
Married	110 (91.7)	90.0%	90.0%	95.0%
Single	2 (1.7)	0.0%	5.0%	0.0%
Divorced	1 (0.8)	2.5%	0.0%	0.0%
Widow	7 (5.8)	7.5%	5.0%	5.0%
Ethnicity				
Sidama	117 (97.5)	97.5%	95.0%	100%
Amhara	1 (0.8)	2.5%	0.0%	0.0%
Other	2 (1.7)	0.0%	5.0%	0.0%
Religion				
Protestant Christian	92 (76.7)	52.5%	87.5%	90.0%
Orthodox Christian	4 (3.3)	2.5%	7.5%	0.0%
Catholic Christian	6 (5.0)	12.5%	2.5%	0.0%
Muslim	5 (4.2)	2.5%	0.0%	10.0%
Traditional beliefs	13 (10.8)	30.0%	2.5%	0.0%
Educational Level				
None	40 (33.3)	50.0%	12.5%	37.5%
Primary (grade 1-8)	71 (59.2)	47.5%	72.5%	57.5%
Secondary (grade 9-12)	9 (7.5)	2.5%	15.0%	5.0%
Occupation				
Smallholder farmer	115 (95.8)	90.0%	97.5%	100.0%
Teacher	1 (0.8)	0.0%	2.5%	0.0%
Artisan	1 (0.8)	2.5%	0.0%	0.0%
Driver/Mechanic	3 (2.5)	7.5%	0.0%	0.0%

[Source: Survey, 2012]

Average family size of survey respondents is 7.13 persons (S.D = 2.26). The minimum family size is 1 and the maximum is 14. Small family size (1-5 members) accounted for 28%, medium size (6-8 members) accounted for (29%) and large group size (8-10 members) accounted for 35%. In other words, over 50% of households had over 8 members indicating high fertility rate and the importance of extended family system. The use of family labour for economic activities is an

attraction to have more family members. Moreover, in a rural society where pension and insurance system is absent, parents prefer to have more children to support them in old age. However, larger family size also carries the seeds of increased vulnerability when combined with shortage of land and food insecurity.

When results of family size across AEZs are compared, Xexicha reported higher frequency of large family size (40%) than the other two sites. The result shows the prevalence of extended family conditions in the highlands implying the strength of social and family ties that take care of children and vulnerable adults or the needy and the disadvantaged people. This role is shared by religious institutions and indigenous social organisations in different parts of Ethiopia (Berhanu, 2002).

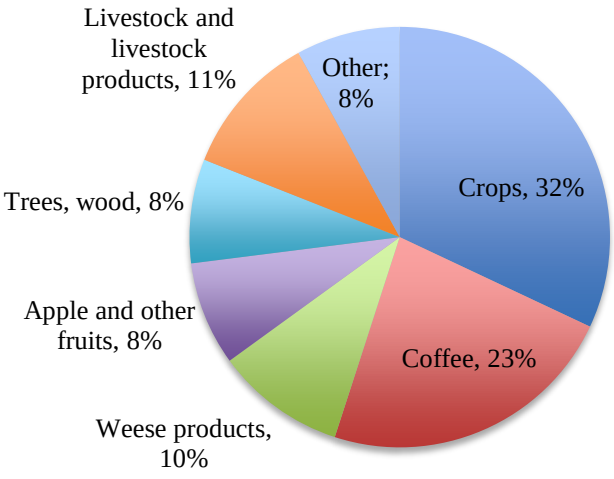
In terms of gender, most of the survey members were male (91%) and an equivalent number reported being married. The latter is not surprising as it partly explains the dominant social expectations and survival challenges outside the norms set by society. Moreover, 97% of respondents were from the Sidama ethnicity, reflecting the population composition and ethnic homogeneity in rural Sidama. Protestant Christianity dominates survey sites (77%), followed by traditional belief systems (11%) – perhaps, a reflection of changing religious dynamism of recent decades where original belief systems were gradually replaced by monotheistic religions as was observed in the 1960s and 1970s (Hamer, 2002).

Households varied in their of educational attainment. While 59% of respondents reported receiving primary education, a third of respondents reported being unable to read and write. The latter group indicated, lack of scientific understanding of climate change, supporting the notion that education would enable better understanding of climate change and adoption of new methods and farming practices. In terms of occupation, most household heads (96%) were smallholder farmers. Noting that wealth and status play an important role in rural livelihoods, the study asked households to rank their status as *poor*, *medium* and *rich*. The response is interesting as most respondents (83%) regarded themselves as medium, with 14% as poor and only 3% as rich. This finding is counter-checked with the type of house owned as indicator of one's status. The majority (71%)

reported living in a traditional hut made of grass roof often the residence of the ordinary and poor people. Only 28% live in house with corrugated iron roof considered as status symbol in rural areas owned by relatively richer households. Wealth status ranking is spread equally across agroecological sites with higher frequency of households reporting *rich* in Xexicha (highland) than the other two sites.

Apart from wealth status, monetary flows of income and expenditure indicated the context of vulnerability to shocks. Interestingly, there is a notable discrepancy between reported average income and expenditure. For example, reported annual income for 2011 (the year preceding the survey year) was 569,165 birr (about £18,972) but reported annual expenditure was 919,138 birr (about £30,637). Arguably, a large gap existed either due to memory lapse or intentional attempt to underestimate income or to overestimate expenditure.

Figure 3: Average household income



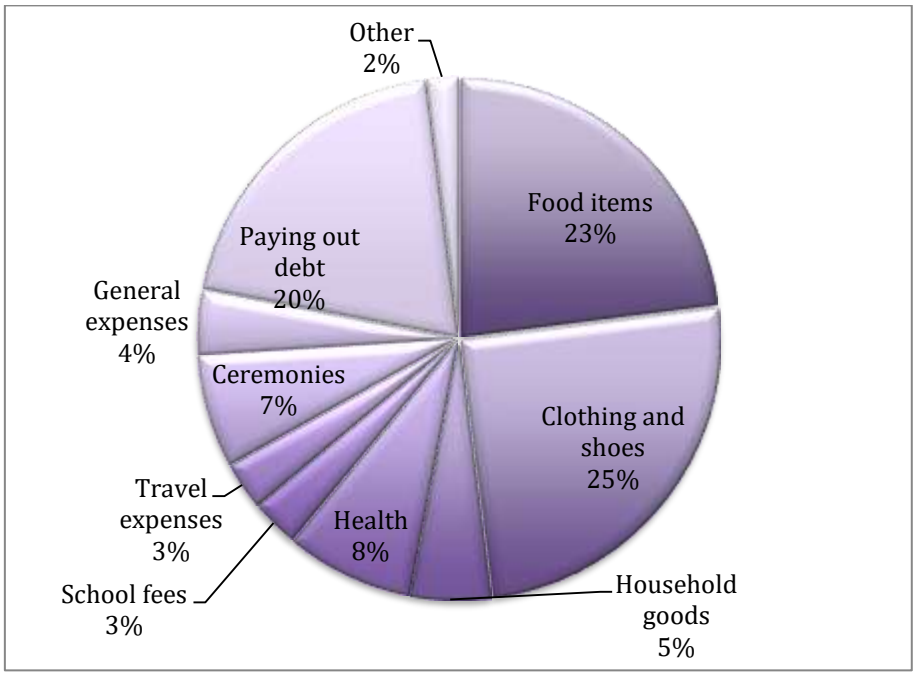
[Source: Survey data, March 2012]

The highest source of income was sale of crops (32%), coffee (23%), livestock and livestock products (11%) and enset products (10%) (Fig 7). Reported income from handcrafts, renting out domestic animals or land was insignificant. Income sources under 'Other' category included income earned by building traditional huts, sale of enset seedlings, beans, sweet potatoes, onions, green paper, bananas, mangoes, honey, being employed as guard at factory, hiring labour, and renting out a second house. The portfolio of income sources indicates some degree of livelihood

diversification in the study areas, although reported income from 'other' sources is small (8%). High dependence on crops and coffee means that households are dependent on climatic stress, hence likely to be vulnerable to climate change.

Expenditure on clothing is the largest outlay (25%) followed by food (23%) and debt payment (20%) (Fig 8). The result implies farmers' susceptibility to the cost of clothing and food. Some focus group discussions highlighted the impact of inflation on wellbeing. The level of indebtedness of smallholder farmers in the reported expenditure pattern is also indicative of vulnerability.

Figure 4: Average household expenditure



[Source: Survey data, March 2012]

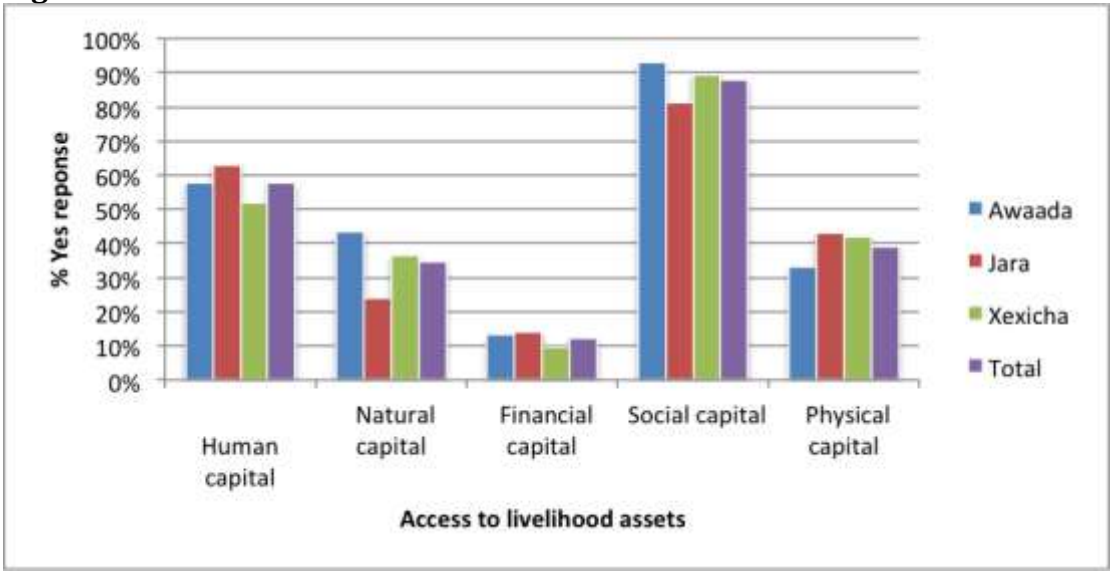
Ceremonies (funerals and weddings) account for 7%. Expenditure items reported under 'Others' were payment of dowry on marriage and for agricultural inputs (e.g. fertiliser and seeds).

4.3 Livelihood assets and options

In relation to *livelihood assets*, respondents were asked if they had access to listed assets in the preceding year. Results are given in Figure 9. Rating of access to social capital in all AEZs is 88% of respondents while the corresponding figure for human capital is 58%. Financial capital scores the least overall (mere 12%). It appears

that social capital serves as a redress for missing financial and other forms of livelihood assets. This is in line with previous studies that highlighted the helpful role of social capital in reducing transaction cost, i.e. lower monitoring costs of hired labour, easier incentives for pooling resources and better dissemination of information (Ruben and Heras, 2012).

Figure 5: Access to livelihood assets



[Source: Survey data, March 2012]

In terms of AEZs, financial capital scores the least in Xexicha than in Jara and Awaada. This could be due to the ability of farmers in the midlands and lowlands to produce coffee and maize for market – hence with greater cash earning possibility, whereas farmers in the highlands lack cash crops as options for earning cash. Yet this situation may change in future with climate change.

Cross tabulation of household livelihood asset in all zones shows that households are differently endowed with assets. Chi square values are calculated to show the significance of association between livelihood assets and AEZs. As Table 6 shows the components of human capital show significant association between agroecological areas and schools and training/workshops with Chi values of 8.412 and 6.037, respectively at 5% significance level. However, the same is not the case with the components of health and nutrition.

In terms of inter-site comparison, Awaada scored higher on schools than Xexicha and Jara. Apart from its proximity to a district town of Yirgalem, Awaada has

relatively better access to schools including to a high school. This is not the case for Xexicha and Jara. On the other hand, more training and workshops appear to be organised in Xexicha (74.4%) than Awaada (57.5%) and Jara (47.5%). All of the sites surveyed had Farmers' Training Centres (FTC) although most of them lacked facilities and equipment.

Table 7: Access to livelihood assets by households (rating)

Capital type/Livelihood asset	Xexicha (N=40)	Awaada (N=40)	Jara (N=40)	Chi Value
Human capital	**57.7%**	**63.1%**	**51.9%**	
Health facilities	71.8%	87.5%	77.5%	3.016
Adequate nutrition	66.7%	60.0%	55.0%	1.131
Schools or adult education classes	17.9%	47.5%	27.5%	8.412**
Trainings/workshops	74.4%	57.5%	47.5%	6.037**
Natural capital	**43.3%**	**24.1%**	**36.6%**	
Cow	97.4%	87.5%	92.5%	2.789
Oxen	20.5%	5.0%	60.0%	31.491***
Goat	20.5%	22.5%	35.0%	2.546
Sheep	66.7%	2.5%	17.5%	43.458***
Bees	28.2%	2.5%	5.0%	15.226***
Chicken	54.1%	65.0%	57.5%	1.006
Donkey	20.5%	7.5%	17.5%	2.869
Mule/horse	38.5%	0.0%	7.5%	25.483***
Financial capital	**13.3%**	**13.9%**	**9.5%**	
Savings	26.3%	60.0%	30.8%	11.059**
Investment	10.5%	7.5%	7.9%	0.264
Credit (formal, informal)	13.2%	15.0%	15.0%	0.071
NGOs	2.7%	0.0%	7.7%	3.600
Remittances	0.0%	10.0%	2.5%	5.166*
Pensions	8.1%	2.6%	0.0%	3.933
Wages	32.4%	2.6%	2.6%	20.650***
Social capital	**92.9%**	**81.3%**	**89.4%**	
Importance of local rules	100.0%	95.0%	100.0%	4.018
Trust and mutual support	94.9%	97.5%	92.5%	1.045
Access to leaders/administrators	89.7%	77.5%	90.0%	3.321
Participation in decision-making	87.2%	55.0%	75.0%	10.427**
Physical capital	**30.0%**	**39.1%**	**39.6%**	
Oxen-plough, plough, wheel barrow	7.5%	72.5%	97.5%	71.469***
Hoe, axe, fork, pick axe	92.5%	97.5%	97.5%	1.670
Knife, sickle, hammer, spade	97.5%	97.5%	84.2%	7.199
Transport				
Donkey/horse cart	7.9%	12.5%	32.5%	9.225*
Tractors, motor cycle, car/truck	5.4%	7.7%	17.5%	3.477
Energy				
Fire wood	90.0%	95.0%	97.5%	2.124

Electricity	13.2%	17.9%	10.8%	0.838
Liquefied petroleum gas, kerosene	42.5%	82.5%	95.0%	30.767***
Solar, biogas, animal dung	32.5%	5.0%	5.6%	15.549***
Other	42.5%	17.5%	7.5%	14.910**
Household goods				
Mobile	20.5%	42.5%	50.0%	7.864**
Radio	28.2%	47.5%	22.5%	6.223*
Television	0.0%	5.0%	5.0%	2.018
Telephone	0.0%	2.6%	5.0%	1.993
Bed	71.8%	97.5%	90.0%	11.826**
Wrist watch, clock	17.9%	42.5%	20.0%	7.510**
Fridge	0.0%	0.0%	2.5%	1.992
Sewing machine	0.0%	0.0%	2.5%	1.992
Paraffin stove	0.0%	0.0%	8.8%	7.072**

* significant at 10%, ** significant at 5%, *** significant at 1% levels
Source: Household survey, 2012

Natural capital scored low in all sites save the figure for cows, sheep and chicken reported to be above 50%. More people reported having or using cows and sheep in Xexicha than the other two sites highlighting the fact that highland conditions are suitable for both. Ownership or access to natural capital is lower in Awaada. On the other hand, oxen ownership is higher in Jara where it is used for farming and least owned in Awaada where shortage of grazing land is intense and farming is wholly done with human labour. Mule or horse ownership is also higher in the highland of Xexicha, where modern transport is poor and people rely on horse-power to transport agricultural produce to markets. Results from survey data for natural capital need to be taken with caution since only livestock element are included and other elements are not listed under of Natural Capital. The missing elements include land, agroforestry/trees, water, and pasture. Some of these form common property resources and they are partly incorporated in qualitative data. They are also included in different parts of the survey without being listed under natural capital, for example water availability and pasture quality are analysed in Table 10, in section 6.2.

Among the components of financial capital, remittances, savings and wages show high significance of association across agroecological sites – with Chi values of 5.166 1.059, and 20.650 at 1%, 5% and 10% significance levels, respectively. Awaada scored high for savings and remittances. In terms of wages, Xexicha scored high on wages mainly income from casual labour. Access to credit is low in all

areas, below or around 15% responses. This data is supported by field observation and FGD that found very limited availability of microfinance institutions. However, one MFI, known as Omo Microfinance Institution, is reported to operate in Awaada which appears to encourage savings among farmers by providing bank accounts and financial advice. Interestingly, the local Sidama Microfinance Institute (SMI) was not seen functioning in this Kebele, for reasons not known. Missing is also empirical research into the role of such institutions.

Social capital and all of its components figures prominently in all sites. This is particularly the case in times of need when livelihood options shrink and support exists in the form of shared moral (informal) economy. The basis for such arrangement is the importance of local rules and mutual support. In this study, local rules score high in the highlands and lowlands, and slightly lower in the cash crop growing midlands. The latter appears to rely on relatively higher trust and mutual support. Access to leaders and administrators is the highest in Jara which is also not far away from decision makers in Hawassa town.

Membership to associations and networks, as per the sustainable livelihood framework (Fig 6), is part of the social capital that enables 'knowledge sharing, spreading of risk and claims for reciprocity in times of crisis' (Eriksen *et al*., 2011, p.16). According to Deressa et al (2009), social networks[1] increase awareness and use of climate change adaptation options. In this study, respondents were asked about their membership roles to organised groups. The results showed that large number of respondents reported involvement as ordinary members in community, Kebeles and church. The most referred category is ordinary membership to Kebele/village followed by funeral societies or *Edir*, church, and informal saving entities or *Equb*.

These results reflect a number of important realities. First, they show the ubiquitous presence of government administration that ensnares farmers. Second, funeral societies serve important role since the rural areas had no formal funeral services. *Edir* operates on the basis that if one person dies, the rest of the group covers the funeral cost. In some cases, a funeral can bankrupt a family and

[1] Social networks comprise ties that facilitate the informal exchange of information, materials or resources.

therefore funeral societies are important ways of assisting people shoulder financial burden. Third, savings clubs exist to support members under circumstances where formal saving and credit market is undeveloped. The vital roles of the above networks confirm IFPRI research that local organisations and informal networks are a source of resilience that help poor, vulnerable people withstand economic, environmental and political shocks (Bernier and Meinzen-Dick, 2014). The findings are also in line with another research that found most households who belonged to traditional voluntary organizations gained benefits 'like the humanitarian supports, labour support, information exchange, reciprocal credit, crop harvesting and farming support for building their livelihood assets' (Abebe, 2014, p.95).

Access to physical capital is expressed in terms of respondents having access to agricultural implements, transport, energy and household goods. The results (as per Table 6) show statistically significant relationships across agroecological areas for oxen-plough, plough-wheel barrow, donkey/horse cart, liquefied petroleum gas-kerosene, solar-biogas-animal dung, mobile phone, radio and other household goods. Jara reports more oxen-plough compared to Xexicha.

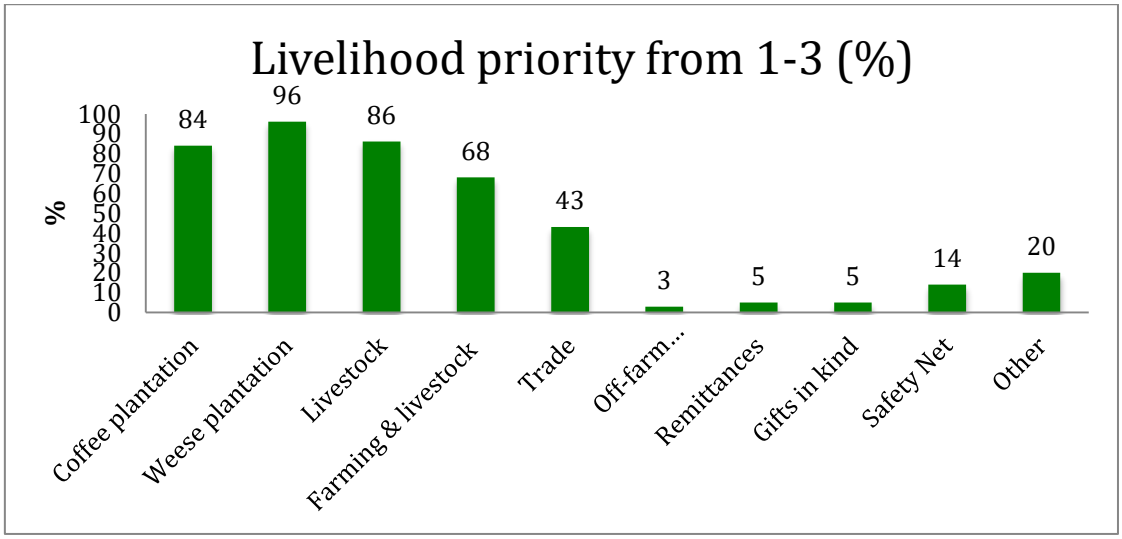
Technologically advance energy use is very low as rural Sidama has meagre electricity power coverage. The highest score for energy use or source are firewood and kerosene with lower percentage of electricity energy. This is not surprising since, according to International Energy Agency, only 15 per cent of Ethiopia's total population have access to electricity (IEA, 2011). Solar, biogas and animal dung scores high in Xexicha, most likely due to dependence on firewood for most of energy needs such as cooking, heating and light.

Ownership of mobile phones is higher in Jara which appears to be associated with respondents' higher networking and communication needs among people and with different echelons of political administrations. The score for Xexicha is the least. This could be linked to limited disposable cash income of highland respondents to purchase mobile phones. It may also depend on availability of mobile network coverage. Some remote areas in Ethiopia have limited mobile coverage, which is run by state monopoly. More people own radio in Awaada than in Xexicha and Jara.

However, in all cases radio ownership is below 50%. Radio is one means of keeping modern and scientific information on weather information. Ownership of clock is low in all sites. Awaada scores higher compared to the two other sites. The notion of time and its measurement is illusive in rural Africa. Conventionally, it is measured by reference to the sun's position than watches. For, when the sun is overhead, estimated time is mid-noon, when the sun rises, it is early morning, and when the sun sets it is the beginning of a night.

Apart from livelihood assets, the survey included questions on *livelihood options*. Accordingly, respondents were asked to rank livelihood priorities in importance. The first three priorities are shown in Figure 10.

Figure 6: Livelihood activity priority



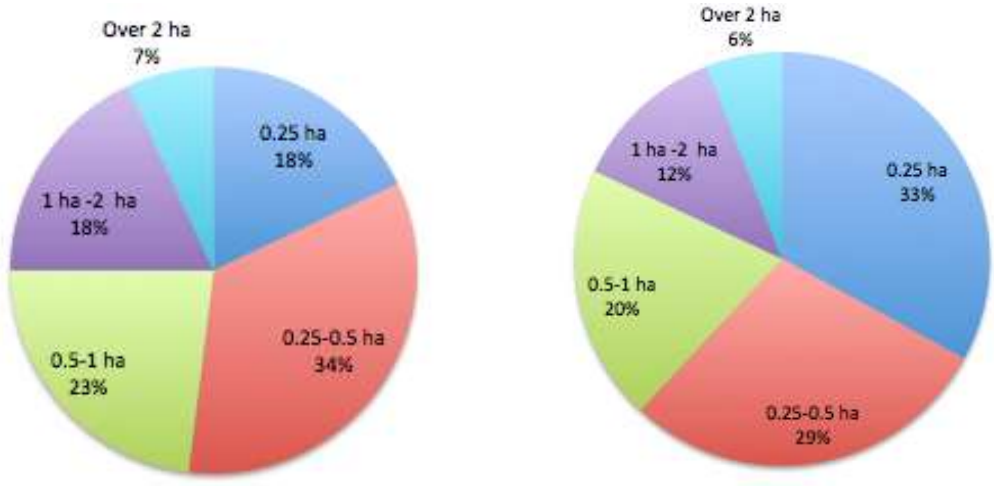
[Source: Survey data, March 2012]

Accordingly, the chief sources of livelihood (which contribute significantly to total food or cash income in such as a way that a reduction in access to that source may have a significant effect on total income) were enset, animal husbandry or livestock rearing, and coffee. The largest percentage of respondents (96%) indicated that enset farming is the chief source of livelihood. This is due to widespread planation of enset in both the highlands and midlands, and to some extent in the lowlands. Data for livestock, coffee farming, and mixed (farming & livestock) production are 86%, 84% and 68% respectively. About 43% respondents took part in trade while 14% reported taking part in safety net or food for work programmes. Under 'Other' category, respondents reported engaging in production and sale of beans, barley, potatoes, maize, green paper,

chilli, crops, bamboo, trees, eucalyptus, and renting carriage. Fewer respondents mentioned off-farm employment, remittances and gifts in kind.

In response to a related question of how much land respondents hold, 51% of respondents have between ¼ or ½ hectare (ha) while 75% have a hectare or less (Fig 11a). Only about 8% have 2 ha of land. In most cases, landholding is small in size, and no one reported holding above 2 ha. The trend for most respondents is one of shrinking landholding with subdivisions of land amongst siblings. Thus fragmented, small size or scale of activity is the main characteristics of smallholder farmers. Some studies linked population growth to decreasing land plot size (Ghirotti, 1998). Indeed, population growth in both the rural and urban areas reduced the land available for farmers. Examples also abound where expansion of Hawassa town into the adjacent rural communities reduced the land available for local farmers.

Figure 7: Land held and cultivated



a. Land held b. Land cultivated

[Source: Survey data, March 2012]

Farm size has implications on vulnerability and adaptation to climate change. With smaller land holding, farmers will have lesser options to carry out alternative activities on land. Potentially, those who hold relatively larger land size could afford to do lesser cultivation and put the land to alternative uses (11b). Studies on comparable setting of Chencha and Arbaminch areas (Ethiopia) found similar pattern with cultivated land expanding by 39% between 1973 and 2006, with decreasing per capita farming land. At the same time, grassland shrank by 69% causing significant decrease in livestock. The same study attributed scarcity of

cultivated land to 'demographic pressure, which was exacerbated by government policy, land tenure, and the nature of subsistence agriculture' (Assefa and Bork, 2014).

Apart from livelihood assets, SLF places emphasis on institutions and markets. In response to survey questions dealing with *institutions, markets and extension services*, farmers reported using market information, extension services and input supply services. They also reported attending training on agricultural development and environmental protection. The quality of extension service is partly dependent on access to extension workers. A third of farmers reported no weekly visit from or to extension worker in a week whereas 41% reported having received a visit and a similar number had access to extension workers (who are mostly based in the same Kebele as with the farmers). This includes access to female health extension worker assigned for three Kebele*s*. Discussions during field trips revealed that women use health advice service on family planning, basic health and sanitation. A different study that examined the activities of health extension workers (HEWs) in Ethiopia found that reproductive, maternal and child health activities represented a major component of the HEW's work (Mangham-Jefferies, 2014). Other tasks of HEWs included family health, disease prevention and control, hygiene and sanitation, and other community-based activities. In addition of health centres many Kebele*s* have established Farmers' Training Centres in recent times, which appears to be part of the government drive to boost agricultural production and productivity.

In response to what farmers think are the major activities of a development agent (extension worker), 41% respondents mentioned advice provision. Other tasks expected of extension workers included control of deforestation or tree cutting, tax collection, fertiliser loan collection, fertiliser and seeds distribution as well as managing public works (schools, roads, and offices). Such expectation is not surprising as other studies on extension service in Ethiopia have also revealed that extension workers (agents) 'have been involved in different activities which are not related to their normal duties' (Belay, 2003) including involvement in party political activity.

In so far as the development of infrastructure facilities play an important role in supporting or hindering adaptation to climate change, respondents were asked about the distance they travel to access the nearest roads, market places, towns and schools. Accordingly, most respondents (92%) reported to have access to dry-weather roads and 90% to elementary schools. In spite of access, the quality of rural roads and schools is problematic. Moreover, the distance travelled to high schools (compared to primary schools) is long. For example, over 30% of respondents have to walk more than 30 minutes to reach the nearest high school. Distance to market towns is also long – the problem already highlighted in other studies indicating that rural people tend to have less access to social services such as health, sanitation and education (Carney, 1999).

Apart from the social services, respondents had minimal access to credit. Only a third (33%) of respondents reported making attempts to access loan or credit and only 22% of respondents managed to secure one. In terms of the sources of credit, most respondents resorted to informal sources of credit, which according to Schindler (2009) involves higher transaction cost. Individual money-lenders topped the list with 32% of respondents followed by friends and relatives (24%). Only 16% of respondents reported getting credit from microfinance (Fig 12).

When respondents were asked about factors that prevented them from seeking credit, 39% mentioned lack of information about credit services (Fig 13). A third feared they might not be able to replay debt.

Figure 8: Sources of credit/loan

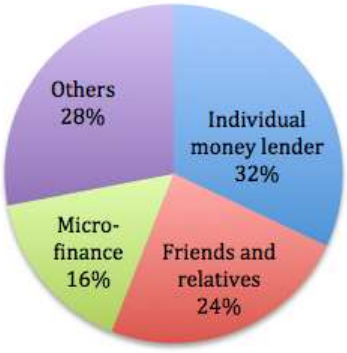
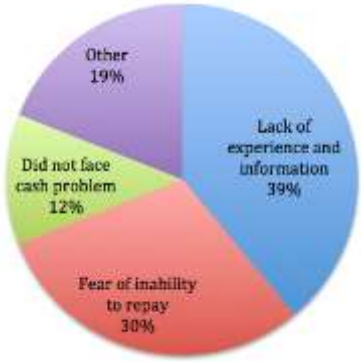


Figure 9: Barriers to seeking credit



[Source: Survey data, March 2012]

Studies elsewhere admitted problems of access to credit and debt facing smallholder farmers. According to Barbier and Lopez (1998) farmers face restricted access to the formal market owing to the small size of their credit operations potential lenders expect little incentives given significant fixed cost per credit operation. Moreover, poor households have limited assets and face institutional problems, such as lack of land title security, which reduces their capacity to collaterize, increases the risks for lenders, and is translated into higher costs of credit. Most small holders therefore have to rely on lenders in the informal market, who run credit operations at low fixed costs and are willing to take relatively large risks. (*Ibid.*)

Policy environment is another important component in SLF. Accordingly, farmers were asked how they rate policies in support of climate change adaptation. Health and education policies were among those favourably rated while the least favourably ranked were investment policies and food safety net measures. Structures and processes were not covered in the survey, but they were dealt with through qualitative data. Hence the following section reports on results on the role of structures, institutions and policies in enabling or hindering adaptation to climate change.

4.4 Structures and processes

Structures and processes hold important position in sustainable livelihood framework (Fig 6). In this section, important structures are explored based on qualitative data from key informants and field observation. According to Ethiopian administrative hierarchy, Kebele*s* are positioned at the lowest levels of formal structures. They are also the final destination of policy implementation. Farmers in Kebeles are organised into Peasant Associations (PAs).[1] A Kebele or PA is attended by three extension workers each having a role on crops, livestock, and natural resources & land administration. On the other hand, three Kebeles combined are allocated one health extension worker. While the division of tasks along the three areas was important, it left out some important dimensions of livelihoods such as water provision, transport and energy. For example, it was observed during the

[1] PAs are a continuation of lower level administration networks from the Derg era in Ethiopia.

fieldwork that there were areas of work outside the remit of these extension workers such as water, transport, energy and metrological services.

Formal structures above Kebele levels include districts, zones, regions and the federal government. In spite of theoretical decentralisation and division of tasks at these levels, policy making in Ethiopia is strictly top-down exercise. This is mainly due to the way the ruling party, the EPRDF, is inclined to function – namely an authoritarian polity informed by 'democratic centralism' (Kia, 2014, p.25). The system is underpinned by the notion of 'revolutionary democratic centralism' that ensures key policy decisions are made at the top, passed through federal structures to flow downwards to regions. Both district and zone structures are policy-implementing bodies rarely empowered for significant policy initiatives. At nearly all levels, the political practice of 'democratic centralism' pervades senior leadership roles. At Kebele, district, zone and regional levels, nearly all of the heads of the major sectoral offices are appointed officials from the ruling EPRDF. The same applies to federal agencies. Hence a closer look at key policy making institutions in the form of a summary cases of GOs[1] and NGOs[2] is important.

Governmental agencies and structures: There are a number of government agencies involved in climate change policy and implementation and each of them are briefly presented below.

Environment Protection Agency (EPA) was established in 1994 under the Ministry of Natural Resources Development and Environmental Protection. In 2002, it became an independent environmental regulatory and monitoring body. In 2009, EPA became the focal point for UNFCCC, the role transferred from NMA. In June 2014, EPA was re-designated as the Ministry of Environment and Forests (MoEF) with enhanced powers to play a leading role in matters relating to climate change. Since the 1990s, the EPA remained national focal point for GEF in Ethiopia. The EPA describes its objectives as formulating policies, strategies, laws and standards,

[1] Relevant governmental agencies in relation to climate change and development in Ethiopia are: National Metrology Agency (NMA), Environment Protection Agency (EPA), The Ministry of Water and Energy (MoWE), Ministry of Agriculture (MoA), SNNP- Natural resources development & EPA, Sidama zone Agriculture Office.

[2] The NGOs include World Vision Ethiopia (WVE), Forum for environment (FfE), SOS Sahel and Sustainable Land Use Forum (SLUF).

which foster social and economic development in a manner that enhance the welfare of humans and the safety of the environment sustainably, and to ensure the effectiveness of the process of the policy implantation.[1] EPA pursues climate change related activities in Ethiopia including policies and negotiations. It has offices in all regions except in SNNPR and Tigray where bureaus within agriculture undertake its functions, including coordination and preparation of regional adaptation plans.

National Metrology Agency (NMA) is a body set up to provide meteorological services including advice and early warnings about weather and climate. It is also responsible for international treaties Ethiopia had ratified in the areas of meteorology. In 2007, NMA submitted NAPA. Until 2009, the was the focal point of the UNFCC and IPCC. After 2009, EPA became the focal point for UNFCCC while the NMA retained its role as the focal point of the IPCC. Both agencies continued to co-operate with each other on climate change adaptation, forecasting and early warning mechanisms. NMA also collaborates with the international organisations such as the World Metrological Organisation (WMA), International Research Institute for Climate and Society (IRI) and other donors to improve forecasting of severe weather events and early warning services. It uses national broadcasters to disseminate weather information to the public including to farmers.

The Ministry of Water and Energy (MoWE)[2] is responsible for potable drinking water and sanitation programs, irrigation and drainage development studies, design and construction, river basin and master plan studies. It also oversees energy development such as hydropower and alternative energies including solar, wind and bio-fuel.

The Ministry of Agriculture (MoA) is a large structure responsible for agricultural and rural development policies in Ethiopia. Its powers and duties include promoting agricultural development, establishing and providing agriculture and rural technology training, food security, water use and small-scale irrigation, conservation and use of forest and wildlife resources and monitoring events affecting agricultural development and early warning system. The MoA has

[1] Environmental Protection Authority, http://www.epa.gov.et/default.aspx
[2] Was formerly known as Ministry of Water Resources, http://www.mowr.gov.et

regional bureaus in all regions.[1] The functions of MoA have direct impact on smallholder farmers. Among other things, it oversees small-scale irrigation at individual smallholder farmers and community levels, while MoWE undertakes large-scale irrigation projects. At the national level, MoA was part of the agencies involved in the preparation of NAPA which identified soil and water conservation, river basin and watershed management, small-scale irrigation, reforestation and afforestation activities as national adaptation options.

SNNP - Natural Resources Development & EPA is a team in Agriculture Bureau of the SNNP Region with responsibility for natural resource development, land administration and environment protection. The Bureau is based in Hawassa, along with other regional bureaus. NRD & EPA is the principal agency that coordinated and prepared the regional adaptation plan document that fed into the Climate Resilient Green Economy strategy.

Sidama Zone Agriculture Office is one of the zonal sectoral offices responsible for the implementation of policies initiated by the federal government and regional authorities. Whereas the policy initiating powers of lower levels of authority (Kebele*s*, districts and zones) are limited, the Zone Office participates in Early Warning Response Task Force,[2] which alerts regional and federal governments to climate and other shocks affecting the local population. The portfolio of zone administration in Sidama has been characterised by frequent dismissal of administrators risking stability of the seat with implication to see through programmes.

Non-Governmental Organisations: There are a number of NGOs that provide direct support to farmers in addressing climate change in Ethiopia. The following are sample NGO cases selected for this research. Depending on their presence and engagement, the NGOs have impact on livelihoods, reducing vulnerability and

[1] The regions are Afar, Amhara, Benshangul, Dire Dawa, Gambella, Harari, Oromiya, SNNPRS, Somali and Tigray.
[2] Agricultural Office is vice chair of the Task Force, and the administrator of the Zone chairs the Task Force with the representative of the zone's Water Office as a secretary. Other members of the Task Force include Food security, Crops Team, Health, Education, Women and Children affairs, and Youth Office.

supporting adaptation actions. This study divides the NGOs into two – umbrella and operational NGOs.

Umbrella NGOs are often a campaign or advocacy networks. Operational NGOs as the name implies have projects at community or household levels. Two umbrella NGOs are included in this study: The Forum for Environment (FfE) and Sustainable Land Use Forum (SLUF). FfE is an environmental advocacy NGO focusing on five thematic areas: Forestry, Protected areas, Urban Environment, Renewable Energy and Climate Change. Its work includes supporting researchers to conduct research and using research output to produce policy briefs for climate negotiations and for lobbying at national and international forums. As such its functions have no direct link to adaptation practices by smallholder farmers but it indirectly influences national policy on climate change.

SLUF aims to increase agricultural production in Ethiopia through contributing to sustainable land use and natural resource management. The areas of focus include capacity building through training, information exchange, studies and research, advocacy, lobbying and networking. Its members are operational NGOs that work to promote sustainable land use and improve livelihoods. At a more practical level, SLUF is involved in two major climate change adaptation programmes. The first is SIDA-Environment Programme containing 11 projects focusing on community development (for example, community based adaptation) and direct support to households). The second is joint EPA projects consisting of 20 projects working with different sectors, mainly strategic ones to protect flooding and erosion among highland based mega-dams for irrigation and hydro power stations.

Both FfE and SLUF support local NGO start-ups. SLUF is represented at UNDP sponsored Global Environment Facility (GEF) small grants programme and involved in selection and allocation of funds to environmental NGOs and community organisations in and around Sidama. Among operational NGOs, this study included World Vision Ethiopia (WVE) and SOS Sahel.

WVE[1] was set up in 1975 to offer emergency relief especially in relation to 1984 famine and later progressed to rehabilitation (1986-87) and development initiatives. Some of its activities relate to livelihoods such as the supply of inputs (including nurseries) health, HIV, and education, water provision and livestock forage. WVE's broader work remit include food security, agriculture, economic development, disaster risk reduction, health assistance and humanitarian aid during drought events, climate change and environment protection including mountain forest restoration. It works closely with the government, while engaging the community on participatory soil and water conservation works. Examples include agroforestry training to communities on how to develop nurseries by individual farmers. It supplies tree seeds and encourages agroforestry. However, the presence of this NGO is not visible in the study area. Farmers and key informants in different sites complained of lack of NGO services in Sidama. However, there are a few NGOs operating in the area.

SOS Sahel is one of organisations that work on climate change issues in Ethiopia. It is unique in the way it prioritises understanding the problem through applied research to generate evidence before project initiation and implementation. An example of research it conducted was on vulnerability of smallholder farmers and nomads to climate change and their coping mechanisms. Its work is not limited to adaptation but also mitigation of climate change. In association with Farm Africa, another NGO, SOS Sahel was involved in a project to reduce emissions from degradation and deforestation (REDD+) on Bale Ecosystems-Region with financial support from Norway, Netherlands and Ireland. In Sidama, SOS Sahel had initiatives around Lake Hawassa. The problems it identified include de-vegetation and exposure of the land surface to wind and soil erosion as well as associated siltation of the Lake. It responded through environmental rehabilitation or re-vegetation of the catchment through tree planting and area enclosures.

The above are some of the key governmental and non-governmental organisations that are responsible for policy making and implementation in Ethiopia. These institutions have important roles in dealing with the impact of climate change and communicating climate change information.

[1] http://www.wvi.org/ethiopia

4.5 Summary

This chapter presented the results of survey data containing demographic and socio-economic characteristics that partly underpin the social vulnerability of smallholder farmers. The salient points from the data are as follows. Average family size of 7 people per household, given limited land holding, sets a context for vulnerability to shocks. Education is important as it affects perception and adaptation to changes and 59% of respondents reported receiving primary education. Self-reported wealth status ranking is dominated by *medium* as opposed to *rich* and *poor* and only a few respondents consider themselves as *rich*; yet this is cross-checked with the type of houses respondents live, the majority indicated living in traditional hut which is commonly used by the poor. The source of income for households is dominated by earnings from sale of crops, coffee and Wesse products, indicating that climatic impacts directly affect the livelihoods of the majority of farmers. Off farm incomes are insignificant pointing to limited income diversification. The expenditure pattern is dominated by basic needs (clothing, food and debt payment), followed by expenses on health and various ceremonies often revolving around life cycles – birth, marriage and death. Such budgetary allocation hardly leaves room or flexibility to adopt innovative methods and technologies for adaptation to climate change.

The section under livelihood assets and options captures an important dimension of sustainable livelihoods framework. More respondents indicated access to social and human capital compared to other forms of capital, the least being access to financial capital. Membership to social networks contributes to social capital, which helps in the face of climatic hazards. Enset, animal husbandry or livestock rearing and coffee dominate livelihood options. Off-farm employment and remittances are insignificant. Moreover, most people are smallholder farmers, with the majority holding less than a hectare of land. Given higher family size mentioned above, the pressure on land contributes to social vulnerability. Included in this section are also responses on sources of weather information, access to basic infrastructure, access to finance and the ranking of policy environment. Qualitative data on structures and processes presented key government and NGOs involved in climate change in Ethiopia. As the subsequent sections illuminate, the

reported results on livelihood assets, options, institutions, processes and structures have important implications for perception, vulnerability and adaptation to climate change.

Chapter 5: Results & discussion: Perceptions of climate change

5.1 Introduction

This chapter presents the results of climatic data and perceptions about climate change. It is divided into two sections: observed climate, perception of climate change by smallholder farmers and by policy makers. The objective is to survey perceptions to understand how smallholder farmers perceive climate change in different agroecological areas. The question is addressed in steps by examining and comparing climate data with the responses of farmers and policy makers.

5.2 Observed climate

The presentation of results of climate data entails a cautionary note relating to its limitations. The availability of quality climate data is a challenge in rural settings and the problem is not unique to Sidama. For example, studies on climate risk management and data needs for agriculture in Ethiopia, noted the limitations of data from meteorological stations. Dinku (2011, p.13) pointed to the problem of limited availability of climate information, particularly in rural areas, and uneven distribution of available stations (dense and relatively good over the central highlands, while very few stations over the lowland areas). Moreover, the location of almost all stations is in cities and towns along main roads. The number of stations with long time series is even much less imposing severe limitations to availability of climate data on the farms where the data are needed most.

While cognizant that these limitations present challenges in identifying long-term trends, available data provide vital insight to analyse climate change in the study areas. Data are aggregated to illustrate average annual maximum and minimum temperature and rainfall from which three findings emerge: increasing temperature, high rainfall variability, and inter-annual and intra-seasonal variation across agroecological sites.

Temperature is influenced, among others things, by elevation. As elevation decreases, local temperature increases and vice versa. For example, the lowlands are the warmest parts of Ethiopia with annual mean temperature ranging from

20°C to 25°C (Coppock, 1994) and thus Hawassa, located in the Rift Valley, recorded the highest temperature. The data show that, irrespective of differences in elevation, temperature has increasing trend implying climate change. Table 7 displays cumulative average for minimum and maximum temperature alongside analysis of the same in Figure 14a-f. Interestingly and common to all sites, average minimum temperature in December is at its lowest in Hagereselam (6.8^{o}C), Yirgalem (9.5^{o}C) and Hawassa (10.4^{o}C). This coincides with reports in FGD and semi-structured interviews about dew or extremely cold conditions for the same month in the past two to three decades.

Farmers also reported colder conditions to extend to February and early March, indicating a shift in seasonal weather patterns. Average maximum temperature is at its highest (30.1^{o}C) in February in Hawassa, Yirgalem (29^{o}C) and Hagereselam (20.8^{o}C).

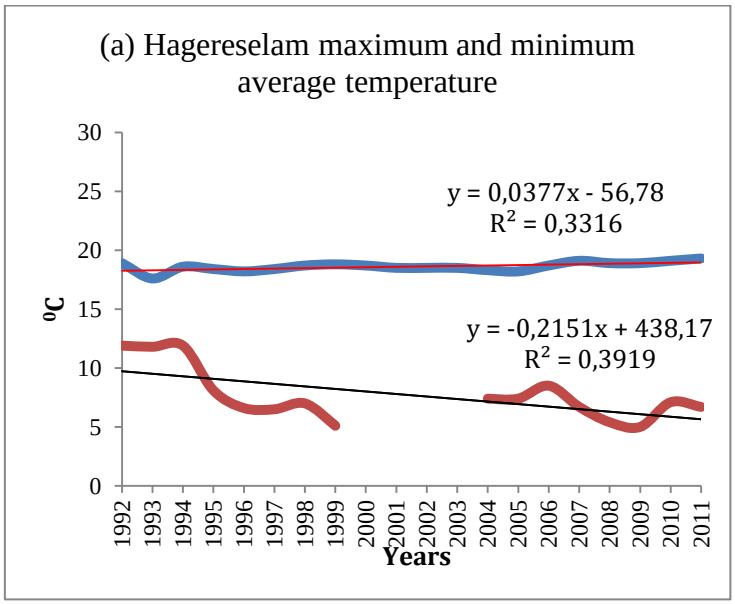
Table 8: Station Temperature Data

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hawassa												
Av.MaxT	28.8	30.1	30.0	28.6	27.3	25.8	24.6	24.8	25.7	26.9	28.1	28.3
Av.MinT	11.7	12.0	13.0	14.2	14.3	14.3	14.5	14.6	13.8	12.8	10.5	10.4
Av.RF	33.4	33.3	77.0	104.9	115.0	102.4	122.0	123.8	116.0	75.9	39.6	24.7
Yirgalem												
Av.MaxT	28.3	29.0	29.0	27.5	26.0	25.1	23.9	24.3	24.7	25.6	26.8	27.4
Av.MinT	10.4	10.7	11.8	12.5	12.7	12.6	12.9	12.6	12.1	11.6	10.5	9.5
Av.RF	35.5	28.1	87.4	166.9	174.5	102.6	110.3	125.6	137.9	169.5	46.3	25.2
Hagereselam												
Av.MaxT	20.1	20.8	20.5	19.3	18.8	18.0	16.6	16.8	17.3	18.0	18.8	19.4
Av.MinT	6.5	7.6	8.0	8.7	8.6	7.8	7.3	7.7	7.6	7.5	7.4	6.8
Av.RF	47.4	49.5	84.5	162.4	193.1	118.2	100.8	159.6	125.3	184.2	66.2	25.7

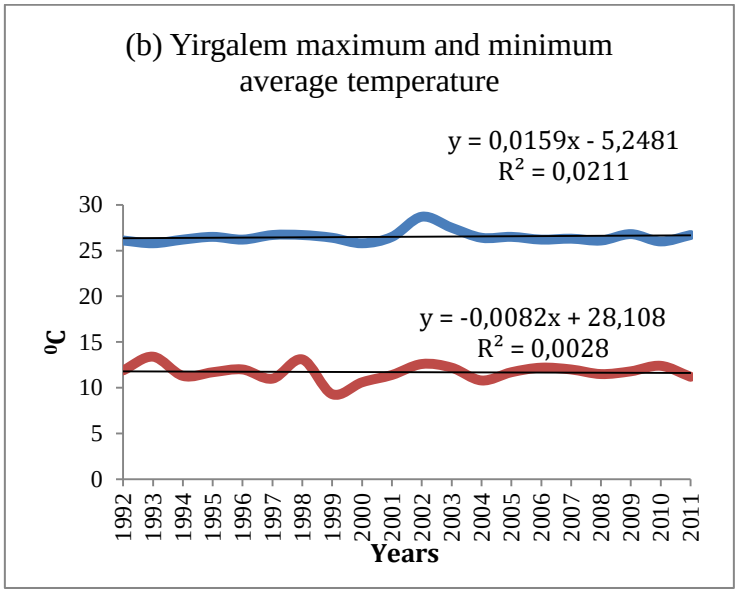
[Source: National Metrological Agency]

Figure 14 present data on temperature on selected sites, namely Hagereselam meteorological station (representing Xexicha), Hawassa meteorological station (representing Jara Galalcha) and Yirgalem meteorological station (representing Awaada). It is notable at the outset that the regression lines show statistically non-significant increasing trend of annual maximum temperature with a positive slope, partly owning to shorter time series data with missing elements.

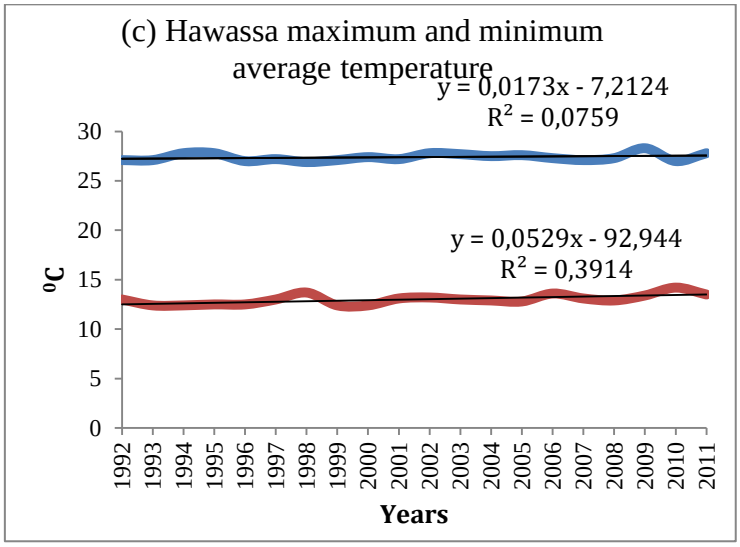
Figure 10: Temperature data



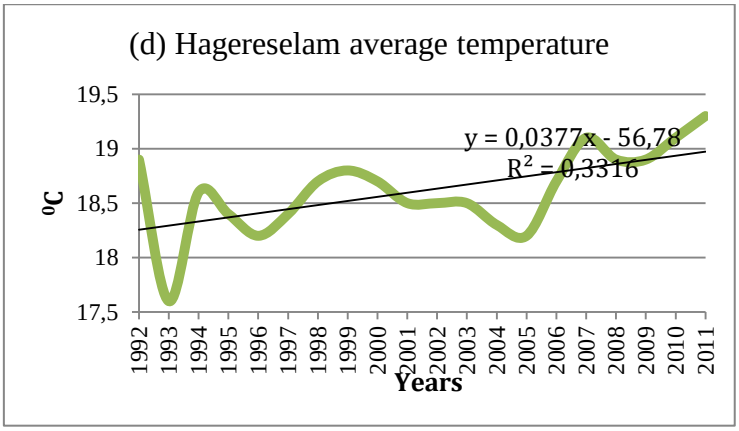
The trend line for the highland station of Hagereselam shows falling minimum temperature and slowly increasing trend maximum temperature. However, due to its higher elevation, Hagereselam's maximum temperature is around 20°C, which is below the average figure for Yirgalem and Hawassa stations.



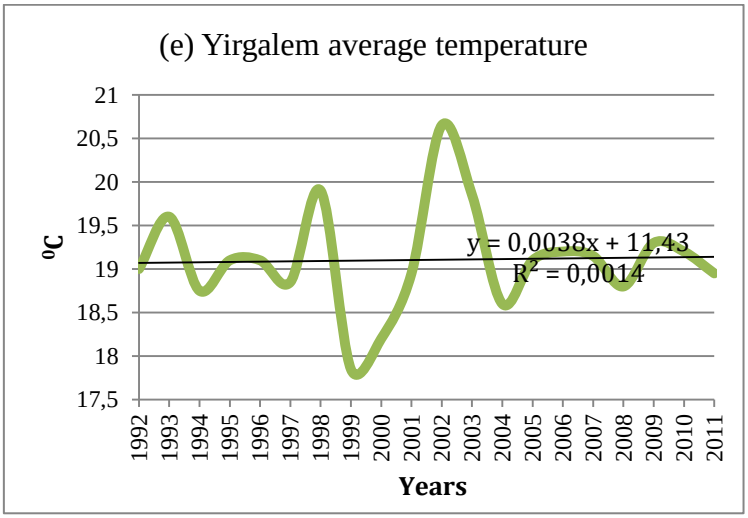
In Yirgalem, both the minimum and maximum temperature remained stable around 25°C with an increase in 2002 to 28.7°C. According to the trend line, there is an increase of maximum temperature. The minimum temperature shows stable, mildly fluctuating trend.



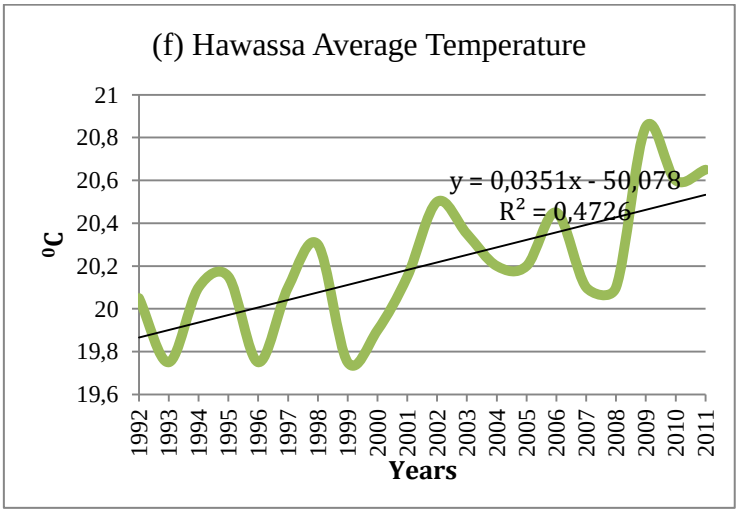
In Hawassa, both minimum and maximum temperature show a higher temperature compared to the highland. The highest maximum temperature increase is reported for 2009 to be 28.3°C.



Reflecting the maximum and minimum temperature trend (above), average temperature in Hagereselam shows an increasing trend.



Temperature in Yirgalem fluctuates, yet with increasing trend. Perceived climate by farmers in FGD indicated high levels heat wave. 1999 recorded low temperature in Yirgalem and Hawassa. The year 2002 had the highest temperature.



Temperature in Hawassa shows a rising trend. It recorded an average of 28.3°C in the year 2009. The lowest temperature was recorded for 1996 and 1999.

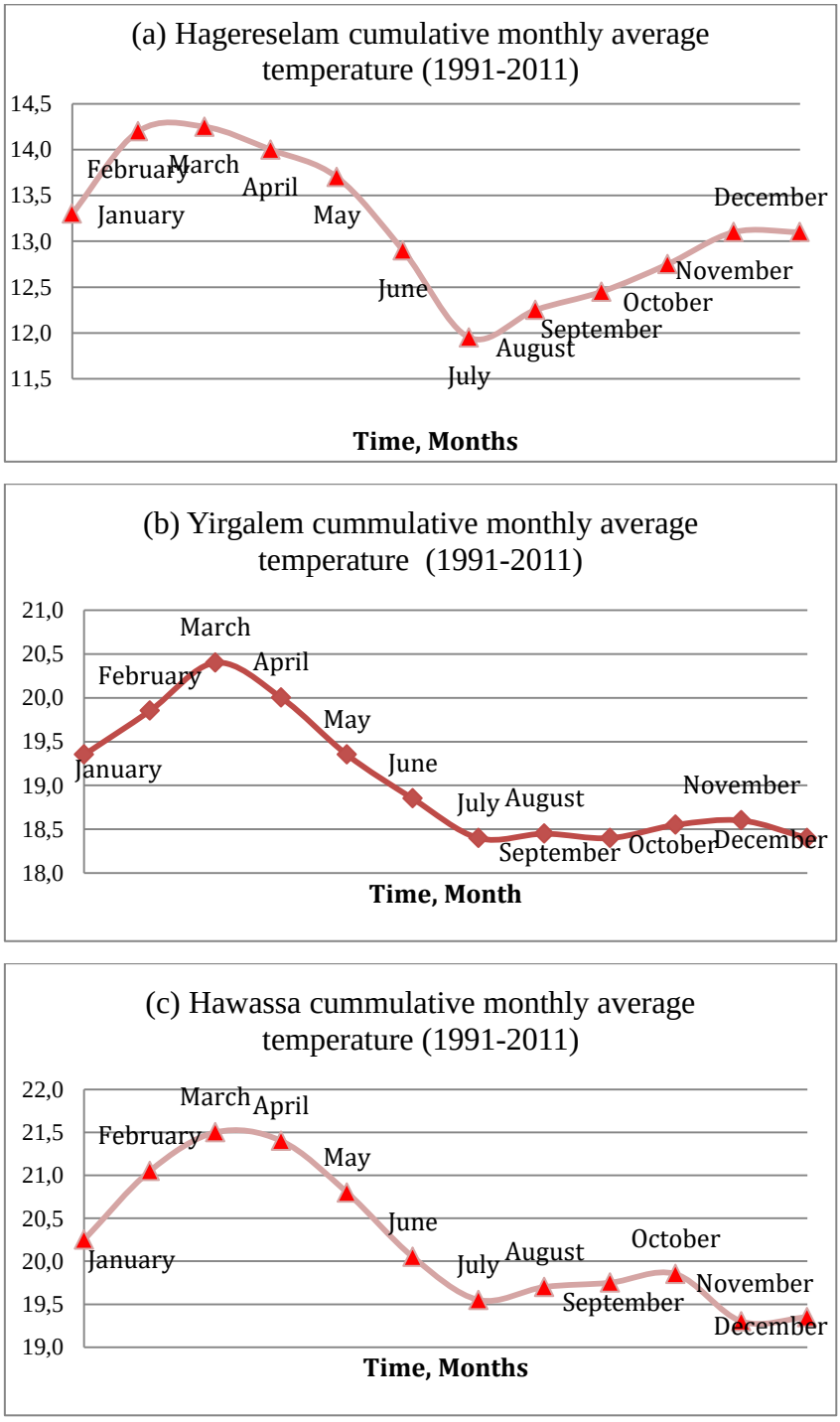
The above results are compatible with a national study which found broadly consistent warming trend or rising

[Source: National Metrological Agency]

minimum and maximum temperatures over the past fifty years (McSweemy, *et al.,* 2010). Although the model is not a good predictor of future trend, the observed weather station data reveals the direction of change in temperature that did not only rise but also varied across seasons. In addition to increasing trend in temperature, there is also seasonal variation in the form of cumulative monthly average temperature (Fig 15). For example, in the highland of Hagereselam,

February is the warmest month. It recorded peak temperature 20.8°C gradually falling to 12°C in July and slightly rising from August to November.

Figure 11: Seasonal temperature, trend



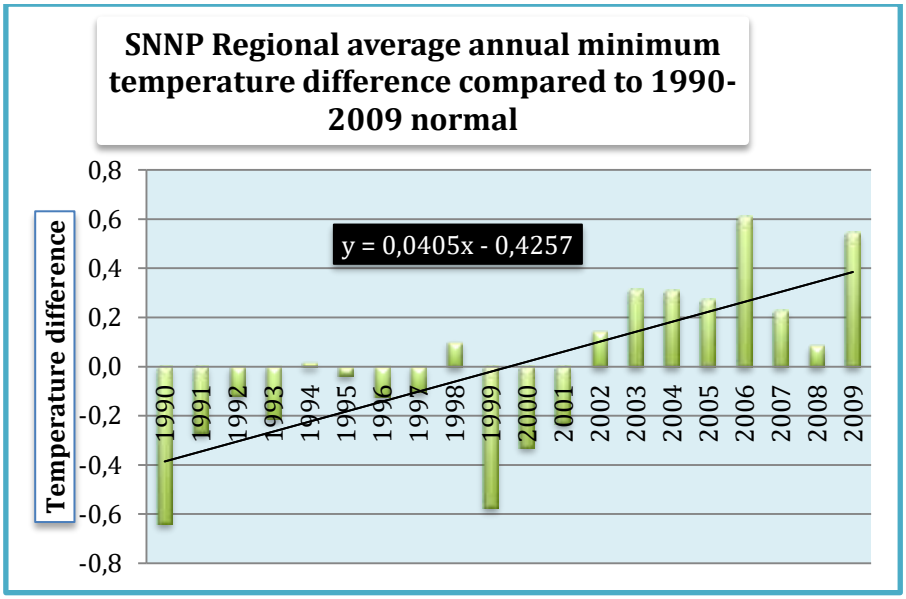
[Source: National Metrological Agency]

The midland station of Yirgalem recorded the highest temperature (20.4°C) in March, with temperature gradually falling to 18.4°C in July, and remaining around 18°C until December with only marginal rise. Hawassa recorded the highest

temperature (21.5°C) in March, with temperature gradually falling to 19.6°C in July, and remaining above 19°C until November.

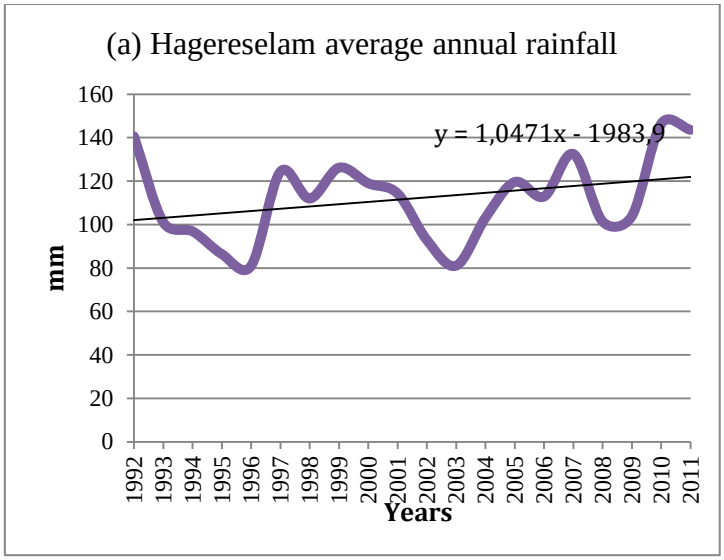
Metrological data for this study can be compared with regional trend from Ethiopia-wide data that showed the SNNPR region experiencing 0.4 ^{0}C average temperature increase in the last decade (NREPA, 2012) (Fig 16) whereas the comparative national figure 0.37 ^{0}C (NMA, 2007). As part of this region, temperature trend for Sidama Zone is subsumed within this pattern.

Figure 12: SNNP regional average annual minimum temperature



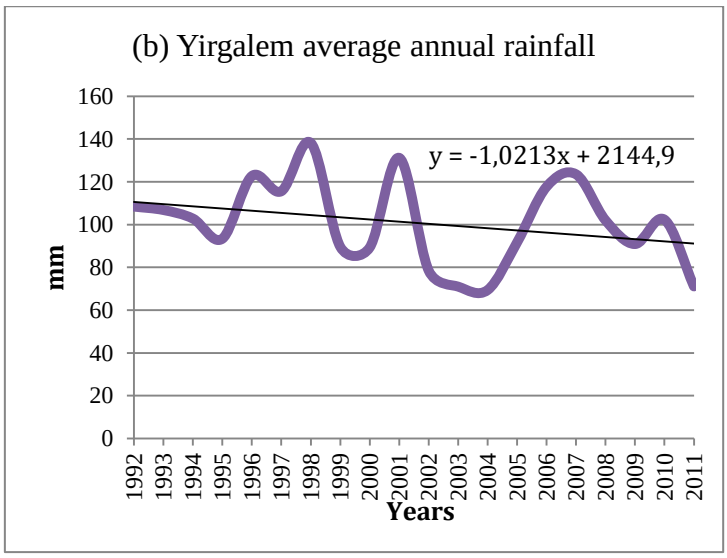
(Source: NREPA, 2012)

Figure 13: Rainfall data

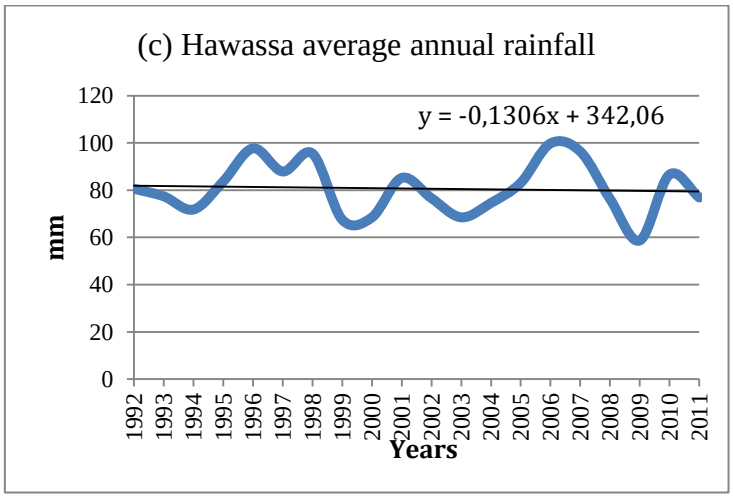


In terms of cumulative average rainfall, data demonstrated a mixed condition (Fig 17).

Hagereselam from the highland appears to have fluctuating annual average rainfall pattern with a tendency for rain to increase. The year with the lowest average annual rainfall (81 mm) was 1996 and the highest (146 mm) was in 2010.



In the midland station of Yirgalem, rainfall displays fluctuating pattern with tendency to decrease. The year with the lowest average annual rainfall (64 mm) was 2009 and the highest (100 mm) was in 2006.



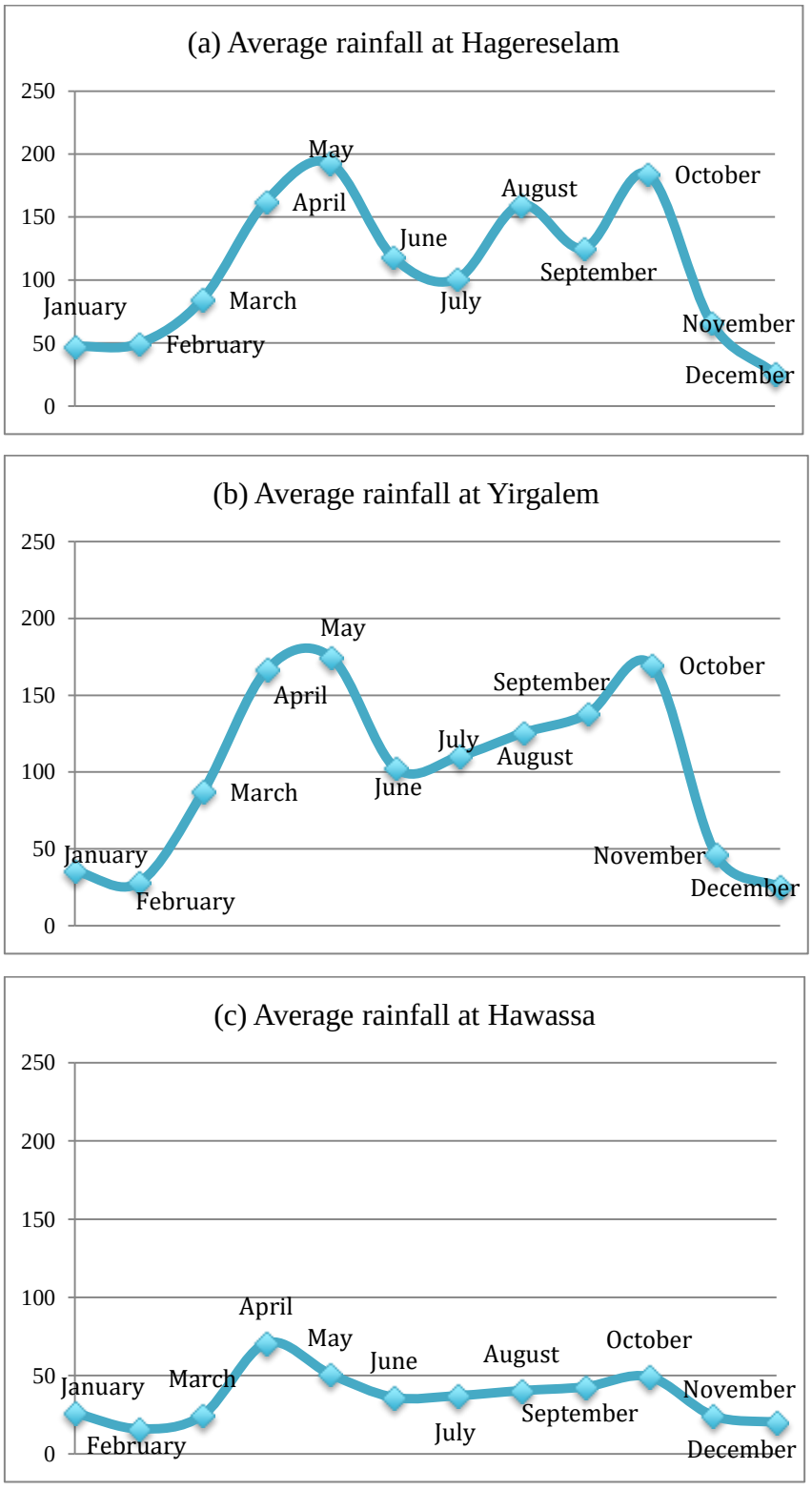
The low-lying Hawassa exhibited relatively stable but falling rainfall pattern. The year with the lowest average annual rainfall (81 mm) was in 1996 and the highest (146 mm) was in 2010.

[Source: National Metrological Agency]

The above meteorological data is complemented by survey data results from question that asked respondents about the changes they noticed in the last five years. Accordingly, 96% of them recognised late onset of rain, 93% of recognised erratic rain, 88% recognised less rain and 71% recognised floods from heavy rainfall.

Apart from total rainfall, season-to-season variability and distribution of rainfall within a season is critical to agriculture (Dinku, 2011). In this study, the highlands and the lowlands exhibit variation in seasonal rainfall, both in amount and monthly spread (Fig 18).

Figure 14: Seasonal rainfall trend (cumulative average 1991-2011)



[Source: National Metrological Agency]

In the highland station of Hagreselam, cumulative average monthly rainfall (over 20 years) is higher (above 50 mm) throughout the year except December to February, peaking in May and October. In May, average rainfall is the highest (191 mm) (Fig 18a). The midland station of Yirgalem exhibits similar pattern but the

amount of rainfall is below that of the highland. Yirgalem also reports more rain in April and May than what is customarily expected of the rainy season (June, July and August) it continued to rain until October, from when rainfall reduces in amount during the dry season (November, December, January and February). In the case of the lowlands, average rainfall is significantly lower (between 16 mm to 70 mm) in February and April, respectively (Fig 18b). Hawassa station recorded the highest rainfall in April, which gradually declined in the subsequent months to slightly increase from July to October (Fig 18c). In all agroecological sites, the month of December showed the lowest rainfall. It means that December is the month of lowest precipitation throughout Sidama. This is confirmed in FGD meetings and therefore the weather data corresponds with farmers' responses. Farmers also observed that the dry months extended well into February and March.

The above seasonal pattern shares some similarity with other parts of Ethiopia. For example, according to a study conducted for the United States Department of Agriculture (USDA)[1] parts of Ethiopia have unimodal and bimodal[2] rainfall which can be generalized into two, three, or four seasons. The three seasons are Belg (February-May), Kiremt (June-September), and Bega (October to January).[3] This temporal classification explains many parts of Ethiopia, yet it does not explain all, some of which are represented by two or four reasons. The classification which resembles this study area, belongs to the later day studies (Seleshi and Zanke, 2004) which described three seasons known as Bega (October – February), Belg (March – May) and Kiremt (June-September) seasons. In this study, participants to FGD and semi-structured interviews referred to two main seasons: *hawado* and *arro*, as wet (March-September) and dry (October-February) seasons, respectively. October is a cut off month, known locally as Birra, which literally means sunny time, far removed from the cloudy, rainy months of July, August and September. This localised two-season classification appears to have practical ease of considering the two rainy seasons (belg and kiremt) as one, yet separate from the dry season (bega).

[1] USDA, Foreign Agricultural Service, Production estimates and crop assessment. [Online] http://www.fas.usda.gov/pecad2/highlights/2002/10/ethiopia/baseline /eth_annual_rainfall.htm
[2] Unimodal rainfall contains one maximum per year and bimodal refers two maximums per year.
[3] The Belg season is characterised by small rains; Kiremt is the main rainy season, and Bega is the dry season.

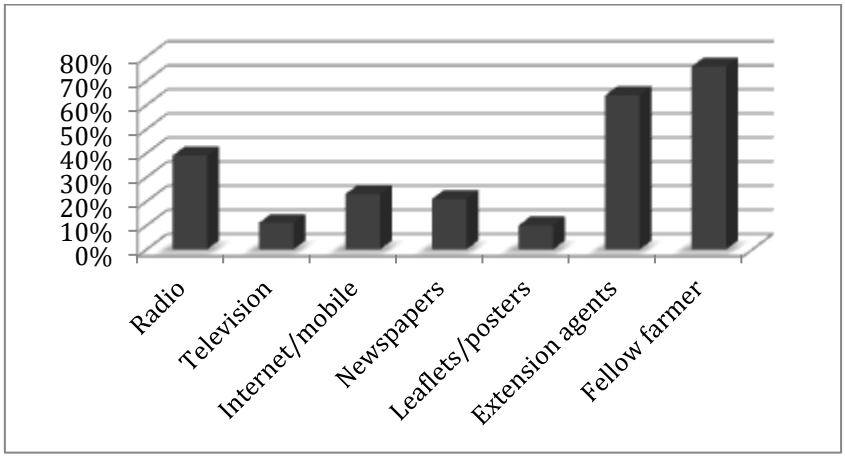
In sum, the climate data showed rise in temperature and less rainfall with changes in seasonal patterns. The next section reports on how farmers and policy makers perceive climate change and how such perception compares with observed climate trends.

5.3 Perceptions of climate change by farmers

Results from survey data show that farmers rely on their own counsel, fellow farmers and extension workers as prime sources of information to form opinion about their environment (Fig 18). Their first port of call is direct experience based on years' of personal knowledge about climate conditions, which they share with fellow farmers, community elders, religious leaders, peers and neighbours that are more accessible than formal sources. Noting the significance of farmer-to-farmer interaction, it appears that the government promoted what it calls 'model farmers' to help farmers share experiences and adopt new methods from fellow farmers.

In additional to personal and shared experience, farmers also receive information from external sources that include policy makers and experts. According to survey data, farmers hardly use written sources or TV broadcasts as information sources (Fig 19). Radio broadcast[1] trails behind fellow farmers and extension workers with 39% followed by mobile phone (20%).

Figure 15: Information sources



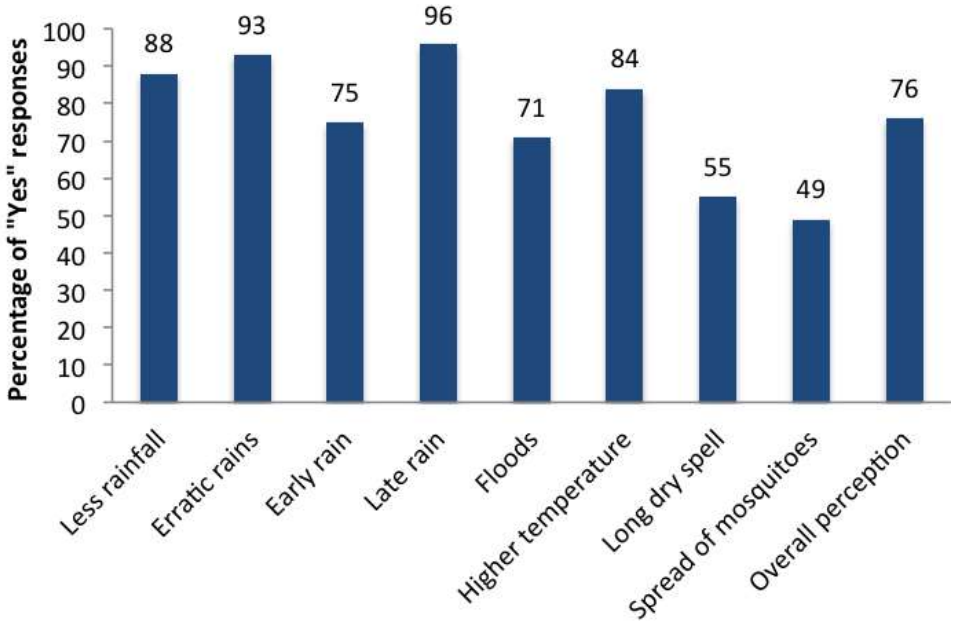
[Source: Survey data, March 2012]

[1] There is a single radio station that broadcasts in Sidamuafo language from Yirgalem town. Regional FM and national radios broadcast through Amharic language.

Based on personal experience and information they gleaned from external sources, farmers in the study sites have noticed climate change. Results from qualitative data showed that times have indeed changed for smallholder farmers in Sidama. These people are never new to changes; they had experienced a host of social, political and economic changes through generations, some more tumultuous than others. However, the magnitude of changes of recent decades is so deep that they refer to live in 'changed times.' For most farmers in the study areas, climate change is a reality manifested in changing seasonal patterns, increased aridity, extreme heat, drought, erratic rainfall, floods, changing wind conditions and changes in their ecosystems as well as the emergence or spread of diseases such as malaria (Hameso, 2014b).

The survey data confirms similar patterns. Accordingly, over two-third of respondents (76%) perceived climate change (Fig 20). Among specific indicators of change, 96% of respondents recognised late onset of rainfall, 93% of respondents recognised erratic and 88% of respondents recognised less rain. Floods from heavy rainfall is recognised by 71% of respondents. Higher temperature is perceived by 84% of respondents. The spread of mosquitoes (hence malaria) is recognised by nearly half (49%) of respondents.

Figure 16: Overall perception of climate change



[Source: Survey data, March 2012]

In terms of AEZs, the highest overall perception of climate change is reported in Xexicha (89%) followed by Jara (83%), and Awaada (58%). This implies that higher percentage of farmers in the highland noted climate change than in the midland and lowland. This confirms the findings from the Nile Basin study in Ethiopia (Deressa *et al.,* 2010, p.28) that people living in the highland better perceive climate change compared to those in the lowlands contrary to evidence from West India (Moghariya and Smardon, 2012) that drought prone areas possess significantly more understanding of climate change.

The above results from survey data are supported by results from qualitative data. Table 8 is constructed on the basis of qualitative data derived from FGD and semi-structured interviews with farmers. The table encapsulates emerging themes on perceptions about climate change. The most common indicators are higher temperature, erratic rainfall patterns and higher incidence of diseases.

Table 9: Farmers' perceptions about climate change

Perception	Xexicha (highland)	Awaada (midland)	Jara Galalcha (lowland)
Perception of climate change	Climate change exists	Climate change exists	Climate change exists
Perception of indicators of climate change	Higher temperature, erratic rainfall pattern, emergence of diseases (malaria), disappearance of plant (crop and tree) species, growing new crops such as maize and coffee, change in wind direction, emergence of parasites/insects	Higher temperature, heat wave, erratic rainfall pattern, higher disease incidence	Higher temperature, drought, heat wave, erratic rainfall pattern, higher disease incidence
Perception of causes of climate change	Destruction of indigenous trees and expansion of eucalyptus trees, God's wrath, weakened indigenous practices and values	Deforestation, God's wrath, weakened indigenous practices and values	Deforestation, God's wrath, weakened indigenous practices and values

[Source: FGD; Hameso, 2014a]

Given repeated reference to certain indicators of climate change in all study sites, the following section discusses perceptions of climate change in relation to high temperature, rainfall and seasonal shifts as well as incidence of certain diseases.

Farmers' perceptions about temperature differ among agroecological sites. Farmers at higher elevations noted increase in temperature consistent with weather data and qualitative data. For example, FGD participants in the highland of

Xexicha thought that their land was gradually drying. A FGD participant from the highland said: 'The sun has turned our highland to dry midland'. Farmers in the midlands did not only report drought conditions but also a decline in river levels and underground water. In the lowlands, there was palpable indication of aridity, and the survey data confirmed long dry spells. Participants from Jara were quick to mention increased temperature. One participant argued that 'temperature has increased …. It has increased specially in the last three years. While rain is decreasing, temperature is rising.'

In the midland of Awaada, participants emphasised both drought and heat waves. They felt that drought got stronger and sustained with significant impact on their livelihood including lost crops. A participant explained the gravity of heat waves and attendant exposure to discomfort in the following way:

> The heat wave is so high that we sleep without wearing blanket in the night. It is also warm during the day. The drinking water is warm [there is no refrigeration in rural villages]. Milk does not ferment due to temperature. Even when it does, it yields no butter. (Participant from midland)

Comparing appearances to the reality of lived experience with heat waves, an elderly farmer said that 'with the changed times, all people are in trouble (…) Life with heat waves is very difficult' (Participant from midland). In both midlands and lowlands, farmers had lived through higher temperature and declining moisture. However, farmers in the highlands are more articulate about the indicators of climate change than the causes and mitigation. The following expression conveys the force of climate change in the highlands.

> We entered a new era. We are living in a new era. Old things have changed. … While the habitual calendar of months remains the same, the weather is changing and we don't know why it is so. … there is climate change at [different levels]. What we know to happen in the past and what is happening now are different. In the past, people knew what to expect. They knew what happens during the autumn…. People knew what happens in those months. Then they prepare for farming activities. With full knowledge of the events, people organise their life and prepare for work. They produce foodstuff for their own consumption and for the market. Then [they] improve their living standards. … In recent times, however, an unexpected event emerged. While changes in the past were imposed on people, such as revolutionary change in politics, now there is a change in climate. It has unexpectedly engulfed people without their knowledge … (FGD participant from highland)

The exposition of the challenges posed by climate change in Sidama is in line with findings in other areas of Ethiopia. For example, a farmer in rural Oromia reported that 'nothing seems … like in the past. On the contrary, the problems are getting worse. The temperature, shortage of food and rainfall situation is worsening' (quoted in Kidanu *et al.*, 2009).

Interestingly, different AEZs displayed varied perceptions about the timing, regularity and amount of rainfall. On the basis of survey data, more respondents in Jara and Xexicha recognise late rains. Early rains are reported in Awaada. Erratic rain is recognised both in Jara and Xexicha and it is more pronounced in the lowlands. However, this result is not consistent with rainfall data for Hawassa, which had relatively stable rainfall pattern over 20 years (Fig 18c). The anomaly might be explained by the difference in rainfall situation between Hawassa (the weather station) and Jara (the survey site).

In the case of the highlands, rainfall data (which showed fluctuating annual average rainfall pattern but with rising trend, Fig 18a is also inconsistent with the results of the survey data where most of the participants reported less rainfall. These results indicate that rainfall pattern is hard to establish with accuracy and in conformity with different data collection methods.

The perception of climate change as manifested in seasonal variability is common to all ecological zones. Participants reported that rain used to start in January or February in the past, but it moved to April-May in recent times. Indicating the late onset of rain and changes in cropping calendar, a farmer from the midland recalled: 'While we used to plant enset and maize in January and February in the past, today planting the same moved to April or June.'

Shifting cropping seasons are recognised by indigenous knowledge through which farmers establish regular seasons that separate the flowering of fruits or grasses, in ways quite similar to findings from an Australian study (Leonard *et al.,* 2013). In the words of a FGD participant from Jara, 'the rain used to come on its time (…) The spring rain comes on time. In the meanwhile, there is a flowering time which happens without changing its time.' Through experience and knowledge, farmers

established seasonal calendars[1] to predict times to prepare land, plant and harvest. Table 9 denotes the seasonal calendar for the midlands. According to the calendar, preparing land for planting takes place from January to March. Most crops are planted when the rain starts. Enset is a long maturity plant, taking about 4-6 years to fully mature; but it is often processed and consumed before full maturity. It requires longer rainy season to flourish. Coffee is also a long maturity tree (3-4 years) and once planted and maintained, it can produce for decades. Depending on altitude, coffee beans are harvested between September and January. At lower elevations, harvesting takes place between October and December.

Table 10: Seasonal calendar in Sidama midlands

Livelihood	Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maize & haricot beans	Land preparation												
	Planting												
	Green harvest												
	Dry harvest												
Coffee	Harvest												
Cat	Harvest												
Pepper	Harvest												
Enset	Land preparation												
	Planting												
	Harvest												
Livestock	Milk production												
	Livestock sales												
Emergency	Peak hunger season												
	Peak livestock sales												
Health	Malaria												
	Diarrhoea												

Adopted from: SNNPR Livelihood Zone Reports, Chuko district, Sidama (Maize belt livelihood zone, 2005).

Maize and other annual food crops are generally intercropped amongst the coffee and enset plants. The time before maize harvest (April to June) is critical for

[1] According to the habitual Sidama calendar, the following are the months in a year: Arfaasa=January, Ammajje=February, Badheessa=March, Dotteessa=April, Onkoleessa=May, Elle=June, Maaja=July, Wocawaajje=August, Fooqa=Leap year, Wocawaaro=September, Birra=October, Bocaasa=November, Sadaasa=December. Except the Leap year, which has 5-6 days, the rest of the 12 months have 30 days each. Most of the months are named in connection with the conditions of rain and sunshine. For example, Birra=October indicates the end of rainy season and the start of dry season, while Badheessa=March represents rainy conditions and the start of cropping season.

famers. It is referred to as the 'hunger season' covering the time before crops ripen. This is a critical period when the prices of staple foods peak and people sale livestock to raise cash income needed to purchase food. Malaria occurs throughout the year, but it gets worse from April to October. Seasonal calendars are subject to modification with climate change. For example, seasonal changes in rainfall and temperature can alter the length of growing seasons, and planting and harvesting calendars (Rosegrant *et al.,* 2008). Altered seasons and uncertainty are nothing new to households both in the lowlands and the highlands. At the time of the fieldwork, the following is a response from a farmer who was waiting for rain:

> This is the month (March) to plant maize. … Now without sowing any crop, we don't know what to do. We are waiting after ploughing the land (...) People are asking what to do. They are sad and moaning. We are asking how this situation came about, what shall we do, how to work and grow, how to get rid of hunger (...) we are struggling and working hard but time is running out and April is in front of us. The month of April used to be one in which most of the work is completed; now we haven't done anything except ploughing the land which is dry and dusty (...) (FGD participant from highland)

The researcher visited several farms and confirmed dry conditions in the highland. Crops and trees affected by dry conditions in the months of March and April are ever visible in many locations (Fig 21).

Figure 17: Arid conditions in highland Xexicha

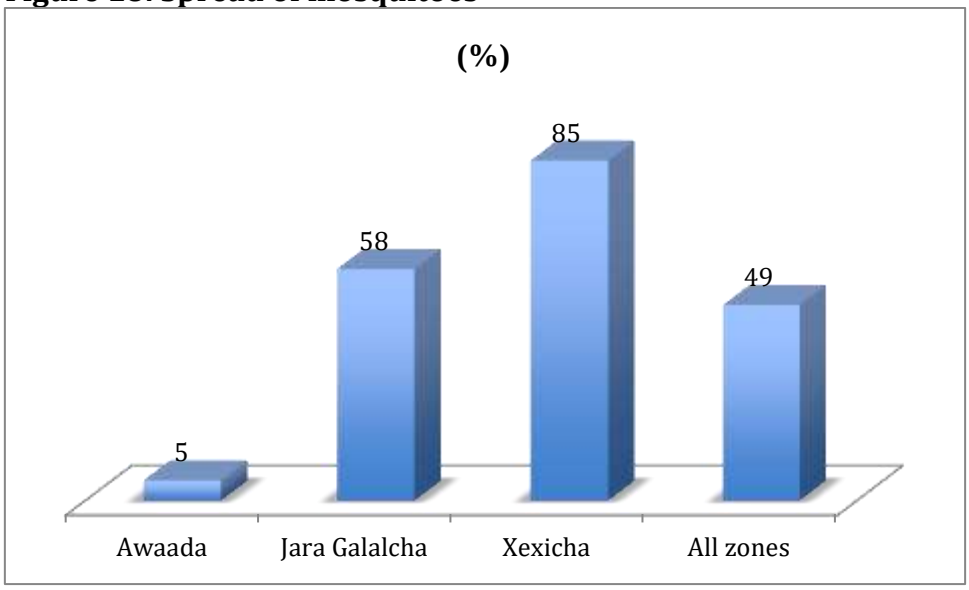
(Xexicha, 18 March 2012)

Thus the magnitude of changes in agricultural pattern and seasons indicate that excessive reliance on past experience and indigenous knowledge alone cannot help

fully predict changing seasonal scenarios. Moreover, data from focus group discussion attested that knowledge and interest on environment is eroded among young generations. Lost alongside are also old skill sets. Apart from this uncertainty, there is ample evidence from the study that seasonal shifts had occurred.

High incidence of diseases: As per survey data, the highlanders are particularly alarmed by the incidence of mosquito spread (Fig 22). The spread of mosquitos is reportedly lower in Awaada (midland) compared to the others. This is interesting given that, in the past, it is usually the lowlands that were affected by mosquitoes.

Figure 18: Spread of mosquitoes



[Source: Survey data, 2012]

These results correspond to predictions that highland areas formerly unsuitable for malaria will become epidemic (Ermert *et al.*, 2012). Thus as temperatures warm, the Plasmodium parasites that cause malaria and the Anopheles mosquitoes that spread it thrive (Gage *et al.,* 2008).[1] As temperature data in Figure 15 (in this chapter) demonstrates, the highlands are within the reach of both malaria varieties.

[1] *Plasmodium falciparum* transmission is limited by temperatures below 16° to 19°C, whereas *Plasmodium vivax* development can occur at temperatures as low as 14.5° to 15°C (Gage *et al.,* 2008).

While some indicators of climate change are commonly perceived in all agroecological sites, respondents in some areas reported facing distinctive climatic challenges. For example, participants from the highland of Xexicha highlighted change in wind direction, disappearance of plant (crop and tree) species, growing new crops such as maize and coffee and emergence of new parasites and weeds. Participants in the highlands noted that some people started growing coffee but they do so under different soil conditions from the one produced in the midlands with implications on the quality and quantity of coffee. Reported change in wind direction and intensity is perhaps due to changes in forest cover and mountainous terrain. A participant summarised the wind condition in the following statement:

> In highly unknown ways, change happened in manners that harm our area (…) It does not wind the way it used to (...). It does not wind the way we knew. In the past, the wind was heavy. It can carry a person. But it was not harmful (...) It would not destroy anything. It sweeps away peacefully. Today's wind causes damage to people. Its behaviour is not known. When rain appears on the horizon without signals, the wind disperses it across the land and we don't enjoy abundant rainfall. (Participant from highland)

Interestingly, wind condition was not mentioned in other sites of the study. It is something that needs further exploration, noting that previous studies reported altered wind patterns and areas on the path of rain-bearing winds (Rosenzweig & Hillel, 1995).

Respondents from the highlands reported another unique challenge in the form of disappearance of plant species. In the last twenty to thirty years, some trees known as Duwane in Sidamuafo and Dokma in Amharic are driven into extinction in many parts of Sidama.[1] Another tree that disappeared included orange. Orange trees used to grow in many areas of Sidama's midlands until the 1990s. At the time of this research, orange trees have virtually vanished. Unsearched and unidentified leaf and fruit disease possibly caused by *phaeoramularia angolensis* could have wiped out orange plantation. The disappearance of orange trees in Sidama needs scientific study if it was linked to climate change or if other factors were at work.

On the other hand, participants from the highlands complained about the changed times while cherishing the possibility of growing new crops such as maize and

[1] The fruits of these trees were used as food for birds and wild food for people.

coffee trees. The positive possibility is overshadowed by reported emergence and spread of new weeds affecting their farms. In the past, the highlands used to have fertile soil with lesser weeds and pests. The emergence of new weeds meant that farmers spend more time and effort to destroy the weeds. For example, a participant expressed frustration after spending considerable time to remove the weeds on his land. 'I do not know what to do; I don't know how to get rid of it. The weeds share soil nutrients and affecting crop growth' (Participant from highland).

The indicators of climate change are either commonly shared or uniquely felt by particular AEZs. In all cases, however, not only did participants held views and opinions about different indictors of change but also discussed what they believed were the causes of climate change.

Perception of causes of climate change: Scientific literature classifies the causes of climate change into two: natural and human induced conditions. Natural climatic variations emerge from processes internal to the Earth or driven by external forces whereas human-induced climate change or global warming is largely caused by GHGs emissions. The IPCC (2007a; 2013) determined that human activities have grown since pre-industrial times. For example, there has been 70% increase in GHG emissions between 1970 and 2004. GHGs are generated from the burning of fossil fuels, land use changes and deforestation. And CO_2 contained in these processes is one of the main GHGs that contribute to global warming.

One would expect some components of the above scientific explanation to filter into discussions related to causes of climate change. Yet the connection between CO_2 concentration and climate change was not directly established during the focus group discussions. For instance, the burning of fossil fuels or even the use of chemical fertiliser or dung as contributors to GHGs was hardly mentioned as a cause of climate change. This is not surprising given the context of rural communities who don't use fossil fuel products save kerosene. Firewood is commonly used for cooking food and for generating light and heat. In contrast to farmers' perceptions about the causes of climate change, policy makers recognised that the majority of Ethiopia's carbon emission is caused by deforestation through

changing land use to agriculture and degradation from cutting trees to provide wood for fuel (EPA, 2011).

On the other hand, farmers' explanations about the causes of climate change were rather focused around cultural, religious and environmental causes. Only the latter explanations support the climate science view that climate change is anthropogenic. The common explanations in all study sites were *weakened indigenous practices and values, God's wrath, human activities and deforestation,* which will be discussed below.

Weakened indigenous practices and values as the cause of climate change is an important dimension of farmers' perception of the causes of climate change. Participants repeatedly mentioned the erosion of respect for norms and values, protection of trees, paying sacrifice and praying for rain, use of indigenous crop seeds and strategies to cope with disasters and adjust to changed times. Others studies (for example Tauli-Corpuz et al, 2009) also made reference to the value of indigenous knowledge belonging to locales as the following statement testifies:

> We, indigenous peoples, have long observed and adapted to the climatic changes in our communities for tens of thousands of years. Because of our sustainable lifestyles and our struggles against deforestation and against oil and gas extraction, we have significantly contributed in keeping giga tonnes of carbon dioxide and other greenhouse gases under the ground and in the trees.

Unfortunately, the value attached to indigenous people, knowledge and practices seem to erode in different parts of the world with globalisation. In the case of Sidama, all focus group discussions mentioned the erosion of respect for norms and values. In one such meeting, a participant has the following to say:

> When we were young, people lived respecting each other. A child respects his parents. Wife respects her husband. All that is non-existent today. When you talk to women, they say they have equal rights. A son does not obey his father. God has forsaken us, people stopped respecting each other. God could not handle people and forsaken them. And abundance is lost. (Participant from highland)

The above perception of weakened indigenous practices as the cause of climate change has generational, gender and religious tone and shared by people in other parts of Africa. For instance, farmers in Zimbabwe identified the decline of social and cultural practices to climate variability (Mubaya *et al.*, 2012).

In this study, farmers did not only indicate *decline* in cultural practices, but also identified the *termination* of indigenous practices that were once called upon to resolve natural disasters including drought. A participant from highland described how he witnessed rain immediately after customary ritual in response to a long dry season.

> From what was said (...) about sacrifice, I have seen it with my eyes. It was in 1999. The rain did not come until April. The land was dry and had seen no drop of water. In this land, when the dry season is extended, water holes dry up. If people didn't have water, senior people called for community assembly. They announce: 'the rain is failing and as we do in the past, we should pay sacrifice.' Some people heeded the call; they crossed a nearby river and they slaughtered a young bull. … Then the seniors spread their blanket on the land, prayed and slaughtered the bull. The moment was dry and windy. As soon as people (…) tasted the first round of meet [of sacrificial bull] (*dhadhama*), it started to rain without notice and without people knowing where the rain came from.

The study found repeated tales of similar stories. Participants reminisced hard times with late rains or failed rains. They recalled situations where community elders used to sit under the shade of large tree while women carried flowers in market places requesting for donations. The actions and the elders who used to pray and sacrifice no longer exist. According to a participant from the midland, 'Today, the women who hold flowers and collect donation for sacrifice no longer exist. Today everyone goes to church to pray, yet there is miscommunication between people and God.'

Another participant from the midland remarked about the skills and knowledge of old generations. 'Our predecessors had astrologists who examine the arrangement of stars and predict the arrival of rain or otherwise. Today's generations abandoned age old traditions and follow gospel, both young and adults.' Another participant complemented the above view: 'They see the sky and cloud formations. They sacrifice on fateful dates. Then it rains. They also see the direction [and speed] of wind. But today, people are accustomed to modern religions and they abandoned all that' (Participant from the lowland).

Appreciation of the role of indigenous knowledge is not limited to farmers. Other studies in Ethiopia (for instance, Pound and Jonfa, 2005) prised farmers for being

adaptable to changing circumstances mainly due to high level of indigenous knowledge and its flexible application to short and longer-term challenges. Another study noted that farmers are resourceful and 'developed skills over millennia to cope with the problems associated with population density and scarce resources' (Assefa and Bork, 2014).

The resilience of farmers in the face of adversity notwithstanding, certainty about continued validity of local knowledge is no longer guaranteed in the case of climate change. For one reason, climate change does not only challenge indigenous knowledge but also science and scientific practice. In recognition of the latter challenge, Schipper (2004, p.10) noted that scientific uncertainties exist regarding the characteristics and impacts of future climate change and especially questions about the magnitude, frequency and other characteristics of climatic processes. Hence, climate change challenges both forms of knowledge. Yet the challenge did not stop participants lamenting the abandonment of tradition and associated knowledge. A participant from lowland told a FGD meeting: 'Today people do nothing.' Another participant complained that 'They claim they are believers, they are not even good believers. They pray but it does not rain.' In these cases, modern religions seem to make matters worse by excommunicating those practices. According to a participant from the lowland:

> Today's people claim they believe in God and they think God does not like the old practices (…) The old way are gone. The old ways are considered the work of Satan (devil). We quitted all as we were told it is the work of the devil. (Participant from lowland)

The abandonment of customary practices coincided with the conversion of youth to different Christian denominations. While the conversion of the youth is understandable, it is not immediately clear why and how members of the older generation resigned into submission. According to a participant from the midland, the answer lies in the fear of social isolation:

> When you take calves away from the cows, what is left will be old [cows]. The old [people] became isolated and follow the rest for their own survival. They are frightened that there will be no one to burry them when they die.

Religious conversion went hand in hand with the abandonment of traditional practices. Abandoned in the process are not only cultural and religious practices

but also some forms of livelihoods. According to a farmer: 'In the past, people use indigenous crop seeds but today people use hybrid seeds obtained through the ministry (MoA). As these seeds cannot be re-planted, they have to be consumed or sold. Every year, we have to buy hybrid seeds' (Participant from lowland).[1] Lost in the process, amid incompatibility between hybrid seeds and smallholder practices, is also the habit of getting people to reflect about natural conservation. Time and again, participants felt that contemporary people are less concerned about the long-term future as the past generations. Participants appear to blame modern men and women for pursuing short-term benefit derived at the cost of long-term soil fertility. The common example is the choice of eucalyptus plantation. The motivation to grow eucalyptus is explained below by a participant to FGD from the highland:

> Here (...) we are highlanders. Our people are getting information from the mid-landers (...) We hear our people saying: mid-landers earned a certain sum from the sale of Khat (*caat*) grown in fertile land, close to a homestead. When such news arrive here (where Khat doesn't grow) people hurriedly plant eucalyptus trees. When it is cut for firewood or sold as timber, it fetches a good sum of money. The news about this spreads fast. People have now entered into competition of this kind.

The rationale for the change in attitudes appears to lie in economic imperatives, increased population and the introduction of markets and urbanisation. The shift led to declining importance attached to indigenous knowledge and community forest resource management. Sacred places that were once filled with sycamore and other native trees have withered in the face of enormous pressure from environmental, economic, and socio-political changes. The attribution of weakened indigenous values and practices to 'changed times' goes with the notion of God's wrath.

God's wrath as a cause of climate change: Reference to God appeared in all focus group discussions. In a FGD in the highland, a participant summed it thus: 'This climate change, when we think about it, is an act of God.' Another participant added 'I am of the opinion that what is happening is due to the wrath of God'. These are widely held views but such perception is not part of the lexicon of scientific explanation of the causes of climate change. Yet such perceptions are

[1] Study participants regularly conveyed the sense of dependency on seeds and fertiliser purchased from government or affiliated businesses.

exceptional to Sidama. For example, a study of rural Indian communities stated that people do not only 'correctly detect climate change, have good understanding about causes and solutions, but also have views about climate change causation that are different from scientific perspectives' (Moghariya and Smardon, 2012, p.14). This is partly due to limited extent of formal schooling among many rural people who often lack the capacity necessary to grasp detailed scientific views on climate change.

In this study, as there are participants who attribute the causes of climate change to weakened values and God's wrath, there were also others who equate it with their own actions, thus absolving God from blame.

Climate change is the result of human activity: A few participants held the view that climate change is the work of man. With reference to deforestation, one participant from midlands admitted: '… the mistake is ours only. What God is supposed to do?' Explaining the fact that human action contributed towards climate change, a sense of responsibility is palpable as the following statement shows:

> It is wrong to blame God for lack of rain after planting trees in a wrong place. The land was fertile even when there were no rains. Planting wrong trees ruined it … Similarly, we plant eucalyptus tree where it should not be planted and we bring poverty upon ourselves. What I mean is, we dried up the rain by inappropriately cutting down indigenous trees, which were balancing our climate. (FGD participant from highland)

While accepting responsibility for misuse of natural resources is admissible, hence linking climate change to human activity, participants' knowledge seemed to be largely limited to the local world. For this reason, they did not seem to establish direct links to global warming, except remotely associating climate change with activities of 'wealthy people'. However, a few take proportional responsibility for their own actions, instead of putting blame entirely on others, especially God. The following explanation is forwarded along this line.

> In the beginning, it is not the extension workers who planted trees. It is not government. In the days when neither development worker nor government existed, God had balanced our climate on this land with forest, water (...) and everything. We messed up and we complain that God has withheld rain (...) As the saying goes: 'a cloth owner at fault blames her cloth.' After causing the problem, after failing to conserve trees, after planting trees in inappropriate places, we complain of land aridity (...) Without taking care of the land, we denounce

government and God. This kind of thinking caused problems (FGD participant from highland)

The same participant continued:

> There is, however, something which harms our way of life, our pleasant way of life. It is coming from wealthy people. It is the heat produced by their activities. The heat is causing us problems. For example, when a man installs a coffee processing machinery, that could benefit him and his children, it can cause problems to other people. The residue of coffee berries pollutes the river. Other people, who live downstream, use polluted water for washing and drinking. Both people and animals drink from it. Similarly, what rich people are doing, what the government is doing (...) has impact on our land; it is changing our climate (FGD participant from highland).

This position corroborates the shift in thinking from the idea that 'humans were at the mercy of the environment' (Schipper, 2007) to the one that humans possess agency to impact the environment both detrimentally and positively. One factor over which people have control is population. Information emerging from the study sites showed that respondents started to see population growth as a factor of declining standards of living. A participant in highland has the following explanation about the population challenge and the competition imperative that led to expanded eucalyptus plantation:

> (...) As time went by, and in many ways, what people have has decreased. The increasing population number and size did contribute to this decline. Human birth in the past was small. As human birth has increased, it is only population numbers which increased, not the land. As land did not increase, there are now many problems for people. Too many problems. People teach their children. They have large families. For this reason, people resort to quick results, prefer items that grow quick (...) That is how eucalyptus tree comes. In the past, its numbers were limited; it is not as widespread as today. Government has been teaching us about eucalyptus tree. They told us that the roots of this tree go 50 metres deep. By so doing, it develops itself while hurting other trees. It sucks all the minerals in the soil (...). It dries up underground water. But people are not looking further back and taking note of this problem since economic necessity is taking precedence. People's attention is captured by urgent problems and they only weigh the immediate benefits to solve their needs and they do not realise the damage caused. It is planted because of problems. It is because of the hard times that people plant eucalyptus …. (FGD participant from highland)

Deforestation as a cause of climate change: Participants in all AEZs identified deforestation as a cause to climate change. A female FGD participant from the highland used the metaphor of 'umbrella' to amplify the problem.

> It is known that trees attract air. It is obvious to everyone that trees attract good, fresh air (...). Even if heavy sun exists, where there are forests, we get milder environment. People are not conserving the environment, forests and native trees. …. Trees are not handled with care (...) In the past, we had good trees that attract good air. Now our land is exposed, we are unable to get fresh air. We are now exposed. It is as if we are not holding umbrellas, hence we suffer from dry sunlight. The same applies to our land. Due to forest shortage, the area is warming. I think that is the reason for [climate] change. (FGD participant from highland)

Field visit showed that the highlands are home to native trees used for medicinal purposes. An example is a *koso* tree whose leaves are crushed and used to treat tapeworm. This and other native species are threatened by combined pressure of climate change, agricultural land expansion, wood for construction, timber production, and firewood collection (Kewessa, *et al.,* 2015).

Participants from the lowland of Jara recall experience of deforestation and growing up in an area filled with forest but later cleared for cultivation. According to a participant:

> I was told that before I was born, there used to be forest in this area but that has changed since then …. The area was converted to farming fields. One landowner was called Daguye (Deguye) who built a big store and used tractors for crop farming. Later the derg (military government) confiscated that land and converted it to state farm. With the downfall of the derg, the land was distributed among our fathers (indigenous farmers) who planted trees.

Deforestation in the scale mentioned by farmers does not only cause environmental degradation but also removes the socio-economic, cultural and ecological importance of forest resources. For communities that are highly reliant of natural resources, the loss of forest resources means loss of economic, cultural values and ecological benefits. Removed are the benefits of forest resources in terms of soil and water conservation, watershed protection, nutrient recycling, nitrogen fixation, amenity and recreation, creation of microclimate, wildlife habitat, gene conservation and carbon sequestration from the atmosphere (Melaku *et al.,* 2014, p.215). Deforestation removed these benefits. A study of rapid deforestation of once highly forested part of the Ethiopia blamed land use change thus:

> …[L]and use changes caused by investments were identified as a major contributor to the decline of forest coverage. Investors leased forestland to produce coffee. Most investors also harvest forest products, mainly cutting old and important trees. Most

> respondents (about 81%) believed that soil erosion, shortage of NTFPs [non-timber forest products], shortage of fodder for animals and climate change result from the destruction of forests in the study area. (Melaku *et al*., 2014, p.219)

Sustained deforestation and land use changes led to the conversion of ecosystems. Participants clearly identified loss of trees and forest as contributing cause of climate change. This perception is mediated by generational gap in attitudes towards trees and forest. An example is varying attitude toward cutting trees and forest protection. Older generations appear to believe in a kind of conjugal bond with nature. The bond seems to get loose with younger generations. According to a participant in the highland, 'people in the past pray to God and pay sacrifice under a tree. Today's people hurriedly cut trees and devastate native forest'. The same view is reinforced by extension worker:

> Older people know about the past. For example, they say, they used to sacrifice when the going gets tough. They cherish nature. They do not rush to cut trees. When they offer sacrifice, the do it under the shade of a tree. That time has changed. Sacrifice is rare act (…) The way older people think is different from the way young people think. The older people do not want trees to be cut. The new generation do not care if trees are wiped out. They focus on current, fast technology, but they do not foresee the future problems. They look at cash to be earned. Our fathers inherited us good environment, we are bequeathing future generations with bad legacy. We focus on quickly becoming millionaires. We are seen destroying what the past generations purposefully preserved. We are not looking into the future. (Extension worker from highland)

Another participant blamed lack of awareness or carelessness of current generation:

> A generation of people who cut trees preserved by fathers won't be expected to hesitate to foolishly spend what is in their pockets. People did not foresee long-term problems and focused on short-term benefits derived from cutting and selling the trees. Our forefathers did not know the monetary value of trees but consider its benefits in environmental terms of providing shade, hence they protected trees. Today's people know the environmental benefits, yet they cut trees. This is the main cause of climate change. (FGD participant from midland)

Cutting down trees is considered as one of the causes of climate change not only in the midlands. A participant from the highlands recalled: 'In the past, all what you see here was forest, and partly open fields. Today there is no space even to keep cattle.' In the words of a female participant from the highland, cutting trees is one of reasons for climate change: 'When observed deeply, one reason is the cutting down of trees. There are some trees left but not in large quantity as before.'

The perception of deforestation and land use change as causes of climate change is well established. Results from this research link well with findings from a study of Eastern Tibet where people strongly believed that human actions are the root cause of climate change, directly or indirectly by angering or weakening gods or deities (Byg and Salick, 2009).

In sum, the above are results about the lived reality and lay peoples' perceptions of climate change. Based on their observation of natural phenomena of which they maintain shared and selected repertoire, they formulate opinions of climate change (Roncoli *et al*., 2002). Their understanding is based, as research elsewhere noted, on their knowledge, values, and moral responsibilities and cultural interactions with nature (Bulkeley, 2000; Moghariya and Smardon, 2012). Thus in matters of perception, people's subjective thoughts and ideas proved as important as quantitative assessment of climate change knowledge.

5.4 Perceptions of climate change by policy makers

The above section surveyed the perception of climate change among farmers. In this section, the result of qualitative data on perceptions of climate change among policy makers is presented and discussed.

Qualitative data showed that participants at various levels of government structures held views shared by scientific community, or perceptions were also consistent with the weather data presented earlier. Common themes include the prevalence of erratic rainfall, rising temperature, decline in water availability, and emergence of diseases.

However, depending on the position of participants in government structures, individual responses contained varied nuance. At the district level, participants made a link between deforestation and declining rainfall with subsequent impact on crops. For example, an extension worker from the lowland mentioned longer dry season, rising temperature, erratic rainfall: 'The amount of rain is decreasing … last year, it started to rain on 24 April.' This corresponds with farmers narrative

that April used to be the time of good rain. The late onset of rain is consistent with shifting seasonal pattern and modification in the crop calendar. A district participant from the midland recognised erratic rain and seasonal shift explaining that rainfall distribution varies from place to place. 'It rained in Yirgalem yesterday, but in the nearby Kebele*s,* people tell you it did not rain.' Another district participant compared and contrasted broad ecological change, including introduction of coffee production in some areas of the highlands:

> In the past, our district rarely lacks rain during the rainy and dry seasons. There is now a situation where rain is erratic or sporadic. It is not raining in the times it used to rain. …. The change is visible. We used to have areas covered by mist …. Now there is no mist …. We used to have continuous supply of water from above the ground wells. That changed and people have difficulty to get water for their cattle, especially during the dry season. We had three planting seasons: dry/winter, moderate rain (badhessa), and rainy/summer…. It used to rain heavily in mid-February, followed by greening of grass by March and April. But now [April], there is no rain, and people are using enset leaves to feed the cattle. [Moreover] over ten years ago, coffee planting was limited and it was confined to a few corners of the district. But with climate change, the practice [of growing coffee] is widening beyond these corners. There are now 11 Kebele*s* [in this district] who grow coffee. In the past, if you grow a coffee plant, it does not yield berries; it only grows leaves. That has changed, and farmers now get coffee berry (District official from highland).

Participants revealed different aspects of what they thought were the indicators of change. Examples include decline in water availability, drying up of wells and wetlands that used to exist around lakes or riverbanks to substantiate decline in water availability. The spread of diseases is also marked as an indicator of climate change. This is highlighted in the highlands where changes in agroecology induced the emergence of insects that never existed before. It is argued that warm temperature creates suitable breeding ground for different vectors. The resultant diseases affect not only humans and animals but also plants.

The views about the causes of climate change converge in the sense that most participants were in agreement that it is man-made, often associated with *deforestation*, *CO_2 emissions and global warming*, which is in line with scientific explanation of climate change.

Deforestation is widely mentioned as a cause of climate change. Participants attempted to link deforestation with increased CO_2 emissions. An extension worker from midland confirmed that large trees like *Warka* are being cut and sold. Having

these plants has its impact on Oxygen and CO_2 interface. These trees hold water and maintain soil moisture, their leaves maintain soil fertility. A participant from regional NMA office agrees that decline in forest cover results in decline in soil fertility, imbalance in rainfall distribution or rain variability, environmental degradation, flooding, and increased temperature. And 'due to rise in temperature areas that were not known for having malaria are affected by malaria epidemics.

Among the three areas surveyed, the intensity of deforestation is extensive in the lowlands. A participant from the lowland district compares past and current forest coverage as follows:

> In terms of natural ecosystems-system, this area was covered with forest. The existence of trees contributed to rain and crop cultivation was productive. But now, the forest cover in 14 of the Kebele*s* is depleted. This contributed to rain shortages (...) (Participant from lowland).

The comment of extension worker on forest cover decline in the area corresponds to what farmers reported in FGD and in interviews. Decline in forest cover in general and native trees in particular is associated with changing land use and the expansion of eucalyptus trees. Views among policy makers about eucalyptus trees are mixed. In one instance, an extension worker justified growing eucalyptus tree as follows:

> Planting eucalyptus is not a problem when it is grown away from farms; it adds to the revenue stream of farmers. Form what we observe, farmers do not select or discriminate where to plant eucalyptus trees. What they listen to are stories about how much someone who (may have larger plots of land) planted and grew them in 5-6 years and sold eucalyptus for 5-6,000 birr. Such observations induce farmers to follow these examples and plant it on cropland. We [extension workers] advise people not to plant eucalyptus tree in wrong locations, but we could be supported if there is government policy about where/how farmers could plant eucalyptus trees (Participant from midland).

The role played by eucalyptus plantation in other parts of Ethiopia remains a matter of controversy. Studies (e.g. Tadele and Teketay, 2014, p.935) noted that planting eucalyptus especially on farmlands suitable for crop production has become a great concern due to its alleged long-term side effects. Subsequently, policy makers in some parts of the country took measures to discourage planting eucalypts on farmlands for fear of crop loss, urgency of food security and saving more land for food production. Tigray Regional government is mentioned as

example of banning planting eucalypt species on farmlands (Jagger and Pender, 2003), while the Amhara Region of Koga watershed cleared and de-stumped large areas of eucalyptus on farmlands for agricultural crop production.

On other hand, Tadele and Teketay (2014) cited sources pointing to positive contribution of eucalyptus on improving the livelihoods of rural communities, poverty reduction, restoration of degraded lands and reducing the pressure on remnant native forests in the highlands of Ethiopia. The controversy on eucalyptus plantation is bound to continue, so do the problems it engenders in the context of sustainable livelihoods in Sidama. In this study, discussions with farmers, extension workers and government officials point to pervasive side effects of the tree on soil, crops and the habitat at large. Yet farmers continue to grow for lack of better alternatives. From policy makers' perspective, it can be argued that the continued plantation of eucalyptus as a source of firewood may have postponed the urgency to seek alternative energy sources and eased the pressure to allocate resources on the latter.

The controversy surrounding eucalyptus trees notwithstanding, there is persistent perception among participants linking deforestation and environmental degradation. Here is how a regional agriculture bureau participant posed the problem of how the decline in forest cover results in soil fertility decline:

> The decline in forest is leading to rainfall distribution imbalance [rain variability]. Environmental degradation is leading to flooding with heavy impact. With forest decline also came increase in temperature. We can see this in relation to health. Due to rise in temperature areas that were not known for having malaria are affected by malaria epidemics.

In matters of deforestation and environmental degradation, intergenerational gap is reported by a zonal official who argued that:

> …. it is possible to distinguish between young and old people. Older people tend to keep trees, and conserve forests. (….) But the young, the current generations do not hold such views. There is conflict of ideas here. Older people, more or less, insist trees shouldn't be cut. They live with their culture. They struggle. They don't want trees to be cut. This is what can be seen on the ground. It is what comes out visibly when we talk to people. … But with younger generations, there is pressure. How? They link things with their economic wellbeing. They think that what is happening today was also happening in the past as well. They don't recognise changed times.

These observations make an important link between environmental degradation and climate change. They also point out issues of sustainable use of natural resources and intergenerational equity, which are central to sustainable development.

Moreover, most participants from policy making and implementing bodies share a view of *global warming* as a cause of climate change. And global warming is a global phenomenon and international dimensions of climate change is not lost to a participant from the midland, climate change who goes on to detail the problem in the context of a coffee growing area:

> Our district is a victim of the problem of climate change (…) This district is known to produce coffee. The only way production and productivity of coffee can be increased is by having stable weather conditions. Problems associated with global climate change affect our district (…) The source of global warming is man-made pollution … [which] results from gases released by factories of wealthy countries. CO_2 emissions are released by developed countries. Most vulnerable countries are victims especially African countries and developing countries. (Participant from midland district)

Another participant saw climate change as a complex condition that involves land use, ecosystem and weather conditions. 'There is definitely a (climate) change,' the participant noted, linking it to La Nina and El Nino phenomena that are now occurring frequently, every three years. 'Now their variability is a matter of seasons. If it is La Nina now, it soon becomes normal and then starts to warm as El Niño.' (Participant from regional NMA)

Observations such as the above are aligned with scientific explanations of climate variability. Thus most participants from federal government agencies were well versed with scientific discourse on climate change. An interesting exception is a view from an NGO participant who espoused a slightly different interpretation linking climate change to weakening customary practices. This view corresponds to farmers' perception about the causes of climate change. The same participant lamented the lack of upgrading and validating indigenous knowledge.

> Customary practice is declining everywhere. When I was a child on Oromo area, and when rain fails, elders carry grass and go to the top of a mountain and pray for weeks. Then surprisingly it rains. … The traditional systems are being weakened. As development practitioners, first, we have to understand them. And also support them, recognise them, and protect them. We should build on [existing] knowledge.

> We worked a lot on Borana Gada system. We informed the role of Gada system in decentralised administration and implement its principles. As development practitioners, we need to show the usefulness of these systems, then secure their recognition and protection. Imagine a scenario when these old people are gone, even our generation passes. Our children live in Addis or aboard. They don't have attachment. It can be even more eroded. It is a pity. In all this religion is a big influence. (Participant from NGO)

The kind of 'good old days' view of the past, if not nostalgia of time past, is not new; it is widely spread across cultures. The concern for traditional knowledge, cultural heritage and livelihoods is also shared. These concerns fed into broader set of vulnerabilities to current and future climate change, and more importantly what could be done to reduce it and adapt to changing situations. These are subjects of discussion in subsequent chapters.

5.5 Summary

This chapter presented the results of data on observed climate and perceptions of climate change by farmers and policy makers. Climate data for two decades showed rising average temperature, high rainfall variability and seasonal variations. The majority of farmers perceived these changes. In terms of AEZs, the higher percentage of respondents in the highland noted climate change compared to respondents from the midlands and lowlands.

Moreover, while climate change is widely perceived to be a reality, its causes are mixed and at times different from scientific explanation. Their explanation centred on deforestation, God's wrath, human activities, and weakened indigenous practices and values. Participants from policy-making community espoused views shared by scientific community. Depending on their positions of authority, they emphasised different indicators of change. Their perceptions about the causes climate change were also largely in agreement with scientific explanations such as deforestation, global warming and CO_2 emissions. However an observation from a participant from NGO community was about lack of recognition of indigenous knowledge and the weakening of traditional practices. In sum, climate change is widely perceived to exist at all levels; and it is understood to worsen vulnerability – the subject of the next chapter.

Chapter 6: Results & discussion: Vulnerability to climate change

6.1. Introduction

Chapter 5 presented climate data and perceptions of climate change. This chapter presents the results of the study on vulnerability of smallholder farmers commencing with the discussion of climatic stressors and their impacts.

6.2 Climatic stressors and impacts

Important climatic stressors that affect farmers and their livelihoods are drought, heat waves, flooding, wind and soil erosion, water scarcity, ecosystem degradation and deforestation. The impacts of these climatic stressors on livelihoods are categorised under socio-economic conditions, water and soil, crops and plants, and livestock. This categorisation bears semblance to studies in Africa that noted the impacts of climate change on food production, water supplies, health and people's livelihoods (Nyong and Niang-Diop, 2006, p.235; Rosegrant *et al.,* 2008).

Table 11: Observed changes in livelihood conditions

Reported changes in livelihood	**Increased** (%)	**Same** (%)	**Decline** (%)
Socio-economic conditions			
Food availability	18	3	**78**
Income from agriculture	34	5	61
Human health	47	16	37
Water and soil			
Rainfall amount	11	7	**82**
Water availability	12	18	69
Soil erosion	32	26	42
Crops			
Crop yields	23	6	**71**
Crops types, varieties	38	5	57
Crop pests and diseases	40	24	34
Livestock			
Livestock populations	12	8	**80**
Livestock products (milk, meat, egg)	15	8	**76**
Pasture quality	9	7	**83**
Livestock diseases	32	27	41

[Source: survey, 2012]

Table 10 shows results from survey data indicate respondents reported declining socio-economic conditions. For example, most respondents (78%) reported

decline of food availability in all sites. From AEZs, Awaada and Jara reported most significant decline of food availability. This result confirms findings from comparative studies on Africa that pointed to reduced household food availability owing to failure or irregularity of rainy season (Haile, 2005). This result also confirms findings of a study on Ethiopia that associated reduced household food availability and increased risk of child under nutrition to the amount and distribution of rainfall and temperature (Hagos *et al.,* 2014).

Besides decline in food availability, 61% respondents reported a decline in income from agriculture. The decline in income from agriculture is severe in Awaada and Jara (75% and 72% respondents, respectively). Interestingly, Xexicha reported increase in income from agriculture presumably from the sale of bamboo and eucalyptus trees. As a reflection of its growing use, bamboo has recently attracted attention both in the highlands of Sidama and elsewhere in Ethiopia (Endalamaw *et al.,* 2013). However, the case of eucalyptus is different due to its negative effects on soil moisture and water availability in the long term while it provides income in the short term.

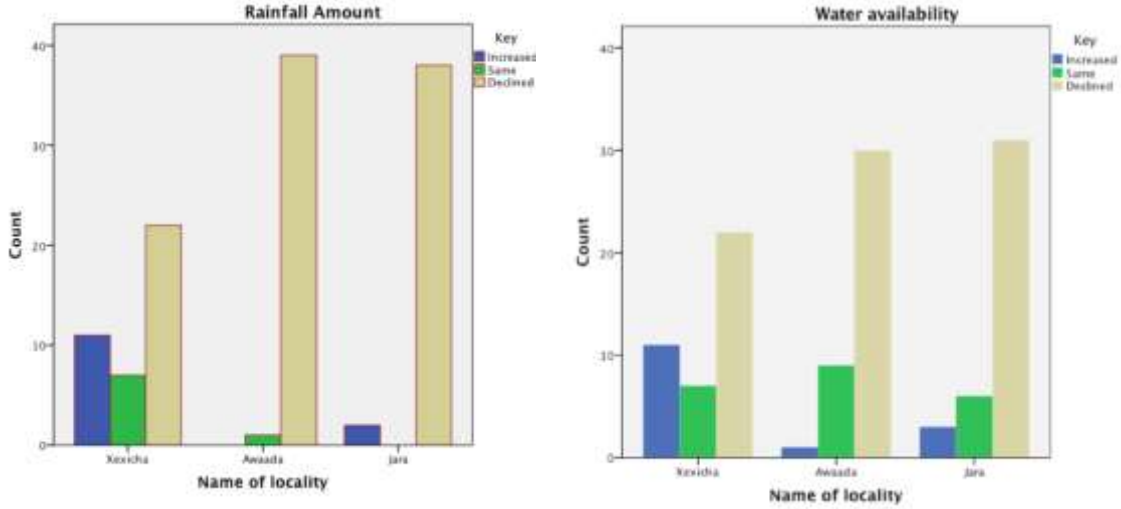
In terms of human health, the survey data showed modest improvement – slightly under half of respondents – compared to those who reported a decline (Table 10). On the other hand, survey results are in contrast to results from FGD and personal observation of the health impacts of climate change such as the heat waves, spread of diseases and the risk of malnutrition. In the midland of Awaada, for example, a participant lamented about higher temperature and heat waves as follows: 'When people are seen walking on the streets, it looks as if they are well and comfortable, but underneath we think that survival is at stake (FGD participant from midland).

These results support findings from WHO (2013) that explicitly noted the health impacts of climate change such that many of the major killers including diarrhoeal diseases, malnutrition, malaria and dengue are highly climate-sensitive. Malaria in particular is a notable public health risk in Sidama and elsewhere in Ethiopia (MoH, 2005; Daddi *et al.,* 2005; Jima *et al.,* 2005; Sena *et al.,* 2013). A recent study on climate change and malaria incidence predicted that without mitigation, climate

change would result in an increase of malaria in the densely populated highlands of Ethiopia and Colombia (Siraj *et al.*, 2014).

In terms of water and soil, Figure 23 shows that most respondents reported declining rainfall. The reduction is most pronounced in the midland of Awaada, followed by the lowland of Jara. Directly linked to decline in rainfall is the availability of water which is reported to decline in all areas with the largest decline reported in the midland and lowland.

Figure 19: Rainfall amount and water availability



[Source: survey data, 2012]

Jara is highly affected by decline in water availability followed by Awaada. The case of Awaada is paradoxical because it is surrounded by two rivers, although they are prone to partial drying up due to long dry conditions.

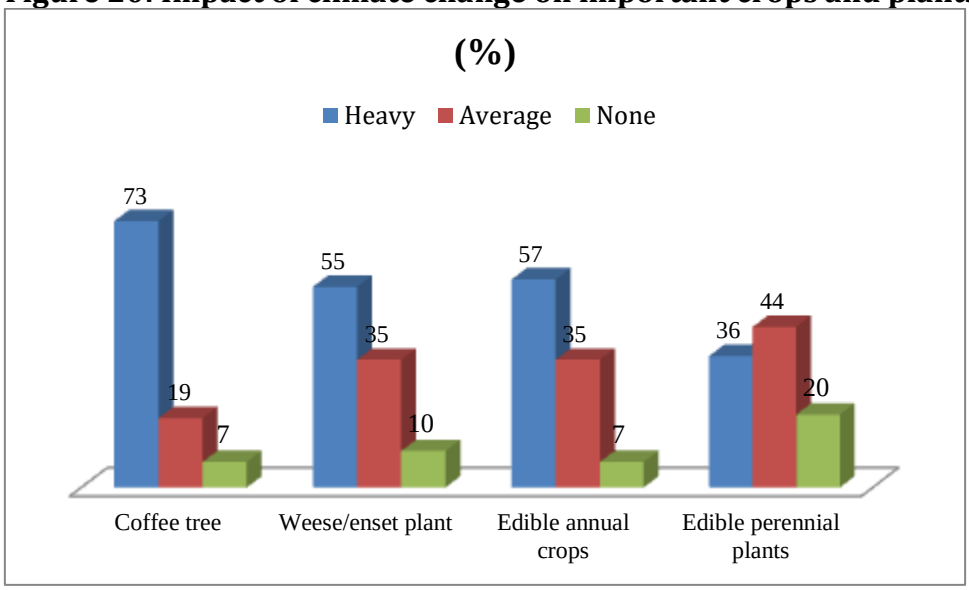
Soil erosion is reported by a large portion of respondents (more pronounced in the lowlands) reflecting broader Ethiopian environmental profile where soil erosion and degradation are said to be 'one of the most critical and far ranging environmental issues affecting the country' (Mckee, 2007).

In terms of livestock, the study reported decline in numbers. Awaada and Jara reported the highest decline in the number of livestock than Xexicha. In tandem with decline in livestock numbers, livestock products such as milk, meat and egg have generally declined, with Awaada midland reporting most of the decline followed by Jara and Xexicha. The decline in both livestock numbers and products

is attributed to shortage of grazing land and declining pasture quality and quantity. The decline in pasture quality is higher in Awaada (90%) followed by Jara (85%). At the same time, more respondents reported a decline in livestock diseases compared to those who reported an increase. The implication is that the decline in livestock population is attributable to lack of availability of pasture than to animal diseases.

In terms of crops, about two-third of respondents reported decline in crop yields. Jara reported the largest decline in crop yields followed by Xexicha. Interestingly, crop varieties or types reportedly increased in the highland while some crop or plant species disappeared altogether. Qualitative data confirmed that farmers in the highland noticed being able to grow new crops. For example, in the words of a participant 'things that never grow in our lands are currently growing due to climate change. We are now growing things that used to grow in the lower altitude' (FGD participant from highland). On the contrary, crop type declined in Awaada. This could be due to increased use of land for perennial plants in competition with annual crops. It could also be due to increasing shortage of land, given increased population density. About 40% of respondents reported increase in crop pests and diseases, most of which is reported at Xexicha and Jara (Fig 24).

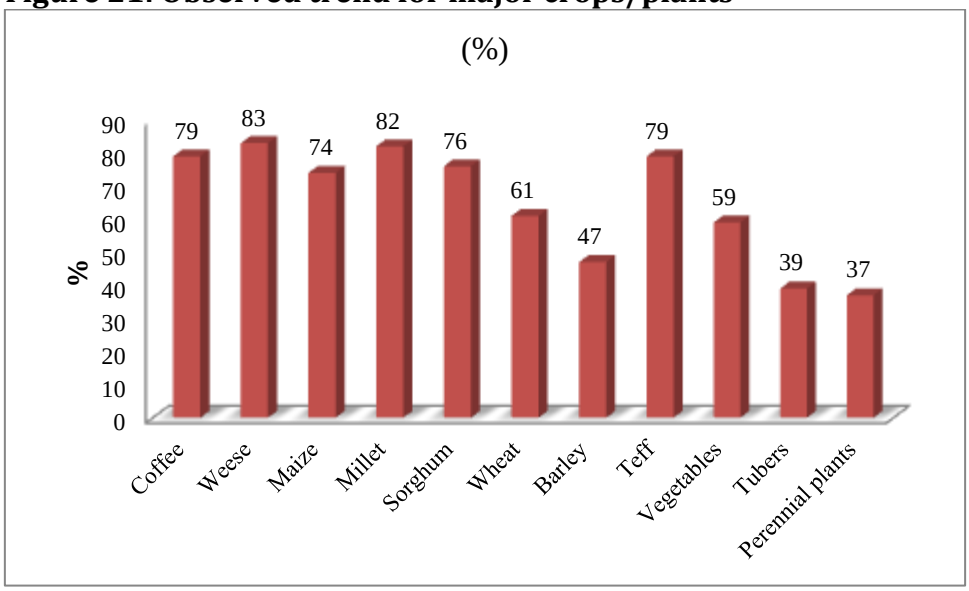
Figure 20: Impact of climate change on important crops and plants



[Source: survey data, 2012]

The impact of climate change is reported to be the heaviest on coffee and on annual crops compared to perennial plants.[1] Annual crops such as maize are more sensitive to water stress than perennial plants such as avocadoes, papaya, and banana.

Figure 21: Observed trend for major crops/plants



[Source: Survey data, 2012]

Farmers reported declining trend for a number of major crops in the last 5 years (Fig 25). The largest decline is reported for Enset/Weese (83%). Field visit also revealed the extent of damage on enset during extended dry season. Coffee, teff, millet, sorghum and maize registered substantial decline (79%). The least decline is reported for tubers. Edible perennial plants are largely drought resistant and they are reported to increase.

Given the abovementioned impacts on livelihoods, over two-third of respondents reckoned that climate change is a serious problem. FGD participants from all AEZs described their vulnerability to climate change. The impacts found expression in food insecurity, poverty, decline in production, overpopulation and general uncertainty. Some zones mentioned problems unique to their areas. For example, farmers in Jara Galalcha (lowland) complained of shortage of grazing land, shortage of water, and flooding. In the midlands, the sense of decline in general wellbeing is aptly described in a comparison of the past with the present: 'We lived

[1] In the context of the study areas, perennial plants and trees such as sugar cane, avocado, mango, papaya, apple, orange, banana, and pineapple.

in affluence [in the past]. Today carrying through a year is a struggle. Everything is on decline' (FGD participant from midland). Conway and Schipper (2011) conveyed the sense of despair arguing that food insecurity in Ethiopia 'is a chronic complex emergency that stems from political, social, environmental and cultural sources.'

Having explored different impacts of climate change, the following section presents how these impacts translate into different dimensions of vulnerability of smallholder farmers.

6.3 Vulnerability to climate change

The study reports that socio-economic and political factors exacerbate vulnerability to climate change. Moreover, following on Eakin's (2008) approach, vulnerability is viewed as a dynamic property emerging from the structure of human relations and dependent on place or population, associated with historical patterns of resource allocation, relationships of social privilege and economic marginality and the political disempowerment of particular social groups. Thus vulnerability of people or systems is not only linked to climatic hazards, it is socio-political and economic in nature.

On the basis of results from qualitative and quantitative data, vulnerability to climate change is categorised as having economic, social and environmental dimensions (Table 11).

Table 12: Summarized multi-dimensional indicators of vulnerability

Dimension	Factors	Xexicha	Awaada	Jara
Economic	Endemic poverty	X	X	X
	Dependence on rain-fed agriculture	X	X	X
	Declining productivity levels	X	X	X
	Increasing food insecurity	X	X	X
	Rising food crop prices	X	X	X
	Limited access to markets	X	X	X
	Low level of technological development	X	X	X
	Poor infrastructure (transport, energy)	X	X	X
Social	High population density		X	X
	Increased conflict			X
	High incidence of diseases	X	X	X
	Weak institutions, political setups and marginalisation in decision-making	X	X	X

	Despair and fatalistic world view	X	X	X
Environ-mental	Geographical location	X	X	X
	Unpredictable and erratic rainfall	X	X	X
	Increased water stress	X	X	X
	Deforestation, flooding, landslide and soil erosion	X	X	X
	Sustained ecosystem degradation			X

[Source: Adapted from Admassie and Adenew, 2007]

Economic dimensions of vulnerability are examined in terms of poverty dynamics, dependence on rain-fed farming, declining productivity levels, increasing food insecurity, rising food crop prices, limited access to markets, low level of technological development, and poor infrastructure.

The extent of the problem of *endemic poverty* is epitomised by an extension worker from the lowland who expressed general decline in living standard of farmers: 'I have been in the field of agriculture for 18 years. All along I saw decline in livelihood.' This comment supports findings of Oxford Poverty and Human Development study[1] that found 71% of total population of Ethiopia to be in severe poverty of which 82% are rural and 21% are urban, thus indicating the extent of rural poverty in Ethiopia. According to the UNDP Human Development Index, Ethiopia stands at 173rd country, the lowest being Niger (187), Democratic Republic of the Congo (186), Central African Republic (195), the highest scorers being Norway (1st), Australia (2nd) and Switzerland (3rd) (UNDP, 2014).

It is notable from the survey data that respondents' self-reported wealth status ranking is dominated by 'medium' as opposed to 'rich' and 'poor' (see sections 4.2 and 4.5). However, this finding is cross-checked with the type of house owned as indicator of one's status and only 28% lived in house with corrugated iron roof considered as status symbol in rural areas owned by relatively richer households. The majority (71%) reported living in traditional hut made of grass roof, which confirms the extent of poverty and thus vulnerability to climatic shocks.

Within the sustainable livelihoods framework, the extent to which individuals or groups become vulnerable to climatic hazards depends on livelihood assets at their disposal. People who lack of assets and capabilities are more vulnerable to

[1] http://www.dataforall.org/dashboard/ophi/index.php/mpi/download_brief_files/ETH

different shocks than those with access to the same. Lack of basic assets is a manifestation of endemic poverty, which contributes to vulnerability to current and future climate change. For smallholder farmers, land is by most critical asset. In this study, the sheer shortage of land is expressed through low acreage per farmer (75% of participants hold a hectare or less), which shrinks with increasing population and limited alternative livelihood options. Ethiopia's land policy, which makes land the prerogative of state, also limits farmers what they could do in terms of using, selling and transferring land. Besides, farmers' vulnerability is heightened by lack of livestock and other forms of capitals.

Study results further reported falling agriculture income and falling livestock numbers and pasture quality. Participants recalled that, in the past, long rainy season kept grass availability intact throughout the year and livestock were sustained. But increased intensity of dry conditions and shortage of grass have affected livestock. The following is what a participant in the midland said: 'The shortage of grazing land and fodder meant that both people and cattle are forced to consume Wesse. The grazing fields of the past are no more; they are all used for farming. We have no place to turn our cattle, therefore we've sold them. Now we have less milk and butter'. Given inflationary pressure, the rise in prices of cattle also meant that those who own cattle prefer to sell them at the expense of household consumption and nutritional needs. The same applies to diary products such as milk and butter. This has implication on nutritional uptake of households, their health and general wellbeing. Stunting in children is real and easily observable phenomenon during the field visits. For those people who managed to keep a few cattle, the shortage of grazing land is reported as a problem. A female participant from highland stated the gravity of the situation by comparing what cattle would do if they were able to complain:

> There is no place to send cattle for grazing. Cattle are in problem just as people are. It is only that they don't talk that we don't hear them complain, but they are in problem. They are in more problems than people.

Under these circumstances, people are caught up in a vicious cycle of low income, poor food availability, ill-health and lacking social protection and susceptible to climatic hazards.

Dependence on rain-fed agriculture is another dimension of vulnerability. Farmers in all survey sites expressed dependence on rain and on other forms of natural resource base which render them prone to changes in rainfall and seasonal shift. The manifestation of vulnerability is expressed in the form of lack of control is told as follows:

> It is already out of their hand. If they plant late, it is useless. So the long-season crops such as maize need continued rainy months. The disruption of rain in one season will cause decline in their annual production. So it is not only the flooding and drought, but rain's delay in timing and its unbalanced distribution, have direct and indirect effect on farming. (NGO participant)

Crops get damaged not only due to lack of rain but also due to excessive rain. Similar conditions were observed in midland Dale district where farmers explained the damages and associated problems of gullies that resulted in loss of land, dissection of farms, and deposition of sediments on growing crops and restriction of movement of animal and people (Osore and Moges, 2014). The problem is worse with the lowlands around Jara where deforestation and over-grazing contributed to gullying and subsequent decline of soil quality exacerbated by continued, non-stop farming of land. In the past, when land was available, farmers used to apply traditional practices of fallowing and crop rotation. Some of these options are not available in contemporary conditions.

The outcome of these conditions, namely, soil erosion that clears fertile topsoil and land degradation is *declining crop and livestock productivity*. The attendant shortage of grass or fodder negatively affected livestock production and productivity. For example, according to the survey data bee keeping in study areas has declined. On the other hand, low endowment in production factors such as land, water and other capital assets, meant that smallholder farmers produce low quantities of products. The result overall, according to the participant for the Zone, is a negative impact on agricultural production and productivity, which translate to increased *food insecurity* and vulnerability. Describing the magnitude of the problem of food insecurity and dependence on government support, a participant from midland intimated:

> … since time immemorial, Sidama people have never seen a problem of such a magnitude … and since last decade we are overwhelmed with problems. In the past, people are used to work, use rain water for farming. They never look for

government hand-outs. They would want to help the government instead. That is all in the past.

Dependence on food aid, even in the form of PSNP or food-for-work package, is mentioned as evidence of food insecurity. As Tiwari (2013) rightly observed, farmers in Sidama were concerned about increasing dependency on food-for-work programmes, which they felt trapped them in a precarious equilibrium.

Food insecurity and vulnerability of farmers in semi-arid lowlands is at its highest during dry seasons when the shortage of water is at its peak. In the months of February and March, the researcher observed water being carried in yellow jerry cans (water containers) by carts, or even trucks, for sale to households (Fig 27 shows road conditions and water scarcity in Jara lowlands). As a last resort, some households in Boricha district resort to Therapeutic Feeding Programmes (TFS) under emergency situations amid food insecurity, malnutrition and poor health.

Human wellbeing is affected by decline in food availability and fall in income from agricultural activity, as per data from FGD and survey questions. These findings are in line with broader comparative study on Africa that SSA is the most food-insecure region in the world with many of the small scale farmers facing numerous challenges, including climate change, resource scarcity, government neglect and severe ecological degradation (Munang and Nke (2011, p.1511).

Rising food crop prices affected those farmers who buy crops for food. According to FGD and semi-structured interviews with farmers and policy makers, rising food prices had pervasive impact on smallholder farmers. Households are not self-sufficient in all their food needs, even if they grow some food crops or cash crops. Studies indicated that high food prices will increase the vulnerability of the very poor, with the nature of vulnerability dependent on the distribution of wealth in society (Adger *et al.,* 2004), which is exacerbated by negative terms of trade between agriculture and other economic sectors, mainly manufacturing. In this context, farmers reported disadvantage flowing from fast rising cost of industrial goods compared to slowly increment in the prices for their produce (Tiwari, 2013). On the other hand, marginal increase in food crop prices reflects the rising cost of production, particularly the cost of fertiliser and seeds. The following

account by a district official reflects farmers' predicament with the rising cost of fertiliser.

> They are complaining of high prices of fertiliser. It is beyond their ability to pay. They don't have other alternatives. The land does not yield without fertiliser. Especially, the hybrid seeds require fertilisers. Generally, soil fertility has declined making it necessary to use fertilisers. The rising prices of fertiliser is causing further problem for farmers. (Participant from highland district)

Failure to adapt new technologies due to high risks to farmers involved in taking up relatively expensive new technologies, including fertiliser, without insurance against harvest shortfalls are also noted in other studies, for example, Krishnana and Patnamb (2012). Yet farmers in study areas appear to have no option other than purchasing high price inputs (often on loans, hence debt) to stave off starvation.

Low level of technological development characterises smallholder farmers. In the study areas, the technology used by farmers for production, storage, transport and distribution of their products is rudimentary, and remained so for centuries. In the study areas, farming is largely undertaken by man-power except in the lowlands where oxen are used for ploughing. Most of the tasks are labour intensive. Storage too is undeveloped. The lack of all-weather roads connecting rural communities with one another or to urban areas is further complicated by climatic hazards, making it hard to speedily exchange produce when heavy rain is involved. Dry months, on the other hand, are accompanied by heavy dust on roads resulting in health hazards – especially diseases affecting eye and lung. Sight problems, especially trachoma, and problems linked with inhalation were observed. Eventually, the distribution of products under such circumstances is badly affected adding to vulnerability of the people involved.

Farmers have *limited access to markets*. The study reveals that well functioning and modern markets, both for input and output, hardly exist. Inputs such as seeds and fertiliser are supplied through government channels while agricultural produce is sold to local markets. At the village levels, open field markets exist (as shown in Figure 26) using customary measurement tools due to lack of access to scientific measurements of weight such as kilograms. In the nearby towns, traders use

scientific instruments, but the towns are found in considerable distance from the farmers.[1]

Figure 22: Open field rural market in Hula

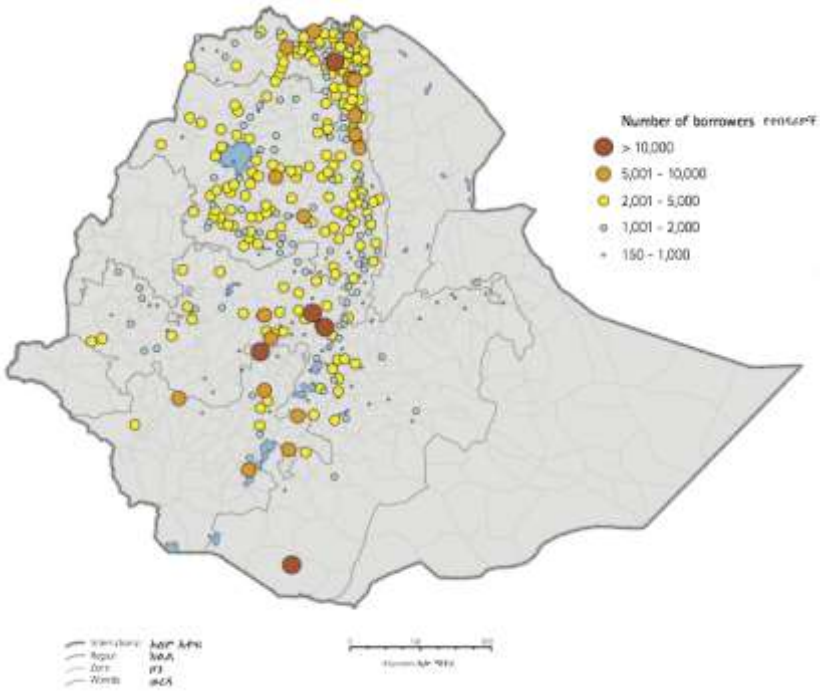
[April 2012]

Market access was also difficult because of poor infrastructure related to the quality, condition and density of roads, which weakened the ability of smallholder farmers to transport cash crops and to access markets.

Parallel to undeveloped product markets, financial markets are pretty undeveloped in the study areas. Consequently, there has been limited scope for credit and insurance services to redress farmers in case of crop failure due to flooding or drought. Studies confirm that smallholder farmers in Sidama are least beneficiary from microfinance institutions compared to other areas of Ethiopia (Fig 27). For examples, results of the national study confirmed that 'rural borrowing is much more concentrated in the central highlands, especially eastern Tigray and Amhara, than elsewhere' (IFPRI, 2006, p.29).

[1] In the case of coffee trade, the establishment of Ethiopia Commodity Exchange (ECX) in 2008 seems to improve coffee marketing conditions. ECX has not only started trade functions in regional locations closer to the farmers but it also built storage facilities. Large coffee marketing storage depot is built in Hawassa in recent times, replacing the previous situation where coffee was stored and sold in Addis Ababa, which is over 275 kilo metres away from Sidama.

Figure 23: Distribution of microfinance institutions in Ethiopia



(Source: Atlas of Ethiopia)

Even if microfinance is made available to smallholder farmers, recent literature spells doubt on its efficacy. For example, a study from north Ethiopia noted that microfinance intervention helped livelihood diversification in urban areas than rural ones. In the case of the latter, the study recognised the contribution of loan to asset building, women empowerment and an increase in income, although it was used for consumption smoothening (Eshetu, 2014).

Poor Infrastructure is a notable feature of the study areas where farmers faced poor road networks and unreliable storage and distribution systems. For example, people in Jara lowland use horse cart as a means of transport for goods and people. The researcher observed people transporting water in carts and trucks at a cost of 20 to 30 birr per jerry can of water (Fig 28). The need for this mode of transport appears to rise in the months of January to March – reportedly difficult times for the local population.

Figure 24: Road conditions near Jara area

[Hawassa Zuria District, February 2012]

Elsewhere in Africa, it is reported that logistical problems forced farmers to grow their own food and less of perishable commodities causing lower productivity (Co-operative and Enterprise Development Directorate, 2012, p.1). Road transport exits in Sidama, yet most of the rural roads are hard to use during the rainy seasons.[1] For the population of over 3.5 million, there is neither an airport nor air transport service. There is also **no** railway transport network at the time of the research.

Social dimensions of vulnerability are observed and reported in all study sites. They included high population density, increased conflict, weakening of social cohesion, changing livelihood pattern, high incidence of diseases, weak institutions, and political setups, and marginalisation in decision-making.

High population density in Sidama is one of the highest in the country (506 people per square km) (chapter 1.3). The sustainability of such a high density of population, given the current production and technical and livelihood options, is doubtful. Concern about sustainability persists in spite of the argument that high population density leads to increased intensive utilization of land and mixed systems that are more efficient than specialized crop or livestock systems (McIntire *et al.*, 1992 quoted in Ghirotti, 1998). On the contrary, with rising population, marginal land is cultivated further reducing the option to keep

[1] The researcher observed asphalted roads being built linking some districts although the durability of the all-weather roads remains a challenge in terms of maintenance and quality.

livestock. The situation is not dissimilar to trends in highly populated regions elsewhere. A recent study on Wolayta identified cases of steady decline in livestock holding and increasing pressure on land as key challenge of human livelihoods (Eneyew and Bekele 2013).

The problem is very much similar to the farmers in the study areas. A participant from the highland problematized the issue of population density as follows: 'Human birth in the past was small. As human birth has increased without commensurate increase in land size, there are now many problems for people. Too many problems.' The study areas are obviously under pressure from population growth. The resultant large family size appears to contribute to vulnerability when combined with higher dependency ratio, i.e. higher proportion of dependent members of family compared to productive and active labour, and operating in the context of inefficient use of natural resources. Farmers themselves are forthcoming to problematize population growth in a way that underscores the Malthusian worldview which is not limited to Sidama. For example, a study carried out in 2008-2009 in Oromia and the SNNPR regions (Kidanu *et al.*, 2009) noted expression of similar views by farmers:

> ... if a family has limited children, he will have enough land for his kids and hence we can protect the forests... in earlier years, we had a lot of fallow lands, but now, as a result of population growth, we don't have adequate fallow land. (Rural community member, SNNPR)

Diminishing landholding translates to decline in natural capital, especially, commonly held resources. The rural communities used to rely on common property resources including pastureland, agricultural land, forests and water, all of which are under stress due to combined impacts of population and climate change. In this connection, it is recognised that, in addition to the possible impacts of climate change on these resources, there have been significant changes in access to common property resources at some of the study sites. For example, communal pasturelands in the midland study site were converted to either farmlands or given to investors that use them as private commercial property. On the other hand, communal forests disappeared in all study sites with few exceptions of forests of local religious interest in a pilot study site at Wonsho district. Indigenous or native tree species known for maintaining moisture are on decline being replaced by alien or exotic species such as eucalyptus trees. At the same time, commonly used

water sources such as rivers and ponds faced reduction in size during extended warm conditions impacting on the welfare of human and livestock populations.

In addition to strained common property resources, traditional conservation practices are also compromised. For example, farmers in the study sites abandoned rotation cropping that was practised in the past when land was plenty and population density was moderate. With heavy population density and growth, these conservation measures appear to be no longer practised. When different sites are compared, the story of shortage of grazing land is stark in the lowland as the following complaint demonstrates: 'We wonder why the government which cares for wild animals in parks is not looking after the needs of our livestock which provides us with milk and butter' (Participant from lowland). The same farmer applauded Ethiopian government's efforts at improving health access and coverage, but blamed inflation as a problem:

> We were pleased with the departure of the Derg. Our children had milk. Mothers are getting attention. Babies are weighed … they are cared for while they are in the womb; they are delivered safely without problems. They grow without problems. Now what is a problem is inflation, the cost of maize seeds and fertiliser has skyrocketed. (Participant from lowland)

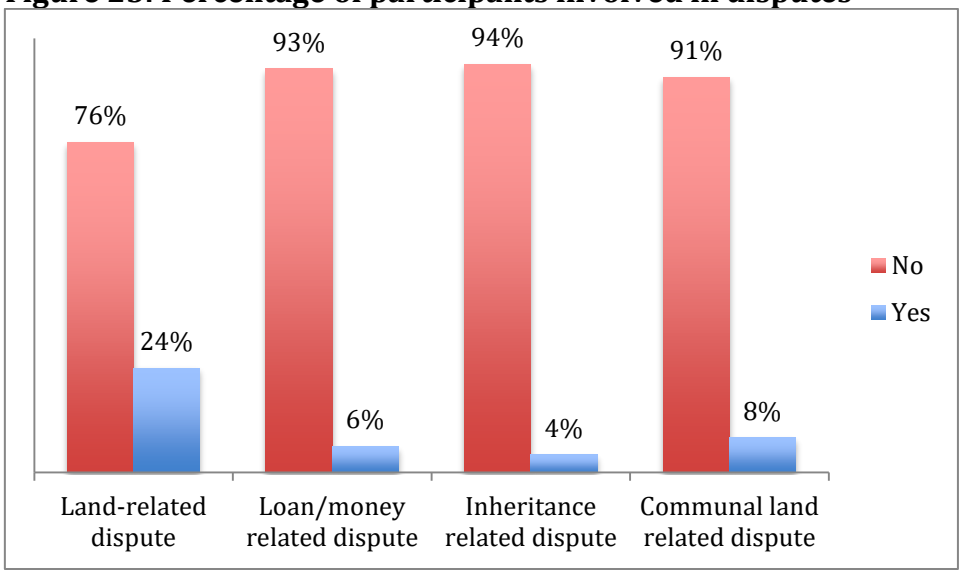
Increased conflict[1] emerge less as a factor of vulnerability to climate change in this study. Survey responses showed that a quarter of the respondents acknowledged disputes or conflict (Fig 29). Among the factors that threaten social cohesion, land related disputes account for 24% followed by communal land related disputes (8%). Money and inheritance related disputes accounted for 6% and 4%, respectively.

In terms of AEZs, Awaada reported higher percentage of communal land related disputes and inheritance related dispute than the other two sites. This locality used to have large communal grazing field called Awaada Xawo. In recent years, the government allocated the community land for investors and, as a result, people lost vital community resource. The privatisation of commons land thus resulted in an important loss of livelihoods assets for the community, namely grazing for livestock. As the consequence, farmers were compelled to reduce the number of

[1] The study assumed involvement in disputes as a proxy for social conflict.

livestock they use to get diary products and income generation that would support livelihoods at times of climatic stress.

Figure 25: Percentage of participants involved in disputes



[Source: survey data, 2012]

On the other hand, Jara reported higher percentage (27%) of land-related disputes. Indeed, the FGD in Jara has clearly highlighted the conflict dimension of climate change. There, participants clearly pointed to conflict or even violent fighting for access to pastureland with what the local residents call 'Aruse' Oromos. In these and other areas, tension over grazing lands often existed for generations in Sidama border areas with some of the neighbouring ethnic groups. Climate change seems to aggravate the conflicts by worsening the quality, quantity and availability of resources (mainly land, water and pasture).

With the exception of Jara, the results from survey data on social conflict could not confirm earlier studies and reports that relate vulnerability to climate change with the escalation of conflicts. Declining rainfall and accelerated evaporation due to rising temperature are known to reduce water supply. The subsequent loss of water supply coupled with food insecurity may lead to increased conflict. In the case of Kenya, for example, the Earth Watch Institute (2009) cited territorial disputes, increase in cattle raiding and violence over receding water bodies. Furthermore, a report exploring the link between climate change and national security from the U.S. perspective drew attention to issues such as water, food, and health security, humanitarian crises, disruptive migration, severe political

instability and state failure, and interstate and intrastate conflict and violence[1] (Steinbruner *et al.*, 2013). Another study cited West Africa, the Nile Basin and Central Asia as areas where climate-related shocks have sparked violent conflicts in the past and the problem remains a serious risk (Stern, 2007). Within Ethiopia itself, a study into resource-based inter-ethnic violence established the impact of social mobilization in stoking underlying communal cleavages, breaking trust and cooperation and in escalating communal unrest where 'ethnic competitors failed to minimize mutual harms and maximize mutual gains' (Hussein *et al.,* 2014).

In most circumstances, the result of violent conflicts is heightening vulnerability, since once unleashed, violent conflicts directly impact on livelihoods; they also compound vulnerability to climate change. At the same time deteriorating livelihood options exacerbate theft, robbery, corruption and conflict. Again examples abound from Ethiopian history. The 1974 violent revolutionary change of regime was preceded by drought and attendant famine in the then Wollo province. The 1984 drought and famine that affected Tigrayan areas led to the escalation of violence and violent change of regime in 1991. In both cases, famine was 'manufactured' with some climatic input such as drought or failed harvest.

However, the survey data[2] for this study did not amplify conflict. The results could be interpreted in two ways. First, the respondents could have been influenced by 'social desirability bias'[3] where people report less of what they consider as socially undesirable actions/behaviour or to respond to questions in a socially acceptable direction. Secondly, even if there were no bias, people would rank risks of social cohesion at lower scales given their social values and goals. In the case of Sidama, the value attached to social (even spiritual) capital is so high that reporting its decline may indicate some form of social failure. Tension, however, prevails in all levels of society to maintain social cohesion in the face of multiple stressors including climate change.

[1] These approaches are criticised as dystopian account that climate change leads to conflict, causing state failure and mass population movements' (Verhoeven, 2011).
[2] It seems that social conflict and tension come out more clearly through qualitative data than the survey.
[3] Social desirability bias is the tendency of respondents to answer questions in a manner that will be viewed favourably by others, for example over-reporting desirable behaviour or under-reporting undesirable behaviour. In the cases of self-reported responses, especially questionnaires, the bias interferes with the interpretation of average tendencies. (http://en.wikipedia.org/wiki/Social_desirability_bias).

High incidence of diseases: Changing climate has implications on different aspects of life including plant, human and animal health. The emergence of malaria in the highlands of Sidama is a new phenomenon. For example, anopheles mosquitos that transmit malaria parasite have been observed in the central highlands of Kenya, where malaria-bearing vectors have not been recorded previously (Munga *et al*., 2006; Chen *et al.,* 2006). Increased temperatures and more prolonged rainy seasons may extend the transmission period of the disease (Juana *et al.,* 2013).

Survey data results showed that 76% of respondents rated the incidence of malaria to 'medium' to 'very high' (Table 12).

Table 13: Survey data on health experience

Variable/Household characteristics	Frequency (%)	Xexicha	Awaada	Jara
Current incidence of malaria				
1. Very high	18 (15.0)	5.0%	17.9%	22.5%
2. High	27 (22.5)	30.0%	23.1%	15.0%
3. Medium	35 (29.2)	15.0%	38.5%	35.0%
4. Low	39 (32.5)	50.0%	20.5%	27.5%
Incidence of water borne diseases (e.g. diarrhoea) related to flooding				
1. Very high	8 (6.8)	7.5%	2.5%	10.5%
2. High	27 (22.9)	30.0%	27.5%	10.5%
3. Medium	34 (28.8)	35.0%	20.0%	31.6%
4. Low	49 (41.5)	27.5%	50.0%	47.4%
Incidence of respiratory diseases (e.g TB, asthma)				
1. Very high	5 (4.2)	12.5%	0.0%	0.0%
2. High	16 (13.3)	35.0%	2.5%	2.5%
3. Medium	32 (26.7)	27.5%	27.5%	25.0%
4. Low	67 (55.8)	25.0%	70.0%	72.5%
How do you rate your general health well being?				
1. Very Poor	1 (0.8)	0.0%	0.0%	2.5%
2. Poor	17 (14.2)	7.5%	22.5%	12.5%
3. Good	67 (55.8)	67.5%	40.0%	60.0%
4. Very good	35 (29.2)	25.0%	37.5%	25.0%
Sanitation				
1. Open field	4 (3.3)	7.5%	0.0%	2.5%
2. Toilet near home	88 (73.3)	70.0%	80.0%	70.0%
3. Toilet in home	28 (23.3)	22.5%	20.0%	27.5%
Water supply source				
1. Deep wells	7 (5.9)	0.0%	12.8%	5.0%
2. Pipe	79 (66.4)	50.0%	64.1%	85.0%
3. River	31 (26.1)	50.0%	23.1%	5.0%
4. Rain	2 (1.7)	0.0%	0.0%	5.0%
Average walking distance to water supply source				
1. Very Poor	4 (3.4)	2.5%	5.1%	2.5%
2. Poor	17 (14.3)	20.0%	12.8%	10.0%
3. Good	35 (29.4)	22.5%	25.6%	40.0%

4. Very good	63 (52.9)	55.0%	56.4%	47.5%
Access to health services/ **Hospital**				
1. Very Poor	7 (5.9)	17.5%	0.0%	0.0%
2. Poor	11 (9.2)	2.5%	7.5%	17.9%
3. Good	63 (52.9)	52.5%	35.0%	71.8%
4. Very good	38 (31.9)	27.5%	57.5%	10.3%
Access to health services/ **Clinic**				
1. Very Poor	2 (1.7)	5.0%	0.0%	0.0%
2. Poor	7 (5.9)	2.5%	0.0%	15.4%
3. Good	90 (75.6)	70.0%	77.5%	79.5%
4. Very good	20 (16.8)	22.5%	22.5%	5.1%
Access to health services/ Community health centre/station				
1. Very Poor	1 (0.8)	0.0%	0.0%	2.5%
2. Poor	5 (4.2)	2.5%	2.6%	7.5%
3. Good	71 (59.7)	50.0%	66.7%	62.5%
4. Very good	42 (35.3)	47.5%	30.8%	27.5%

[Source: survey, 2012]

A third of them rated 'low.' Xexicha highland reported the lowest incidence although it is more alarmed by emergence and spread of mosquitos, some of these could be non-malaria bearing mosquitoes – which needs further research. Incidence of water borne diseases due to flooding and incidence of respiratory diseases rank lower. A fewer percentage ranked their general health as poor or very poor, perhaps a case of social desirability bias mentioned elsewhere in this book. The same applies to sanitation whereby having toilets inside a house are exception and not a general rule. Open defecation is widespread although extension workers and Kebele officials were observed in some sites, for example, in Jara, encouraging people to build latrine pits in their gardens or close to their huts. Moreover, health is closely linked to water supply. A quarter of the respondents collect water from rivers that are susceptible to contamination due to coffee processing plants, washing clothes in upstream areas, and feeding the same to animals.

In particular, most of the rivers that flow through the midlands are polluted by primary coffee processing and yet people collect drinking water from unsavoury places without proper chemical treatment. Moreover, respondents from the lowlands reported using *rainwater* for domestic consumption unlike the highland and the midland. Most respondents are satisfied with the distance they travel to fetch water, but the case of Jara lowland is slightly different from the other two sites.

Access to health services (hospitals, clinics, and local health stations) is ranked as 'good.' Clinics are rated above hospitals and health stations. This could be due to low number of hospitals around the study sites, or due to ineffectiveness of health stations.

Qualitative data also stressed a link between higher temperature and human health in general and mental health in particular. So far, scholarly focus has centred on climate change and physical aspects of human health such as malaria, water and vector borne diseases, and heat waves. Less attention is given to climate change impacts on mental heath. In this study, this less explained health condition emerged in FGD and semi-structured interviews in the form of distress and hopelessness. Among the experts,[1] the condition is called solastalgia to describe a sense of distress people experience when valued natural environments are negatively transformed (Doherty and Clayton, 2011; Albrecht *et al.,* 2007). It is the distress produced by environmental change impacting on people while they are directly connected to their home environment as opposed to nostalgia (which is the homesickness experienced by individuals when separated from a loved home). Solastalgia is evident in the narratives of farmers in all localities surveyed. In one such case, a participant remembered the past: 'These were years of prosperity, where we get plenty, and take good care of our families' (FGD participant from midland). When the environment people have known and lived is gone, they feel homesick, yearning for former environment (Albrecht *et al.,* 2007).

In addition to the loss of what they have known, participants in semi-arid lowlands of Jara associated increased temperature and heat waves with speedy ageing and untimely grey hair on men and women. They contrasted the speed of getting grey with slower process of ageing in higher altitudes where temperature is relatively cool. It appears the first time that a link is hinted, but empirical evidence is yet to establish the link between climatic stress and ageing.

Weak institutions and marginalisation in decision-making: In terms of political decision making, Sidama is less connected to the core decision making within the ruling EPRDF regime, hence the society at large possesses less social capital, but

[1] The term first used by Glenn Albrecht, Australian philosopher, and his colleagues.

has strong internal connections and networks that include the spiritual dimensions.

The lack of independent civic associations in the rural areas to empower farmers is one source of vulnerability to both political and market shocks. The EPRDF government structured its political functions in such a way that it controls all levels of society. Farmers at the village or Kebele level are encumbered by 'one-to-five' political formation. They were organized into either the one-to-five system or political 'party cells'. The origin of such structure lies in post-2005 elections when EPRDF was threatened with defeat in the polls. The model of 'one-to-five' where one party member recruits five new people helped mobilise larger membership for 2010 elections in which the incumbent and its affiliates won 546 of 547 seats. During and after the fieldwork, the scaling up of this political structure to economic and social institutions is visible in state's reach and overreach into deeper realms of societies, as in the case of post-1994 Rwanda where hierarchical state structures were reported to branch extensively into rural life (Ingelaere, 2014). The impact of such control and surveillance mechanisms on farming communities is further undermining of their voice and independent representation.

Despair and fatalistic worldview as expressions of deep sense of vulnerability is expressed in more than one instance as the following quotes state: 'We are only looking up to God and government. God wouldn't let this to continue' (Participant from lowland). Another participant added: 'If God and the times do not permit, nothing can be done. Unless there is rain, what can we be expected to do?' (Participant from midland). Such views explain the depth of vulnerability to external shocks including climatic hazards. They also reinforce the sense of despair that may undermine human agency.

Environmental dimensions of vulnerability are expressed in terms of geographical location, unpredictable and erratic rainfall, increased water stress, high deforestation, flooding, landslide, soil erosion, and sustained ecosystem degradation.

Geographical locations exhibit different levels of vulnerability. According to data in this study, all AEZs exhibit different levels of vulnerability. For example, living in the lowlands of Jara predisposes smallholder farmers to some climatic risks than others. The location in the Rift Valley system, the type of soil, temperature and rainfall amount all account to varying degree of vulnerability.

Unpredictable, erratic rainfall and water stress are widely reported heightening the vulnerability of smallholder farmers. Water stress is reported in the form decline in water availability and amount of rainfall, having negative effect on agricultural production and food systems.[1] Both conditions are severe in some areas than others. The most affected are the lowland of Jara Galalcha. Water stress is experienced not only in the lowlands but also in the highlands, which normally receive larger amount of rainfall. A district official from highland related the story as follows:

> Huge problem emerged. First, the wells are drying. Water is in short supply. This means it is hard to keep cattle, it is hard to grow crops. People cannot get enough food. Cattle cannot get grass in time. It used to rain heavily in mid-February, followed by greening of grass by March and April. But now [in April], there is no rain, and people are using enset leaves as fodder for cattle. Even this is possible only for those who have enset, those who don't have, they have nothing to feed cattle.

A participant from the regional agriculture bureau raised similar issues to substantiate the claim by district officials and farmers: 'The problem is already visible this year. When it comes late, then it rains in large quantity, sometimes it is disrupted and unevenly distributed. Farmers start planting when small rain starts, but when it stops all the crops planted will die.' Indeed, the drying up of wells is not limited to availability of water, but also the growth of a controversial tree, eucalyptus. The following is pictorial evidence from Xexicha of a dry well due to planting of eucalyptus tree near the water well (Fig 30).

[1]Food systems refer to the 'chain of activities connecting food production, processing, distribution and access, consumption and waste management as well as all the associated supporting and regulatory institutions and activities' (Munang and Nkem, 2011, p. 1511).

Figure 26: Dry well in close proximity to eucalyptus plantation

[Xexicha, 15 March 2012]

Although Xexicha is a highland where it was rare to think of water shortage, people complained of water stress in some seasons. They said that they travel far in search of water for their own and livestock consumption; and the problem was partly addressed when World Vision (NGO) built pipes in village.

High deforestation, flooding, landslide and soil erosion are related indicators of environmental vulnerability. These factors are more evident in the lowlands than in the highlands. Studies found similar patterns in the lowlands adjacent to Sidama. For example, Pound and Jonfa (2005, p.1) and Jufare (2008) observed that continuous and repeated use of land led to declining soil fertility in Wolayta. They reckoned that the root causes of decline in soil fertility in Ethiopia are a) impoverishment of farmers due to high taxes and a lack of support to small scale farmers imposed by successive regimes, b) the lack of confidence that farmers have in land as a permanent asset, c) increased pressure on land due to increased population, and d) a reduction in livestock numbers (and therefore manure) due to drought, disease, forced sale and lack of feed.

In the past, the relative abundance of pasture allowed farmers in the highland to raise large numbers of livestock, including horses that supply most of the transport in this zone (Ghirotti, 1998). However, as the pressure on land has increased,

rearing horses became equally difficult. Yet the demand for animal means of transport is bound to reduce with the construction of rural roads and introduction of modern transport.

Decline in soil fertility in low-lying areas of Sidama is apparent. Pictures taken during the fieldwork show visible land degradation (Fig 31). A similar trend is identified by a study conducted in Wolayta between 1991 and 1999, which listed several factors that contributed to land degradation. They included the clearing of forests, removal of crop residues from fields, land fragmentation, the reduction of fallows, overgrazing, low fertiliser inputs, inadequate soil and water conservation, the cropping of marginal land, and poor soil management (Pound and Jonfa, 2005, p.1). The result, according to the same study, is lower crop yields and livestock numbers, leading to reduced food security and increased poverty.

Figure 27: Land degradation & flooding

[Boricha District, February 2012]

Figure 28: Road formed by gully erosion

[Hawassa Zuria District, 16 June 2012]

Large-scale flooding and soil erosion is reported as a problem in low lying Hawassa Zuria district, especially the area called Maqbasa.[1] As the picture below shows (Fig 32) a wide road extending from 20 to 30 metres was 'constructed' by gully erosion. The soil from these eroded lands was ostensibly carried onto Lake Hawassa resulting in siltation, rendering the lake considerably shallow. A recent study confirmed that gully erosion due to vegetation removal from the watershed is the most threatening factor of degradation in the area (Gebretsadik, 2014).

[1] Maqbasa is a village in Hawassa Zuria district, adjacent to Oromia region. The picture shows a large road made by erosion.

An expert who studied the area noted that the de-vegetation around Hawassa led to the exposure of the land surface to wind and soil erosion. 'Thousands of tons of soil has been washed and entered the western and northern parts of the lake. Hence the lake is expanding not because of the increase in the amount of rainwater, but because of siltation. The lake is getting shallower' (NGO participant).

Flooding and soil erosion: The following pictures were taken towards the end of the fieldwork when heavy rain caused flooding around the study sites. Figure 33 shows the impact of excessive flooding which wiped away newly planted crops. Figure 34 shows landslide and soil erosion in Maqbasa, in Hawassa Zuria district close to Jara site. Most of the eroded soil from these areas enters lake Hawassa, causing siltation and risking the lake's ecosystem.

Figure 29: Flooded plains in Jara

Figure 30: Gully erosion near Maqbasa

[Hawassa Zuria District, 1 May 2012]

Sustained ecosystem degradation: Extreme heat and extended dry season in the lowlands affects crops, trees and livestock. Even the eucalyptus trees, supposedly the strongest in moisture capture capacity, are prone to damage. The shortage of rain compounded by rising price of seeds and fertiliser has negatively affected farmers. The problem worsens with rain failure since farmers who purchased fertiliser and seeds in anticipation of rain will loose. There is no weather-indexed crop insurance that guards farmers against loss to climatic hazards in Ethiopia. A participant recounts:

> What people produce gets damaged …. People do things. Some would borrow from government to buy fertiliser and hybrid maize seeds. When crops fail, a farmer is left with empty hands. Wealthy farmers, who have their own cash, buy their own seeds. This group will also lose …. Farmers are now saying that it is not possible to develop

> by farming land; therefore they use their land to grow feed for livestock and continue on that path. People are pursuing such alternative paths – paths of laziness. (Participant from highland)

An interesting phrase here is the 'paths of laziness.' For rural communities, farming is not only livelihood but it is also the way of life. Hence diversion from farming is considered as the path of laziness.

Mention is also made of environment pollution caused by coffee processing adding to farmers' vulnerability to health impacts which is supported by empirical evidence elsewhere. For example, research by Beyene et al (2012) into the impact of traditional coffee processing on river water quality in Ethiopia concluded that 'physicochemical and biological results revealed a significant river water quality deterioration as a result of disposing untreated coffee waste into running water courses.' The above analysis showed the various dimensions of vulnerability of smallholder farmers to climate change. Yet the impacts on different social groups and ecosystems vary – the subject of the next section.

6.4 Highly vulnerable groups and systems

Results from qualitative data shows that the most vulnerable are the poor, the marginalised, female-headed households, people with low or no literacy, and low technological capability as well as children and old people. Moreover, annual crops are more vulnerable than perennial plants – in effect those farmers who rely on annual crops are more vulnerable than those diversify into perennial plants.

Poor farmers appear to be most vulnerable for having low asset and resource base. For example, field visits to lowland areas showed that poor households do not have access to safe water supply. The shortage of water compelled people of Jara residing in the vicinity of Lake Hawassa, to collect and drink water from the lake. The water contains fluoride and nitrate acids that damage teeth and bones.[1] The damage was widely visible on young children who have brown, often disfigured teeth. In addition lack of safe water makes them vulnerable to other water borne diseases. Moreover, FGD showed that most poor farmers depend on PSNP's food

[1] This is also an area in need of further exploration.

for work programme. Their poverty translates into poor health and undernourishment. They are the ones who resort to petty trade including selling of firewood by cutting trees from what remains of the commons. Comparing this group with the relatively rich farmers, a participant noted that:

> People with good income, don't rush to cut trees, … or do not tend to get hurt. Thus areas widely affected are those inhibited by lower income groups, and those which are not occupied by durable crops. (Zone participant)

Furthermore, poor smallholder farmers face inherent vulnerability owing to size and the nature of production and productivity. Such vulnerability is related to small size or scale of activity and poor access to technologies or poor use of external inputs. Cases were also observed that poor farmers occupy marginal lands that are susceptible to flooding and soil erosion.

Marginalised people are more vulnerable. People in a society get marginalised due to socio-cultural and related reasons. They can be marginalised and discriminated on the basis of a number of features. For example, one's location or means of earning a living determines their vulnerability to climatic shocks. Similarly, membership to ethnicity is a factor of vulnerability. While most of the survey respondents in this study are from Sidama ethnicity, they encountered historical marginalisation as a collective group in Ethiopia. In spite of its significant contribution to national coffers through coffee trade and revenue, what is clawed back to Sidama community in the form of investment in development and infrastructure appears to be relatively insignificant. For example, the technology used in rural areas remains undeveloped without meaningful economic transformation. Field observations also showed people using archaic tools in the markets including measurement tools. It is recognised that when vulnerable groups are often marginalised and excluded from decision-making, the space they occupy becomes invisible or peripheral (Adger, 2003b). Moreover, their social status and class become marking features of marginalisation as studies elsewhere attest. For example, in their study of environmental policy decentralization in Nepal, Agrawal and Gupta (2005) discovered that richer and upper class households had a higher probability of joining user groups tasked with environmental decision-making and distribution of benefits from environmental

resources whereas institutional arrangements and design principle disadvantage poorer members of communities.

People marginalised by political processes face unique vulnerability factors. Rural people live in distance from urban centres where most decision-making takes place. Studies have shown strong link between poverty and remoteness from urban centres (Carney 1999). Rural people are isolated from economic opportunities; they also face poor infrastructure and poor marketing. The fact that most of the rural-based smallholder farmers suffer from political and administrative inexperience renders them vulnerable to political and bureaucratic capture.[1]

Gender, age and education are indicators of the degree of vulnerability. In this study, female-headed households are vulnerable due to lack of productive labour, even when they had land and livestock. The following is an explanation of the problem by NGO participant:

> So what they [female heads of household] do is, they share their farm or give part of it to other people [male farmers] who prioritize their own farms and only revert to the women's farm as a second priority in a rush to keep to the rain pattern…. Even if the farmland is prepared, it is possible that planting does not take place and the land remains vacant or unused. Unless they have grown up children in their household, women-headed households will be vulnerable. (Participant from NGO)

Results from survey data suggested that families or households headed by women are more likely to report higher risk of vulnerability to climate change than men (Table 13) although the statistical significance of these results is small due to small sample size and small percentage of female respondents.

Table 14: Gender and vulnerability to climate change

a) cross tabulation by gender Is climate change as a problem?	Gender		Total
	Male	Female	
No	26	1	27
Yes	80	10	90
Total	106	11	117

[1] Political capture occurs when government agencies are infiltrated by groups that governments exist to regulate. When political interests capture benefits and control access to economic levers, economic policies could as well be derailed from targeting pro-rural and pro-poor growth.

b) Variables in the Equation		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	HGENDR(1)	1.179	1.073	1.207	1	.272	3.250
	Constant	1.713	.536	10.201	1	.001	5.547

a. Variable(s) entered on step 1: HGENDR

On the other hand, female headed households' vulnerability is intense due to lack of access and entitlement to resources (mainly land and labour) in a culturally dominant division of labour. Moreover, most female headed households happen to be widows and some times widowhood (*gunnimma*) is associated with low social standing as per local custom adding to their vulnerability. At the same time, women's role to fetch water and fuel wood for cooking and heating in the face of declining commons and degradation of environment reduces their coping and adaptive capacity. The following female participant described the role of women as stewards of natural and household resources and at the forefront of day-to-day challenges of survival:

> People here are in big problem. As men do not go out to the market, and find out prices, we (women) know a lot, a lot (...). We are sure of what was called the Wollo famine [of 1980s] is coming to us. Our problem about high cost of living is great. Even in terms of bread, what used to be bought for a shilling or below is no longer available now for that price. We pay 1 birr for a piece of bread which is not enough for a little child to eat. (FGD participant from highland)

Qualitative data also showed that women are disproportionately affected by increased temperature (mainly heat waves) and related health problems, as the following participant to FGD explained:

> Just yesterday, in my village, many people were rushed to hospital last night. The patients complain of heat and they collapse. In the morning, another person is taken to hospital. The cause for all is heat. They complained of heat and removed their clothes … and then they collapse. They also complain of diarrheal and vomiting (…) One of the women was not able to talk and she only talked upon return home. (FGD participant from midland)

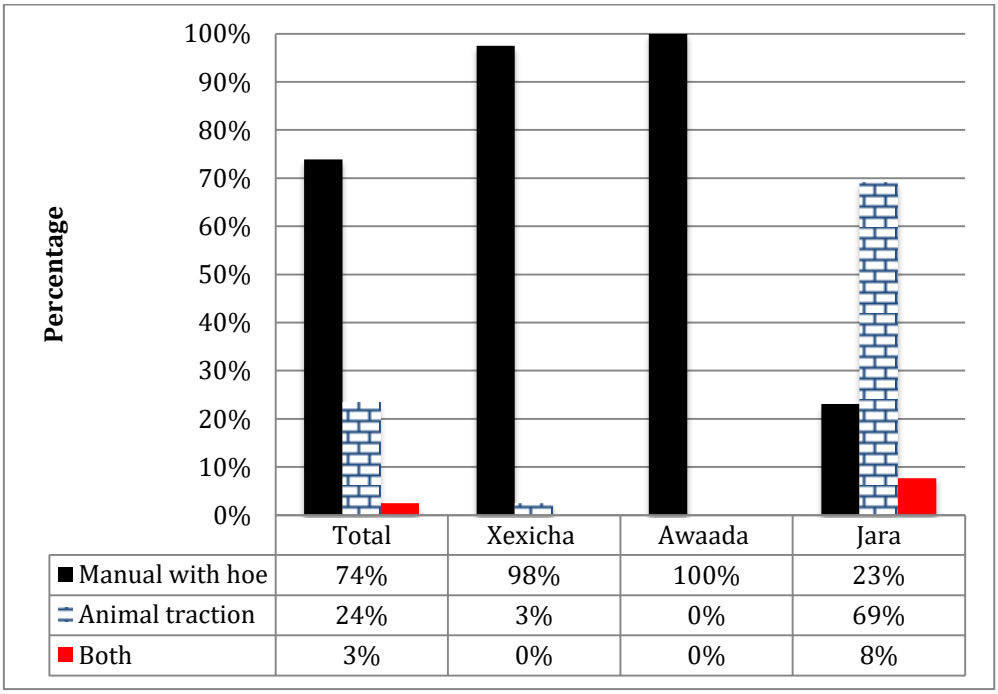
Generally, increased vulnerability of women and children to climate change related hazards is linked to their low access to resources, education, and assets, and lack of empowerment. Other studies (Admassie *et al.*, 2008) also confirm the finding that female-headed households as particularly vulnerable to climate change given greater constraints to adaptation than male-headed households.

People with low levels of education and those who are illiterate, and those with low technological know-how are said to more exposed to the risk of climate change. Education is strongly related to poverty and livelihoods. Thus, populations with overall low levels of education are more likely to depend on climate-sensitive economic activities such as agriculture (Adger *et al.,* 2004).

Location or AEZs express the degree of vulnerability*.* In this study, semi-structured interviews with participants from zone and regional government offices revealed informal assessment of vulnerability of specific areas. They expect farmers who farm highly degraded lands in lowland areas are particularly prone to drought and possible hunger conditions. The areas most vulnerable in Sidama are areas to the west of the Addis-Moyale main road involving all or parts of Hawassa Zuria, Borricha, Shabadino, Daalle, Cuuko, Darra, Lokka Abaya district. These areas face dangerous climate conditions. The soil types in areas close to Hawassa are highly erodible, sandy or made of volcanic ash. Moreover, rural areas of Hawassa Zuria and Loka Abaya, and Boricha districts face high water shortage. In some of those places, Goal Ethiopia (NGO) had programmes providing assistance on food security and basic needs programmes, yet it had no direct climate change or environmental intervention.

Farmers caught up in primitive technology are susceptible to climatic hazards. People with low technological capabilities are more vulnerable to climate change. Most farmers in the study areas are caught up in low level of technological development. Survey data showed that in terms of technology applied to farming, most (74%) use primeval tools such as manual hoe while only 23% used animal traction (Fig 35). This is very much in line with the statement that smallholder farmers production systems are characterised by 'simple, out-dated technologies, low returns and high seasonal labour fluctuations. (Co-operative and Enterprise Development Directorate, 2012)

Figure 31: Farming methods and tools



	Total	Xexicha	Awaada	Jara
Manual with hoe	74%	98%	100%	23%
Animal traction	24%	3%	0%	69%
Both	3%	0%	0%	8%

The technology of tillage is largely manual (74%) while 24% of respondents reported using animal traction. No tractor use is reported. In the highlands and midlands, hand hoe is the major tool of farming while in the lowland such as Jara, the use draught animals is a common practice. Compared to manual and hoe, the use of draught animals is both labour and time saving.

Annual crops: Agriculture in general and farming in particular is vulnerable to climate change. Within farming activity, annual crops are more vulnerable susceptible to climate change than some perennial trees. Among perennial plants, the case of coffee is different, for it forces its growers to face double exposure of global coffee market prices and climatic shocks. According to a study for US Government,[1] coffee growers were impacted by supply and demand factors when coffee prices descended to historical low in 2002-03. On the supply side, climatic and other factors beyond the control of farmers constrained production.

On the demand side, fluctuating coffee prices were determined at international markets beyond the control of the farmers. The impacts of both factors on

[1] US Government communication, Unclassified (2009) Impact of reduced coffee and sweet potato production on food security in SNNP region, 09ADDISABABA214_a. [Online] Available at: http://wikileaks.org/plusd/cables/09ADDISABABA214_a.html (Accessed: 8 June 2014).

households were dire causing significant hardship to families. For the majority of farmers who earn a substantial portion of income from coffee sales or associated casual labour, it meant substantial loss of cash. In favourable times, such income enabled purchase of supplementary food items, agricultural inputs and pay for school fees and health care. The same study found most coffee-producing areas to be prone to food insecurity, to the extent that, even in non-coffee crisis years, children are often underweight for age and mothers are underweight for height due to low average crop yields and limited saved crops. Therefore the impact of low coffee production and falling prices on human nutrition is immediate and widespread.

In this and other cases of cash crop production, reducing vulnerability means helping people develop resilience to external shocks and increase the overall sustainability of their livelihoods (Carney, 1999). It means to develop adaptive capacity, which is the subject of the next chapter.

6.5 Summary

This chapter presented the results of the research on vulnerability of smallholder farmers to climate change. Impacts of climate change are categorised under the themes of socio-economic conditions, water and soil, crops and plants and livestock. Survey data reported heavy decline of food availability, water, crops and livestock. Vulnerability to climate change is exacerbated by, and feeds into, food insecurity, poverty, decline in production, overpopulation and general uncertainty. The study finds the poor, the marginalised, female-headed households, people with low or no literacy and hence low technological capability, children and old people to be the most vulnerable to climate change. Moreover, annual crops are more vulnerable than perennial crops. Coffee, in spite of being a perennial crop, faces double exposure to local risks of climate change and to fluctuations in international market prices.

Having presented and discussed results of the study on the impacts and vulnerability to climate change, the next section presents results of the study on adaptation to climate change.

Chapter 7: Results & discussion: Adaptation to climate change

7.1. Introduction

This chapter presents the results of the study on adaptation. It is divided into four components: coping mechanisms and adaptation strategies, enabling and constraining factors adaptation, mainstreaming climate change to development policy, and opportunities in climate change.

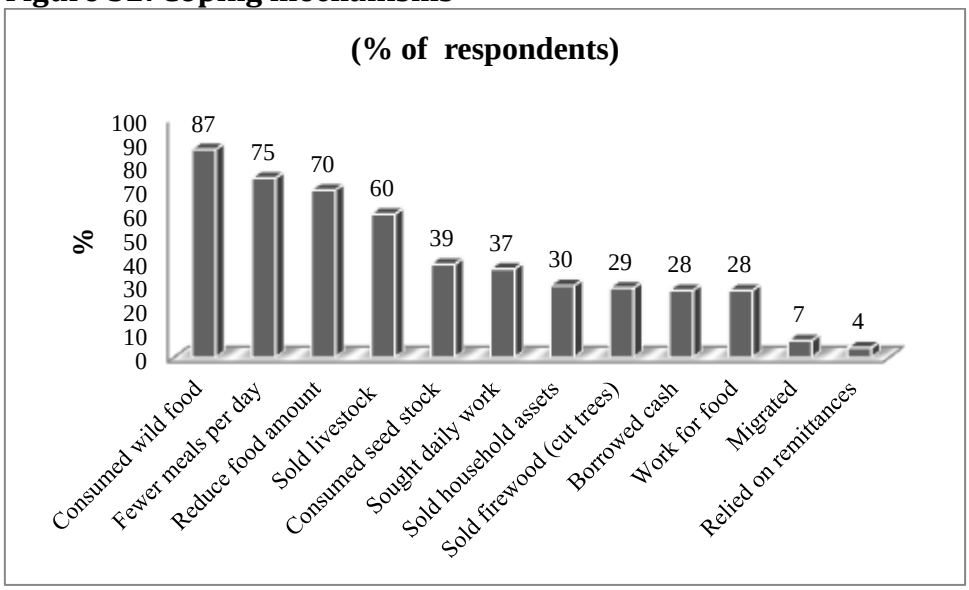
Responses to questions eliciting both qualitative and quantitative data varied in content and context, yet they borne striking similarities with discernible pattern of themes across AEZs, the type of climatic hazard, asset base, and institutional support. For example, in all areas farmers seem to recognise facing changed times and adopting some measures to cope with and adapt to the changes. At the same time, a sense of fatalism, hence mal-adaptation in the form of resort to prayer, planting hazardous trees and unsustainable use of resources were also observed. The next section presents the most commonly used measures of coping and adaptation.

7.2 Coping mechanisms and adaptation strategies

Results from survey data indicate that households deployed a number of coping mechanisms in the face of risks (Fig 36). Most respondents (87%) reported consuming wild food in bad years. Over two-third of respondents had fewer meals per day; 70% reduced the amount of food they consume, while 60% sold livestock. Migration and reliance on remittances are least deployed despite previous findings that migration can play a positive role in improving livelihoods and reduce poverty (Ellis, 2003).

Respondents also mentioned consuming seed stock, seeking daily work and selling household assets. While these actions support people to cope with difficult times in the short-term, some of them contain a potential to reduce one's asset base in the long-term. For example, the sale of firewood supports coping, but it also contributes to deforestation. The same applies to sale of livestock.

Figure 32: Coping mechanisms



[Source: survey, 2012]

Complementing the survey results discussed above, qualitative data picked a number of coping responses. Table 14 illustrates the nature of climatic hazards, the short-term response measures (coping) and long-term measures (adaptation). For example, under conditions of rising temperature, participants reported recourse to prayer, relief aid, and sale of livestock and firewood. During colder conditions and dewfalls, from December to February, people in the highlands of Xexicha reported coping by wearing warm clothing, yet they seemed to have no solution to avoid crop damage from severe cold weather. Under situations of less, erratic and heavy rainfall, farmers resorted to similar actions as during increased temperature, taking additional measures such as consuming wild food, reducing food amount, and reducing expenses. Similar coping actions applied during seasonal shift.

In times of other weather extremes, farmers' coping responses included growing trees that contain a potential to earn cash, reducing non-essential expenditure, reducing meal contribution to social gatherings, temporarily migrating to earn income, and drawing down social capital from social networks. To cope with climate-sensitive infectious diseases, farmers report applying treatment and protective measures.

Table 15: Climate change response framework – Coping and adaptation

Climatic parameters	Coping	Adaptation
Temperature Rise in temperature (drought, heat waves), Fall in temperature (dew)	Prayer, relief aid, sale of livestock, firewood, change clothing type	Change crop varieties, change planting dates, agroforestry
Rainfall Less rainfall (water stress), No rainfall; Erratic rainfall; Heavy rainfall (flooding)	Prayer, relief aid, sale of livestock, firewood, consume wild food, reduce food amount, reduce expenses	Water harvesting, irrigation, intensive cultivation of maize and haricot beans, terracing, water shed activities
Seasonal shift Later than usual start or end of seasonal rain	Prayer, sale of livestock, firewood, reduce food amount	Plant short maturing variety, adapt to changes in seasonal calendar
Ecosystems changes Deforestation, soil degradation	Plant trees, soil conservation	Afforestation, agroforestry
All weather extremes	Grow cash earning trees (e.g. *khat*, eucalyptus)	Income diversification Undertake off-farm jobs
	Reduce non-essential expenditure on clothes, kerosene and other non-staple items	Livelihood diversification
	Reduce meal contribution to *edir* or during mourning period for the dead	
	Migration, earn income, remittances	Earn income outside livelihood zone
	Draw down social capital from social networks (burial societies, *edir, equb, debo*)	Education, training, employment outside farming, educate children, reduce family size
Diseases Climate-sensitive infectious diseases (e.g. malaria)	Mosquitoes nets, anti-malaria medication	Early detection of mosquito distribution[1]

[Survey: FGD and semi-structured interviews, 2012]

In addition to the above coping mechanisms, qualitative data highlighted a few more options. As per the FGD results, these options include seeking relief aid, resorting to social networks and spiritual solutions (faith) and undertaking proactive measures. The option of seeking relief or food aid is mainly associated with the poorest households.[2] It is observed that most farmers resort to social networks and informal institutions for support. An example of this is *edir,* which

[1] Adaptation mechanisms to mosquito spread and malaria remain a challenge. As studies in Africa indicate, despite insecticide-treated bed nets (ITNs), Artemisinin Combination Therapy (ACT) and indoor residual spraying (IRS), the declines in infection, morbidity and mortality are not sufficient to interrupt transmission, particularly in rural, agricultural areas of Africa (Wielgosz e*t al*., 2014; Daddi *et al*., 2005).

[2] Excessive use of this option hardly offers durable solution as it may undermine the community's own efforts to respond to crises.

plays an important role as a local support mechanism in times of need. Vital are also other facets of social organisations such as churches, neighbourhoods and formal Kebele administrations. It is observed that material contributions of one sort or another became part and parcel of social life. Some of the contributions have a long history, for example, food contribution during mourning process (*willa*), but others are new (for example, monetary contributions for weddings).[1] It also appears that social gatherings became venues to receive and hand out food (sort of food banks) resulting in large congregations on burial and other community gatherings becoming a common sight. The number of beggars in streets of towns has also risen in a society that is hardly used to begging in the past.

Resort to spiritual solutions to adapt to change and uncertainty is also common in all areas under study. In some cases, it appears that faith and fatalism replaced human agency. For example, the sense of loss of control is apparent from the following lamentation: 'What is a solution if *Weese (Enset)* is not productive anymore? What will happen to me? I would pray to God. God: what say you? Earth: what say you? I appeal to God, don't abandon me. Earth, don't abandon me. What else can I do?' (Participant from midland). Another participant from the same area added: 'What can I do without the skies relenting?' Thus seeking counsel from faith appears to be one of the coping mechanisms in the face of multiple stressors, and such an approach appears to have more to do with psychosocial effects than material.

Amid despair and fatalism, there were also participants who undertook proactive measures. In justification of human agency, a FGD participant from the lowland said the following: 'As the saying goes, God that gave an itching skin disease (*bijajo*), does not deny nails (*culunqa*). When a problem appears, God offers the means to resolve it.' Thus, rather than being passive victims, farmers took a number of measures to preserve their livelihood, consumption, health and social status, as did other people in rural Sahel where households reportedly coped by

[1] In recent decades, the cost of wedding had grown exponentially including dowry or bride price paid by the groom or his family to the parents of the bride. Some people borrow money to cover the cost of weddings and make themselves vulnerable to debt. Increased monetization and marketization of marriage process is observed in many parts of Sidama.

engaging in constant process of balancing competing needs and limited resources by trading off between objectives given 'the context of crises triggered by one or a combination of catalysts such as drought, civil unrest or the illness/death of a productive worker' (Adams *et al.,* 1998, p.264). Similarly, this study found that farmers attempted to balance different options, for example, planting eucalyptus trees or other cash crops. While decisions to plant these trees appears to be sensible, the also carry a potential for long-term maladaptation.

Another form of coping action is temporary migration of poorer members of households. It takes the form of seasonal migration from cash strapped AEZs (mainly highlands) to cash crop growing areas, especially during coffee production or harvest. A previous study on Sidama's maize belt areas noted that women tend to migrate with their children to enset-producing areas and work. The success of this coping mechanism depends partly on the extent to which neighbouring zones are unaffected by the hazard (or a different hazard) in a particular year (USAID, 2005, p.5). These are largely rural-to-rural migrations although a trend is also emerging of rural to urban migration as shortage of land drives younger people out of deprived and destitute rural areas.

Smallholder farmers were not confined to mere coping measures, they also undertook adaptation actions. In this study, although farmers did not apply all of the adaptation strategy components listed in Table 15, the ones they applied are highlighted while the rest are dimmed. Mal-adaptation responses are depicted in italic.

Table 16: Adaptation categories and strategies

Class of adaptation practice	Adaptation strategy
	Crop choices
	Production technologies
Diversification	**Occupational diversification**
	Skills and occupational training
	Asset portfolio diversification
	Consumption choices
	Animal breeding
	Agroforestry and forestry
Communal pooling	**Infrastructure development**
	Information gathering
	Disaster preparation
	Water storage

Storage	**Food storage (crops, seeds, forest products)** Animal/livestock storage Pest control
Mobility	**Voluntary migration (Wage labour migration)** **Involuntary migration**
Market exchange	**Improved market access** **Insurance provision** New product sales **Seeds, animals, and other input purchases**
Mal-adaptation	*Fatalism, prayers* *Planting trees that contribute to hazards* *Unsustainable resource use*

[Source: Adopted from Agrawal, 2010]

Reporting the results on adaptation strategies, this study drew from two sources: the SLF and the work of Agrawal (2010). While the SLF guided the study to investigate livelihood strategies to achieve preferred livelihood outcomes, Agrawal's work informed the division of basic adaptation strategies into five risk management categories, namely, diversification, communal pooling, storage, mobility and market exchange.

Diversification as adaptation strategy is based on the recognition that diversification could have generic dimensions and at times farmers respond to a combination of socio-economic, political and environmental impacts. Undoubtedly there is a problem of precise attribution of impacts into climate change and other factors, nonetheless diversification options presented below appear to address climatic stress linked to temperature, rainfall and seasonal variability. Both the survey and qualitative data suggest that farmers deployed different diversification mechanisms including change in crop choices, farming practices, and occupational diversification.

Crop choices: Growing more crops, vegetables and edible fruit bearing trees appears to be the most frequent strategy instead of reliance on enset and coffee alone. This means growing such fruits as banana, avocado and papaya. For farmers in the villages close to major markets and roads this strategy produced cash from the sale of fruits and vegetables. A participant commented on diversification efforts in progress:

> Sidama's wealth in the past was Weese (Enset) …. Our wealth was *Weese* and coffee followed by haricot beans, potatoes, and green paper. The latter are not things I cultivate by tradition. They are things I adopted in recent times…. I am trying all these things. I planted red paper near a pond. I also planted sugar cane. I can get money, I can cut it and feed cows. People are not waiting for coffee and maize alone as before. (FGD participant from lowland)

Another FGD participant added: 'We grow green paper, sugar cane, carrot, red onion, and tomatoes. In the past, we were fooled into believing our land is unproductive (dry). But now we even grow coffee in large quantity. Therefore we are doing our best to adapt to climate change and we are not sitting idle. We are also plating trees.' A participant from the highland concurred: 'I think we need to grow more vegetables. (…) More benefit can be obtained from a small plot of land. Wesse takes space and long time to mature.' Likewise, field observation revealed that people started to grow short-season crops such vegetables as haricot beans, red pepper, beans, peas, cabbage as well as tubers such as onion, garlic, ginger, potatoes, sweet potatoes, and cassava. Similar sentiment is expressed by FGD participant from the midland site: 'I am trying all these things. I planted red paper near a pond. I also planted sugar cane. I can get money for it; I can cut it and feed cows. People are not waiting for coffee and maize alone as before.' It is also observed that farmers in the highlands grow bamboo for own use and commercial purposes more than any time in the past (Fig 37).

Figure 33: Local carpentry using bamboo in Xexicha

In this as well other cases, bamboo is increasingly recognised as potentially ideal source of local, sustainable purpose-engineered building materials in comparison to conventional construction materials such as steel and concrete that are expensive, highly energy intensive and unsustainable (Bock, 2014).

Growing multiple crops and plants constitutes farmers' attempts to maintain or improve their wellbeing in the face of multiple stressors. Crop diversification takes the form of using different inputs including hybrid seeds. Accordingly, (67%) of respondents reported using hybrid maize followed by haricot beans and sweet potatoes. Farmers also used hybrid garlic and sugar cane. The uptake of other hybrid crop seeds such as barely, wheat and beans is low. Even when the need for such seeds exist, farmers in the highland report problems in accessing well-researched and scientifically tested seed varieties. The problem is not confined to getting the seed varieties but also getting the right variety suitable for specific agronomic conditions. Responding to the question about the use of hybrid seeds, a FGD participant from highland concluded that farmers who purchased the seeds risked loss. Another participant agreed:

> In the past year, Woreda (district) [officials] told us they brought wheat variety suitable for highland… but we took it and [we] lost. It was prone to disease. One year it was completely destroyed by disease.... When we asked why this is happening, we were told that there was deficiency in its research. (FGD participant from highland)

These and related responses point to problems in identifying suitable seeds for specific agroecological conditions since a crop that is suitable for midland soil and weather conditions may not be equally suitable for lowland or highland conditions.

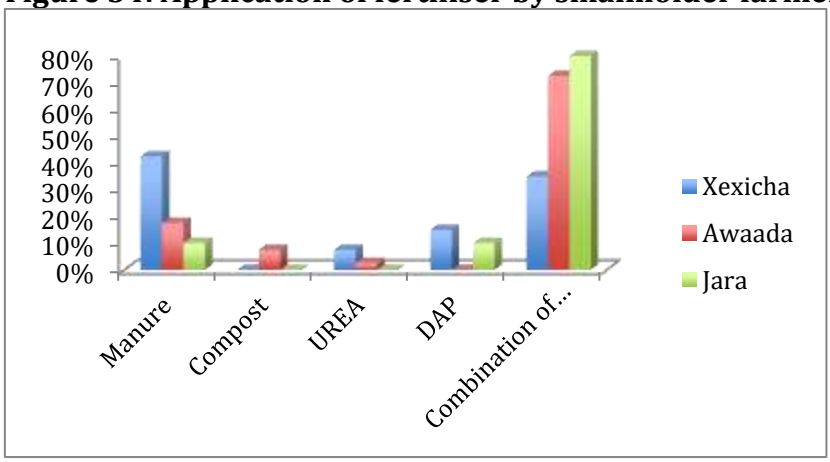
In terms of agroecological comparison, the survey data results showed that more farmers reported using different *crop varieties* in Awaada (midland) than in Xexicha (highland) or Jara Galalcha (lowland). This could be attributed to milder weather and suitable soil conditions for different crop varieties. On the other hand, qualitative data for this study reveal that farmers in Jara reported heavier use of hybrid seeds and fertiliser than other areas. This could be linked to seed intensive cropping, mainly maize which also required the application of chemical fertiliser.

Production technologies: Survey data results on the use of improved farming practice and tools suggest that most respondents (74%) used row-based planting

than the customary broadcast or spread planting of crops. The same data reveal that soil conservation methods are not applied to a large extent. On the other hand, qualitative data imply the use of intensive cultivation of crops and intercropping as adaptation practices.

The kind of production tools used for adaptation depends on the nature and intensity of climatic hazard. As per survey data results, in times of less rainfall, the most frequent adaptive actions were growing short duration or early maturing crops (37%) followed by using pond and a combination of different methods (19%). 'Others' responses to less rainfall included digging water wells, praying to God, doing nothing, and planting short maturity plants. Results from FGD showed that, in times of irregular rainfall, participants undertook water harvesting, cultivation of maize and haricot beans, terracing, and watershed activities. The use of chemical fertiliser was generally low reflecting a broader pattern in Ethiopia which is attributable to relatively high cost, lack of credit, poor availability and the risk of crop failure (Pound and Jonfa, 2005). On the other hand, farmers apply a combination of organic and chemical fertilisers on their farms (Fig 38).

Figure 34: Application of fertiliser by smallholder farmers



[Source: survey, 2012]

Manure use accounts for 23% and it is used mainly in Xexicha where people still maintain livestock. Field observation showed that compared to other areas, farmers in Jara did not use manure even though they have livestock. The combined use of different productivity enhancement methods account for (62%). Chemical fertiliser use is limited to 11% of respondents.

In response to other weather extremes, FGD participants stated income diversification (e.g. deriving income from sale of vegetables, livestock, bees, trade), undertaking off-farm jobs, livelihood diversification, earning income outside the livelihood zone, earning remittances, employment outside farming, educating children, reducing family size and early detection of mosquito distribution as strategies in the face of extreme weather.

In times of drought, survey respondents indicated the usefulness of irrigation and using pond water. Yet most of the farmers in the study areas did not use irrigation,[1] which is in line with smallholder farmers' dependence on rain-fed farming. A few respondents listed 'other' actions in response to drought including offering sacrifice, praying to God, doing nothing, and waiting for rain. FGD results on adaptive actions in times of increased temperature were changing crop varieties, changing planting dates, and agroforestry as appropriate adaptive strategies. Despite the near disappearance of communal forest, most farmers in all sites continue to conserve trees in their gardens as part of the agroforestry system. Limited efforts to conserve and cultivate medicinal tree species are enforced by cultural and spiritual beliefs, as noted elsewhere, for example, by Kewessa et al. (2015). The preservation of agroforestry served a dual purpose, both adaptation and mitigation. It also explains the resilience of farmers in the face of diverse shocks.

Occupational diversification: Study results show limited diversification in the form of participation in petty trade and taking on activities alongside farming. Petty trade is common in all sites. Farmers also expressed a desire to move away from farming. For example, a participant argued that agricultural activity (especially farming) is no more profitable and farming seems to have lost its confidence. He continued:

> [I]n my opinion …. given that the climate behaves in this way, dependence on agriculture is not satisfactory. We need to explore trade and industry. Waiting for rain … is worrisome. Therefore, it is better if one redirects his focus to trade and industry. (Participant in the highland)

[1] Using irrigation is weak despite the fact that Sidama has different rivers inside and around its borders. Major rivers include Logiita, Gannale, and Gambelto (flowing southeast) as well as Gidawo and Bilaate rivers (flowing to the east). Yet their irrigation potential is not realised. Other studies in Ethiopia also confirmed weaker use of this strategy (Deressa *et al*., 2009).

Other studies also rationalised the need for diversification. In the case of North Ghana, it is argued that the 'economy of the peasant society is no longer dependent on farming but is increasingly shifting towards non-farm activities in a process of diversification of livelihoods' (Yaro, 2002). The same study described the livelihoods of peasants as 'characterised by great flexibility through the maintenance of options to meet expected fluctuations in resource endowment, entitlements to food, work and income, climatic conditions, and the reliability of government services.' However, survey data in this study suggested that only a few respondents participated in off-farm activities. Among those who were engaged in off-farm activities, trading represented (36%), handcrafts (22%), renting assets including transport animals such as horses and donkeys (12%) while engagement in charcoal production and PSNP accounted for 8% and 6%, respectively.

Asset portfolio diversification: Farmers in different AEZs grow a variety of grains (such as wheat, maize and sorghum), vegetables and fruit trees (such as mangoes, and avocados). The latter is particularly the case in the midlands. In the low-lying areas surrounding Lake Hawassa, farmers engage in wild fish catches for market and for own consumption. Yet the technology and skills needed to develop aquaculture is non-existent.

Skills and occupational training: For many farmers in the study areas, farming is a trade handed down through generations. Owing to extended experience, farmers demonstrate extensive skills in farming. Through seasonal calendars, farmers are able to predict changes in seasons, temperature and moisture. These calendars in turn serve as warning tools to identify impending crisis, a means of forecasting weather and adjusting planting and harvesting date. However, given the dynamics of changing climate and in the face of multiple stressors, these skills are not adequate. Training and advice services play an important role. Thus, participants mentioned enhancing their awareness through support and advice from extension workers.[1] All the Kebeles surveyed have three extension workers each focusing on crops, livestock and natural resources management & environmental protection. Extension workers are government employees whose remit sometimes extends beyond their roles. For example, according to key informants, they were

[1] In the study areas, extension workers were sometimes referred to as development workers or extension agents.

reportedly involved in the collection of land tax in 2010. This practice did not only put them in conflict with their advisory and consultancy role but also impacted on the relationship and trust. The practice was suspended later. Extension workers are important conduit between farmers and the government by providing farmers with relevant information.

In this study, extension workers expressed strong opinion about their commitment to the wellbeing of their communities, working closely with farmers and being familiar with the problems the latter encounter. The following is a comment describes an extension worker's moral responsibility to his community: 'What is expected of us is to work hard because the people who are dying are ours. The ones starving are our people. Therefore, we feel the problems of our people' (Extension worker from lowland). However there were times relations got strained when extension workers are assigned by government to do certain tasks such as collecting debt. This has happened, as explained by a district official:

> [Until three years ago, farmers were paying the cost of inputs] to DAs (Development Agents). But a problem emerged. The inputs are a form of loan from government, which requires repayment. When DAs were required to collect arrears, as they distributed the inputs, farmers started to distance themselves from DAs. Once this situation is observed, the practice of getting DAs to collect debt was stopped. [Now] DAs are [only] expected to offer advice and distribute inputs. [Kebele chair persons and managers are now the] people who collect debt and payments. (District participant from highland)

Following the problems of trust, the practice of debt collection was stopped and these workers remain vital in training and advice to smallholder farmers.

Communal pooling as adaptation strategy involving joint ownership of assets and resources; sharing of wealth, labour, or incomes from particular activities across households, or mobilization and use of resources that are held collectively during times of scarcity (Agrawal, 2008, p.20). In the study areas, especially in the midlands and highlands, farmers collectively maintained agroforestry in addition to planting new trees in individual or shared plots. Agroforestry in particular takes the form of integration of coffee trees, enset plants and other perennials with a mixture of crops, including vegetables. So widely spread are home gardens (small plots either in the backyard or located close to habitation) fertilised with household waste, hence are rich in plant species diversity (Altieri and Koohafkan,

2008). A participant highlighted the need and the challenges related to planting and maintaining trees:

> People know that rain comes where there is forest, and when there are no trees, winds can uproot houses. People are aware of this and they are planting trees even if extended dry seasons persist and the seedlings are hardly surviving. Planting the trees during rainy season can solve this problem. (Participant from the lowland)

Large scale tree planting or afforestation as adaptation strategy is a challenge, however. A district official from midland, lamented the lack of large tracts of land or community land that can be used for forest in his district:

> For instance, our area is highly populated and available land is covered by permanent crops such as coffee and enset. What remain are pocket lands, which are small. Trees can be planted near fences, on farm boundaries, and on moot lands, or degraded or eroded areas. Some tree planting takes place on farmers' fields. This is the case on hilly and degraded areas. Multi-purpose trees such as avocado and *Birbira* are planted on fields. But at community level, we don't have large tracts of land similar to the Humbo project with a forestation scheme for carbon sale. Even if it is in small scale, planting trees is believed to contribute to protection of the environment. Humbo by comparison is a large area, our people who constitute 2 Kebele*s* are part of Humbo district. It is large desert area. Government and NGOs have coordinated their effort to rehabilitate the area. In our area, we don't have such a large area, but we use what is there to plant trees.

Planting trees is repeatedly mentioned in the midlands and the lowlands. Tree nurseries are maintained by a handful of NGOs in the vicinity of Jara. Expert opinion in the relevant districts in both the midland and lowland confirmed such efforts in tree nurseries. In the midland district, it is reported that some smallholder farmers were involved in developing tree nurseries in addition to government sources.

Planting trees is part of the broader effort to maintain agroforestry in the study sites. Such effort is supported by government policy. A participant from regional agricultural bureau has the following explanation focused on agroforestry and water basin development:

> To address the problems of food security, we are undertaking water basin development works in different parts of Sidama. Such basin development work will, first, reduce water and soil erosion. Trenches are being built in those areas. This will retain rainwater and avoid its flow to the valleys and it will improve vegetation cover and retain soil moisture. Water basin development works are spread in all the areas of our region. The work has biological use apart from the physical one. The plantations around the trenches could be the source of food for livestock. It also has

> agroforestry value. Such work has multi benefits. First, as it retains soil moisture, it helps soil fertility and reduces soil erosion and therefore recuperation of soil. Secondly, maintaining soil moisture means creating conducive conditions for livestock. . (Participant from regional agricultural bureau)

The above-mentioned benefits of agroforestry confirm findings from existing research on agroforestry and landscape approaches. For example, a study that dealt with coffee agroecosystems in Chiapas (Mexico) found that temperature, humidity and solar radiation fluctuations increased significantly as shade cover decreased (Lin, 2007). Agroecosystems influence the microclimate by retaining and planting trees, which reduce temperature, wind velocity, evaporation and direct exposure to sun-light and intercept hail and rain (*ibid.).* Sidama farmers are aware that shade cover maintains soil moisture for coffee plantation. They grow crops in agroforestry designs to protect crop plants against climate extremes and soil moisture fluctuation.

Another communal pooling strategy relates to enlisting households into agricultural marketing co-operatives. In coffee producing midlands, farmers are organised into coffee co-operatives. Theoretically such co-operatives serve as a way to generate economies of scale and scope and to reinforce the bargaining position of smallholder producers (Blokland and Gouet, 2007) as well as a means of dealing with price fluctuations and major difficulties to find remunerative market outlets (Ruben and Heras, 2012). Other benefits from strong farmer cooperatives include lobbing for favourable policies. The beneficial effect of coffee or other cooperatives depends on whether they are run by professionals independent of state control. However, in the context of Ethiopia, co-operatives often tend to become extensions of government whose focus and priority diverges from enhancing adaptive capacity of their members. The problem is not confined to Ethiopia alone as Ruben and Heras (2012, p.465) noted: 'Agricultural co-operatives … in developing countries frequently face problems since many of them are established on the basis of political criteria by external agents, as a part of public investment strategies or rural development programs launched by international agencies, rather than by farmers themselves.'

Historically, most of the coffee co-operatives in Ethiopia were created during the Derg government for the purpose of political control without considering socio-

cultural or economic criteria. These and their successor co-operatives have experienced gradual decline in economic returns mainly due to prevailing deficiencies in internal organization resulting from top-down co-operative policies that seriously hinder autonomous collective action and constrain pro-active attitudes towards co-operative innovation (Ruben and Heras, 2012, p.465). Subsequently, the benefits of farmers' co-operatives as a common pooling strategy are not pronounced in the study areas; yet the potential exists, provided the right institutional setting and support exists.

Information gathering and sharing is one of communal pooling strategies. Weather related information is vital to identify risks and to take appropriate actions. The survey data captured ranking of information provision. Accordingly, 73% of respondents ranked weather related information as 'Timely and adequate' and 78% as 'Useful'. However, the low level of education of participants (presented in section 4.2, Table 5) discounts the significance of these rankings. Qualitative data revealed that most farmers rely on their own experience, fellow farmers and extension workers to gather and share information.

Storage as adaptation strategy include water storage (wells, harvesting rain water), food storage (crops, seeds, forest products), animal/livestock storage and pest control, the only significant option used by farmers in study areas is food storage. Prominent cases involve the storage of *Wassa*, coffee and maize. *Waasa* is kept in the ground in the highlands and the midlands. Maize, on the contrary, is stored above the ground for several months in the lowlands. The picture below is an example of store built from local materials to preserve maize (Fig 39).

Local storage facilities such as the above withstand rain, but farmers complain of their inability to protect maize from pest attack. In the case of coffee storage, while dried coffee is stored by in the homes of farmers, washed (semi-processed) coffee is stored by private, co-operative and public storage units. The Ethiopian Commodity Exchange (ECX) built a modern storage facility in Hawassa. These and related improvements in coffee storage technologies and institutions contain immense potential to improve rural livelihoods (Agrawal, 2010) and build resilience towards climatic stress.

Figure 35: Local crop storage units

[Jara Galalcha, 12 April 2012]

Mobility as adaptation strategy produced mixed results**.** Most Sidama people are settled agriculturalists who pursue sedentary lifestyle, save those people living in Loka Abayaa lowland district who practise both pastoralism and farming. As the FGDs and semi-structured interviews indicated, there is a dominant outlook among farmers in Sidama who viewed mobility and specially migration as undesirable. Participants mentioned voluntary and semi-voluntary migration in the form government settlement programmes to other parts of south Ethiopia such as Bench Maji. They refer to those being resettled as poor people with small or no land. This confirms the view espoused by Agrawal (2010, p.185) that the poor are more likely to migrate in response to crop failure whereas the rich are more likely to rely on storage and exchange since the latter are more likely to have institutionally secure access to resources that make forced migration unnecessary. In a separate case, a person displaced as the result of his land being taken for building a public university campus preferred relocation to areas close to where he lives rather than moving to a replacement land in the nearby town. Apparently he did not wish to move to urban environment where he said 'there is no space for putting up a tent at the time of my death.'[1] (Participant from midland)

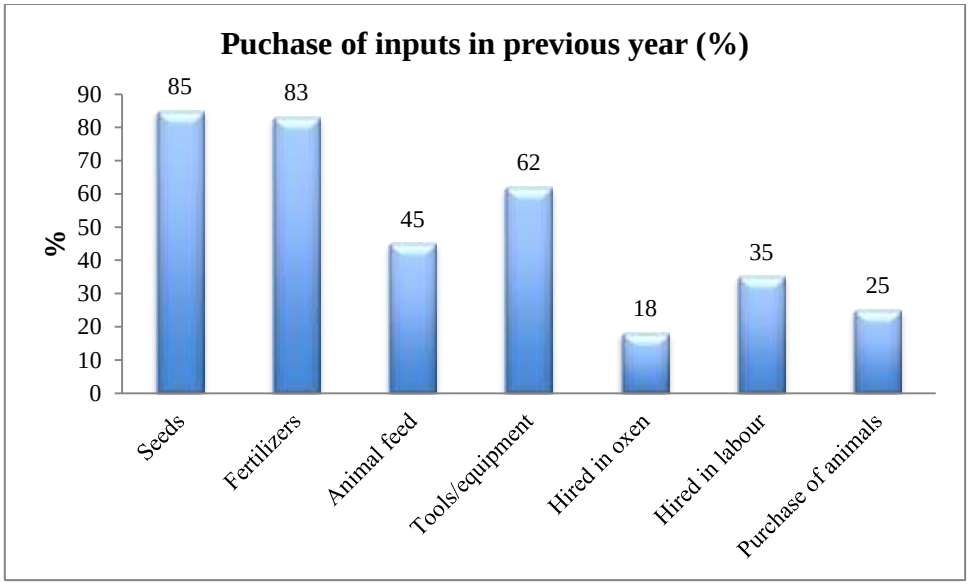
Views on mobility or migration such as the above are not uncommon. For example, a recent doctoral study which explored the impact of environmental stress on mobility decisions in Northern Ethiopia found that climate change *alone* does not

[1] In a number of interviews, the notion of death, burial and its place appeared to indicate the important value residents attach to the termination of life as a signifying event.

explain mobility decisions, or that 'although environmental stress matters in mobility decisions, it does so due to the context of non-environmental factors in which it occurs, not in spite of them' (Morrissey, 2011). Pretty similar conclusion is reached from the main island of Tuvalu, Funafuti, where people reported wanting to remain for reasons of lifestyle, culture and identity. Concerns about the impacts of climate change were not significant driver of migration, and do not appear to be a significant influence on those who intend to migrate in the future (Mortreux and Barnett, 2009). Here a distinction is made between two forms of migration: voluntary and involuntary migration. Agrawal (2010) termed voluntary migration as adaptation strategy (opportunity seeking) and involuntary or forced migration as failure of adaptation (escape). Thus involuntary migrations on a massive scale due to climatic stresses, and with attendant social and political instabilities is maladaptation. Yet these kind of migrations were not observed in the study sites.

Market exchange as adaptation strategy include improved market access, purchase of seeds, animals, and other inputs and insurance provision, purchase of seeds featured prominently. The survey data queried if farmers purchased agricultural inputs in the previous year. The result is shown in Figure 40.

Figure 36: Purchase of inputs



[Source: survey data, 2012]

The most frequently purchased inputs were seeds such as maize, wheat, barley (85%), fertiliser (83%), tools/equipment (62%) followed by purchase of animal

feed (45%). Herbicide and irrigation are least used. For example, only a quarter of the respondents reported using irrigation as strategy of adaptation to climate change.

Insurance provision in the study areas scored least. It is known that farmers face economic, social and environmental risks on a daily basis; yet only a quarter of respondents heard of health insurance, and number of those who heard crop insurance is the lowest. This is interesting as this option is increasingly deployed in different parts of the world. According to discussion with a participant from the EPA, policy makers did not foresee crop insurance or any form of weather-indexed insurance as an immediate option for adaptation.

Eventually, the choice of different adaptation options is not only about economic, technical or market exchange. Adaptation to climate change is also a social engagement. In this study, farmers felt that adaptation cannot be successfully undertaken by individual effort alone. In the words of a participant: 'I am affected by what the times brought. It is not something I alone can do or cope. It is something the community as whole should do and cope. Mine is part of the whole' (Participant from highland).

The study results were not only about active adaptation responses, but there were also reactions that may contribute to mal-adaptation such as fatalism and growing potentially damaging trees. FGD and semi-structured interviews with farmers are dotted with examples of fatalism. Due to their spread and importance, the case of plants such as eucalyptus needs closer look. Eucalyptus trees are widely present throughout Sidamaland having significant role on livelihoods. Experts suggest that the issue is not whether growing eucalyptus tree supports adaptation or but it is to plant it in the right place and time. Farmers, on the other hand, give many reasons for planting eucalyptus trees. Some mention the cash earning potential. Some use the tree as a means of pushing boundaries with adjacent farmers. Others prefer its dexterity in the face of rain failure and its ability to survive semi-dry conditions. In the words of a farmer from the highland: 'Eucalyptus trees generate money. It is very hard to get cash in this area, and eucalyptus serves as a cash tree. It has become a matter or life. We know that it causes damage to soil, it destroys wesse if

planted closer.' The explanation for planting eucalyptus and the side effects it engenders are complemented by another participant who compared it with the bamboo tree:

> When it [eucalyptus] first emerged, there was the view that having eucalyptus trees helps educate children. It is a multi-purpose tree and yields good income. But in due time, we recognise that it is damaging the soil and I started cutting down the ones close to my house. I kept some as it brings cash (…) [on the other hand] bamboo tree is beneficial; it is not as hazardous as eucalyptus. Its shade during the dry season is helpful. I feed bamboo leaves to calves and sheep. It provides good fodder to livestock (…). I have extended bamboo plantation. I sell each bamboo tree for 5 Birr. (Participant from highland)

The debate about growing eucalyptus tree is bound to continue, for while it produces immediate financial advantage to growers thus supporting livelihood diversification, reliance on growing eucalyptus contains side effects. Moreover, growing eucalyptus trees is in direct competition with growing native tree species known for their environmental value and agroforestry importance. The choice to grow eucalyptus trees is an example of maladaptation where human responses actively undermine the capacity of society to cope with climate change or further contributing to the problem (Bulkeley, 2000).

7.3 Factors enabling and/or constraining adaptation

Results from qualitative data pointed to few factors enabling adaptation. Access to extension services, information and training, access to markets, and access to institutions, were mentioned by farmers and policy makers. Similar enabling factors were cited elsewhere in Africa. For example, in Zambia and Zimbabwe, the complex factors that determined the success of coping and adaptation strategies were identified as access to resources, household size and composition, access to resources of extended families and the ability of the community to provide support (Mubaya, 2010).

In this study, information proved vital for decision-making all sites which confirms evidence that access to weather information, assets, and participation in social institutions are associated with households that have reported making changes to their practice or adaptive actions (Wood *et al.*, 2014).

Farmers also mentioned having access to support by governmental and non-governmental organisations as important factors. Farmers revealed appreciation for the work of NGOs such as the World Vision (in Xexicha) and People In Need (Czech NGO) and SOS Sahel (in Jara).

Regarding the factors that thwart adaptation, numerous constraints and barriers exist including environmental, technological, informational, economical, physical and social factors. While some farmers and areas face higher constraints than others, the following are broad themes across the study areas: lack of capacity, technological capability, poor potential for irrigation, lack of information about adaptation options, communication gap and incompleteness of knowledge about impacts of climate change.

Lack of capacity manifests itself in low levels of livelihood assets (especially, financial, and physical capital) are indicators of low capacity (Fig 9 in chapter 4). Shortage of land is an important constraint as evidenced by less than a hectare land holding per household. Moreover lack of capacity, as Carney (1999) rightly stated, reveals itself in the form of lack of knowledge of rights and information about the way government functions which renders people unable 'to exert pressure for change in systems which have often actively discriminated against them both in the allocation of resources and in pricing policies for their produce.' At the same time, the power of governments to resist pressure and impose top-down policies reduces ability for local actions.

Low technological capability is another constraining factor, which limits adaptation options. Farmers in the study areas use traditional tools with the least advance for centuries.

Poor potential for irrigation is another characteristics of smallholder farmers in the study areas. A district official from the midland acknowledged the low potential for irrigation as follows:

> We don't have modern irrigation systems… or if they exist, they are not available in all Kebele*s*. We have two main rivers that cross the Dale district. Those farmers close to these rivers do benefit, more or less. But we have no mechanisms for other farmers to benefit on a wider scale. So, for now it is a serious problem.

The potential for irrigation is not helped by rugged topography of the highlands and midlands unlike the lowlands with larger plain surface, hence greater potential for irrigation. Thus, Sidama has several small-scale rivers and hot water springs, yet they are hardly developed for irrigation or thermal energy purposes. Poor irrigation potential is not an exception to smallholder farmers in the study area; the problem exists in other contexts as well. For example, studies in Tanzania noted shortage of water for irrigation (Sanga *et al.,* 2013). Even when and where irrigation potential exists, smallholder farmers are constrained by having very small plots of land with very low technological capacity to irrigate their farms (Deressa *et al*., 2009).

Lack of information or awareness about adaptation options limits adaptation actions. It is already stated that farmers in the study areas perceive climate change and its impacts, without necessarily having information on adaptation methods. In this study, the problem is not only of lack of new information but it is also of old information and practices or what an extension worker complained as pervasive influence of past habits:

> Traditional knowledge is a constraint; people do not know the emergence of challenges. Our extension work education states that farmers do not rush to adopt new things. They may know the problem, but they take time to adopt new methods. Their risk aversion behaviour results on lag and slow response to problems. That is the main problem. That is why we teach them (….) They think of old days when 2-3 people lived in a household without using fertilisers. The old practices remain attached to their behaviour. Older practices remain a problem. (Extension worker from the midland)

Another extension worker supported the same position:

> People know there is climate change, but as tradition, they are passive. Most people did not proceed with actions. People need to be told repeatedly. Some farmers accept advice and mobilise for action. Some take advice but act slowly. Some imitate other farmers' actions. It takes 2-3 years for adoption processes. Our proposal is to work with model farmers who preserved indigenous trees and demonstrate their experience for others to follow. We tell farmers that such trees help rain. We tell them maintain indigenous trees. But they give different excuses to cut them. They listen to what we say, they say 'Ok' but do not act on our advice. (Extension worker from the lowland)

Improved farmer education built on trust and knowledge can address information related barriers. However, the problem is not confined to traditions alone. It is possible that both scientific and traditional knowledge about climate change

remain incomplete, which could hamper efforts about specific adaptive measures required for a local context. For example, disaggregated weather data at lower resolution is necessary to predict local climate scenarios, but such technological advance is hardly available for the study areas; the same problem was revealed by participant from National Meteorology Agency.

Governance and institutional barriers affect adaptation to climate change. In this study, lack or shortage of NGOs is mentioned in the midland district, in contrast to the adjacent Humbo district (in Wolayta zone), which was supported by both governmental and non-governmental agencies including the EPA, World Vision, and the World Bank. Apart from the lowland district, the study confirmed that NGOs are thinly spread on the ground. Only the names of very few NGOs were recognised among farmers.

Shortage of appropriate trees is found to be one of the barriers to adaptation. In some areas, shortage of modern nurseries is reported to be a problem. For example, in Jara, the following is the comment by an extension worker.

> The number of nurseries to grow tree seedlings is limited. (…) Some nurseries are managed by NGOs (e.g. EDEN, People in Need). These NGOs have their areas of work and only give to farmers when the seeds are over above their own focus areas. So that is a problem of supply. Farmers are now more aware of the problems. They know how hard it they are by the rising cost of living (inflation). They know they are living in times of competition and globalisation. The problem in their entry to the competition is the arrival of this age without their readiness. Many people are lagging behind the competition.

In spite of the abovementioned constraints and barriers to adaptation, there is a broad recognition that climate change poses unprecedented threat to smallholder farmers who depend on rain-fed agriculture. In these circumstances, mainstreaming climate change adaptation in development policy appears vital taking into consideration local vulnerability and adaptation needs.

7.4 Mainstreaming climate change to development policy

This section discusses results of the study on mainstreaming climate change in development policy. It starts with a brief examination of recent development

policies in Ethiopia, followed by views of policy makers on climate change adaptation and mitigation. Moreover, it assesses the state of institutions that coordinate climate change policy at local and national levels. It concludes by examining policy gaps in priorities related to climate change and development.

Results from climate change related policy documents and interviews with governmental and NGO experts disclose that different development programmes of Ethiopia focused on rural development, resource management and food security policies. Only rarely and recently had adaptation or mitigation to climate change been the focus of policy. For example, in the early 1990s, the country's Agriculture Development Led Industrialization (ADLI) strategy and the Plan for Accelerated and Sustained Development to End Poverty (PASDEP) targeted food security and poverty reduction without explicit recognition of environmental sustainability.

The goal of ADLI[1] was to accelerate agricultural growth and to achieve food security. As far as smallholder farmers are concerned, ADLI aimed to increase crop production, raise income for rural households, attain national food self-sufficiency, and produce surplus marketable to the urban or industrial sectors. This meant providing smallholder farmers with appropriate technology and better farming practices, improved seeds, fertiliser, irrigation, rural roads, and marketing services.[2] While effective provision of these inputs have clear implications on vulnerability to climate change, there was no explicit reference to link them to climate change adaptation or mitigation. However, growing publicity of global climate change at international level (through the IPCC and UNFCC) and the focus on some MDGs, led to gradual shift of policy to address climate change. Then Ethiopia established EPA with the stipulation that federal to community level bodies identify and act upon issues through existing structures to integrate environment and development planning.[3] However, the statement is easier said than done as practice often lagged behind policy. At the level of theory, it was

[1]The basic tenet of ADLI is industrialisation where agriculture was expected to perform instrumental role to supply labour, food, row materials, and foreign exchange and a source of demand for industrial goods. Its aim was to transform small, subsistence farming into commercial agriculture.

[2] GRIPS Development Forum (2009) Democratic developmentalism and agricultural develop-ment led industrialization http://www.grips.ac.jp/-e/pdf_e12/JICA&GDF Report_Ethiopia_ phase1/Intellectual_Partnership_for_Africa/7Final_Report_ch5.pdf

[3] Environmental Protection Authority, [Online] http://www.epa.gov.et

recommended that securing Ethiopia's economic and social wellbeing in the face of climate change requires that policymakers and stakeholders work together to integrate climate change adaptation into development process (Admassie *et al*., 2008).

In practice, Ethiopia has made some progress through time in terms of policy orientation to address the challenges of climate change including adaptation and mitigation of climatic risks. In 2011, the government announced a policy framework that integrates climate change into development policy, named Climate Resilient Green Economy strategy (CRGE). Time and again, while the ambition of the strategy is to build a climate resilient green economy by 2025, in practice, current efforts and conditions are ill equipped to deal with the magnitude of the impacts of climate change facing communities. The problems relate to the context in which institutions, policies and priorities emerge.

In terms of key institutions responsible for climate policy in Ethiopia, there are two key agencies, namely the NMA and EPA. From the late 1990s until 2009, NMA remained the focal point of the UNFCCC and IPCC. Since 2009, EPA led the process by involving stakeholder sectors. On its approach to the environmental challenge and its focus on the economy, a participant from EPA was clear about the policy imperative:

> What we should do is to build climate resilient economy. The main strategy is to build the economy. Why do we say that? In developed countries, when you hear floods, you hear the demolition of building, the demolition of bridges, but you rarely hear the death of people as a result. Things will be rebuilt immediately after the event when people have the capacity. Therefore building economic capacity is decisive. (….) This is the goal.

Thus according to the above position, development and capacity building is a priority in managing climate risks. It calls for addressing current vulnerability to deal with future vulnerability to climate change. Research elsewhere has already established that climate change poses important challenge for public policy. As Stern (2007) noted climate change presents 'a unique challenge for economics: it is the greatest and widest-ranging market failure ever seen.' The conditions observed in this study are marked by problems of such failure: incomplete markets, imperfect information, and the pervasiveness of imperfect competition (Stiglitz,

1991). While the imperfections are real, the response to correct them via overly centralised state intervention leaves much to desire. For it is possible that under specific circumstances, both market and state interventions could fail in equal measures. Under these circumstances, a participant from MoWE admitted the capacity limitation at all levels of government sectors. 'There are also gaps in the agency [EPA],' he noted of an agency that leads on climate change policy.

The problems were apparent in the ways the regional plans were prepared to feed into the newest NAPAs as well as in the coordination and compilation of CRGE strategy. In the case of SNNPR, a regional adaptation plan was fraught with methodological problems. For example, the regional agricultural bureau took responsibility to prepare the regional adaptation plan. Subsequently it gathered a team of experts from different sectoral institutions including university researchers. The team relied on secondary data in the absence of primary research and real time assessment of vulnerability to climate change. To their credit, the team produced modest plan document (NREPA, 2012) written in Amharic, slated for translation to English and compilation by EPA.[1] Given the short deadline to get the plan document to the EPA, the draft was sent before it was formally approved at the regional level. Moreover, zones, districts and kebele*s* had no input in the plan and thus community participation was limited.

Besides methodological issues, the SNNPR has structural limitations in planning for climate change adaptation. This region did not have autonomous EPA in contrast to other regions such as Oromia and Amhara regions. Instead, a regional bureau of agriculture coordinated the preparation of climate change adaptation document that became an input for the CRGE strategy document. However, it is notable that agricultural sector contributes to climate change and it is bound to find it difficult to regulate itself and become an arbiter of climate policy design and implementation for other sectors. The federal EPA respondent was not surprised about this structural problem, asserting that what matters at the end is getting the job done regardless of who does it. There is no denying, however, that having suitable structures and processes plays an important role in dealing with the impact of climate change and communicating climate change information to

[1] It is intimated to the researcher that the translation and compilation of all regional adaptation plans is onerous task for the EPA to the extent that the adaptation part was delayed.

stakeholders. Studies showed that effective communication helps identify problems, raise awareness, encourage dialogue and influence behavioural change (Moser and Ekstrom, 2010; Litre *et al.,* 2014).

At the national level, some civil society organizations were involved, but most of the time it was governmental sectors such as water, agriculture, energy, EPA and NMA who dominated adaptation and mitigation plans. Even then, hasty and frequently changing planning and prioritising was noticeable. The question, under this context, is how climate forecasts and inter-sectoral links are managed at the national level. Owing to the nature of their work, some ministries are better placed to address climate change mainstreaming. For example, MoWE maintains key links with relevant agencies dealing with climate change related communication:

> We receive climate and rainfall data from NMA …. but water levels records are available within [the MoWE]. Data about larger hydro dams is organised/available here. NMA is responsible to MoWE, hence closer communication. They were independent organisation in the past. EEPCO is also under this ministry. So there is no problem of communication. (Participant from MoWE)

The need for inter-agency coordination is well established. Studies recommend that governments need to ensure 'locally determined adaptation needs are linked "upwards" to national and international policy and institutional structures' (Yamin *et al.*, 2005). In this study, a notable communication gap between important stakeholders is observed, as the following testimonial attests: 'One actor in climate change may not know what another actor is doing. So this communication gap can sometimes confuse the public. I hope this communication gap is being addressed through different types of consultative workshops; but this should improve.' (Participant from NMA)

Whereas Ethiopia's national policy makers view achieving economic growth and development as desirable goals towards addressing climate change, donors on the other hand view adaptation as an environmental issue. The treatment of adaptation as an extension of mitigation of greenhouse gas emissions by donors lends to think of climate change separate from development issue. It also results in environment ministers, rather than finance and planning ministers being tasked with climate change policy. The same holds true for Ethiopia where EPA and MoFED are the drivers of policies for climate change and development,

respectively. In June 2014, EPA is re-designated as a separate ministry with enhanced powers to play a leading role in matters relating to climate change. The government is keen to be seen as determined 'to consider climate change as one of the priority areas in dealing with the country's long-term development needs' (Eshetu *et al.,* 2014, p.vi). This desire is understandable given that adaptation to climate change requires 'the concerted efforts of decision makers in diverse institutions across multiple scales' (Agrawal, 2010, p.179). However, the context under study is rife with problems of coordination and communication. For example, shifting prioritisation of climate policy is noted especially within the CRGE context where one would expect the publication of adaptation plan within the CRGE to take precedence over mitigation. On the contrary, the green economy component was published in 2011, while the adaptation part was postponed. One simple reason for this mishap was practical logistic issue related to preparation and translation of regional NAPAs to publish national document in English. The other reason, and more substantive, is the shift of government priority in line with historical foreign aid dependent development trajectory. For much of the last decade, the international context has affected how political regimes approached climate policy. For example, in 2009, the current government seized the possibility of external funding when climate mitigation received a boost from donors at the Copenhagen Summit, especially from international donors including the World Bank (2009) and bilateral donors such as Norway and the United Kingdom. This opportunity pulled policy focus toward mitigation and the formulation of CRGE despite what Eshetu et al (2014) called the lack of a marker for 'climate change relevant' spending in the Government of Ethiopia Chart of Accounts. Subsequently, the government selected four initiatives for fast-tracking for implementation of the green economy element of the CRGE strategy: hydropower development, rural cooking technologies, the livestock value chain, and forestry development. Although some writers (*ibid.)* describe this choice as a 'rational policy priority' for its prospect of immediate economic growth, large carbon abatement potential, and perhaps more importantly, its appeal to international climate funding sources, one would argue that such a high level of dependence and sensitivity to external signals could potentially pose challenges on sustainability of climate change policy implementation in Ethiopia.[1] While the government shifts its focus with funding

[1] The policy regime also appears to rely too much on 'political commitment and leadership that is

opportunities, some NGOs admit that adaptation to climate change needed to be a priority to enable famers to reduce their vulnerability and adapt to climate change.

Discussions with policy makers did not only point out to shifting policy focus but also to conflicting policy dimensions. The case in point is the building of chemical factory that produces chemical fertiliser versus the policy of promoting organic fertiliser. A participant explained the construction of fertiliser factory and the dilemmas thus:

> At the government level, factories are being built. I think they are on the way. In the current circumstances, the use of compost is encouraged (…) there is a situation of intensification/agriculture whereby maximum production is expected from small plot of land. For the time being, there will be a problem. Emission levels for using fertiliser are high. It is good to use compost (…) There are dilemmas here. To enhance food security, you should use of fertilisers. There is also an argument that unlike European countries, we are not heavy CO_2 emitters. Therefore we have to use [fertiliser] for sometime. Hence there are fertiliser factories under construction. (Participant from MoA)

Conflicting priorities were not confined to central or federal levels of government, they were also reflected at the regional level. For example, a participant at regional office disclosed that climate change adaptation intervention on vulnerable districts of the region, espoused in the regional adaptation plan, did not start; instead it was cancelled country-wide. The same participant continued to explain the change of priorities:

> The priority moved toward vital infrastructure projects with massive investment including dams and roads that are becoming vulnerable to climate change. This means water basin developments of Tekeze river in Tigray, and Abay river in Amhara received strategic priority. This follows by Gilgel Gibe I in Oromia. In SNNPRS region, the largest project is hydroelectric power of Gilgel Gibe III in Dawuro zone. The reprioritisation is part of the government's flexible policy in relation to development projects. (Participant from regional bureau)

In response to a comment about the top-down nature of NAPA and related policies in Ethiopia, a participant from MoA defended government approach through the following justification: 'Directly or indirectly, it is related to smallholder farmers since we can't generate development without involving smallholder farmers. If they are not involved, we can't bring change. Therefore, our actions will reach out

provided by the Prime Minister of Ethiopia [the late PM Zenawi] at the national, regional and international levels' to promote and enhance the implementation of the CRGE strategy (see EPA, 2012)

to smallholder farmers.' The question still remains about how farmers at the grass root level are involved in substantive decision-making. The lack of participation by private and civil society in NAPA is debatable, and all the more so in the case of the CRGE – an overly ambitious agenda that requires the concerted efforts of all sectors of society and hardly achievable by government alone (Eshetu *et al.,* 2014). Even if one assumes participation of all stakeholders, cross-sectoral coordination at all levels is yet to be determined. While it is known that climate change is linked to several issues (including agriculture, health, transport, energy and water), agricultural bureau in the SNNPR region is vested to handle response measures with limited capacity to coordinate disparate areas of work. However, the problem is played down a participant from the Zonal office, who defended that the system works well over all:

> I have the feeling that the linkage of this system at the country level is strong. If there is a gap, it will immediately be registered with early warning mechanism[1] at the country level. If there is a pressing problem, emergency is announced, quickly. We have an evaluation system…. There are also other multi-sectoral systems that are linked to agriculture. For example, water basin development if often integrated. This means that various sectors such as education, health, road, and agriculture have a linkage. But I cannot say such a linkage is strong. For example, when they build a road, they comprehensively cut trees. Agriculture wouldn't ask 'why'. They do not assess environmental impact. The road builders only look at the roads. There is that sort of gap. We raised this gap at the regional level. The issue is how we can address this gap. But I don't think this is overwhelming. (Participant from Zone)

Explaining horizontal and vertical inter-sectoral links and coordination at district level, a participant from lowland district said:

> Agriculture as a sector has different work processes. One of them is food security and early warning system. This relates to crises emerging within the population especially related to climate change and other related themes. There is a chain of work to take information upwards. Agriculture collects information from the bottom (grassroots) and passes formally to the Zone. The base information is what happening at the farmers' level. Information on health of children, mothers, education, etc… comes to our office, passed to Zone and upwards. The abovementioned emergency disaster process will be activated at the time of disaster.

At the district level, agricultural policies were described in ways that address climate change. The policies include agricultural development, natural resources management, soil and water conservation. The goal of these policies is to expand

[1] This is in reference to US-funded Famine Early Warning Systems Network (FEWSNET): http://www.fews.net

agricultural production and productivity and ensure food security. According to a district participant from the lowlands, soil and water conservation is a priority. The same participant adds:

> Then farmers will upgrade their capacity to enhance production and productivity. While this done, the crop production strategy is for one farmer to produce about 90 quintals of maize from a hectare of land. Examples for this are taken from selected, model farmers which the rest of the farmers will apply. This means they can produce for themselves [and the market] hence moving out of food dependency. In relation to livestock, the aim is to change the livestock variety and replace the existing ones with ones more suitable for meat and milk. This means apart from food needs (achieving enough protein), it will be a source of additional income. On the other hand, those poorer farmers whose wealth rank below 2998 birr/year, is to keep them under PSNP (…) Those people who have shortage of land, and nothing can be dome to enhance their productivity is to resettle them somewhere else…. (Participant from lowland district)

The meaning of adaptation to climate change in Ethiopian context is explained by two participants from the federal ministries:

> Agricultural adaptation is watershed management, soil and water conservation. Whether you are talking about mitigation or adaptation, within the Ethiopian context, you are doing soil and water conservation. We are doing small scale irrigation. We are doing reforestation and afforestation activities… All of these are adaptation and mitigation. (Participant from MoA)

> The adaptation followed by the government is the building of dams. Because, when you build dams, the vulnerability of areas downstream will decrease as you control the runoff. Second through dams, you can undertake different kind of activities starting with irrigation and energy production. So in the water sector, the general direction of climate change adaptation is hydroelectric dams. Then there is the renewable energy sector. (Participant from NMA)

The views of participants from the NGO sector are not at variance from the above as NGOs in Ethiopia work within parameters set by the government. Some of their views are summarised here. According to a participant from WVE, his NGO undertakes different adaptation actions including practical measures in tree planting and supporting government capacity to take over projects from NGOs.

> In terms of reforestation, the aim is to develop degraded areas. This is one of the pilot project which contributes toward climate change adaptation and mitigation. 84% of our population are engaged in agriculture. This means tilling the land which is extensively damaged. Soil fertility is declining highly. Apart from shortage of land, food shortage is increasing. If you go South, the land holding size is from 0.5 to 2.5 on average. Even that varies according to circumstances. If you go to other places, it could reach 1.5 ha. With such a smallholding, it requires focus on soil/land conservation to feed 5-6 family members, and to ensure food security. It means

> farmers' understanding about land has to increase. They have to be sensitive. Millions of tree seedlings have been planted in Ethiopia. Despite rhetoric from the government, none exists [today]. Sometimes, only 10% seedlings survive. There are times when 100% of them will die down. Such approach is not rewarding. Area enclosure should be combined by [Farmer Managed Natural Resource Regeneration] (FMNR) technique for restoration. Once the NGOs works phases out or government lacks capacity, the enclosures will be exposed and become vulnerable again. It will be devastated. It cannot be sustainable. The community needs to have a sense of ownership without which they would not protect and maintain it well. A lot of work must be done on the issue of ownership. We are widely working on this. (Participant from WVE, NGO)

Another participant from NGO sector saw his organisations role in adaptation to climate change in the following terms:

> Our works involve drought resistant plants, land management, and adaptation works. We work on livelihood improvement projects. In the highland, we work on high value fruits like apple and enset plantation. Enset is drought resistant. Secondly, it helps with climate change adaptation. (Participant from SLUF, NGO)

Both government and NGO participants pose climate change as the global problem with local consequences. In one instance, the problem is articulated at the district level in the following way:

> We don't think it is only one district alone which solves this problem [of climate change]. It is a matter given attention at national level. I also think it is given attention internationally. From our perspective, we are moving in the right direction confronting the problems. I also think God will help us. (Participant from the midland district)

There is however a problem of how to prioritise different responses to climate change. NGOs seem to prioritise climate change adaptation to mitigation:

> As we are a developing country our emissions are low and we are not obliged to reduce emission. The reason is our emissions are low. We are not obliged legally. It is not the main problem either. At the level of our development, adaptation is a must. Because, whoever caused it, we are the primary victims of the problem [climate change]. We don't have capacity, financial, technical, knowhow. We don't have preparedness, or even if people have awareness, we lack finance; our people may not understand how to adapt. On the other hand, our education level is also lower. Our societies are more vulnerable to climate change. 83% of the population live in the countryside. They live off agriculture. Agriculture is one of the most vulnerable to climate change. Had there been use of irrigation, vulnerability would have lessened. The production system is vulnerable because it depends on rains. (Participant from WVE, NGO)

> From our perspective, climate change is a global problem, it is an issue that needs a global solution. But then on our part, what we do is first to understand the problem semi-structured, specifically in relation to clients with whom we have direct working relationships such as smallholder farmers and nomads. We seek to understand the vulnerability of their livelihoods to climate change and their coping measures. (Participant from SOS Sahel, NGO)

> We are victims and did not cause the problems. Therefore mitigation is not our issue. Our concern is how the affected sectors can adapt (….) But in Rio declaration of UNFCCC, there are certain principles. Even if not all are equally affected by the problem, everyone has the responsibility to do something. Hence common but differentiated responsibility according to capability (…) Developed countries have been damaging the environment and we would not have equal responsibility with them. But to progress to a better environment, all have to be responsible. Therefore in terms of mitigation, it is mainly the job of developed countries, which need to reduce their GHG emissions. We have to contribute our share/ability. We need to move to clean development mechanism. (Participant from SLUF, NGO)

The above are views and conclusions drawn from interviews with participants from government and non-government institutions about policy priority on climate change. However, the same conclusions were not drawn from interviews of farmers who were gripped by their local world and experience. The gap in understanding remains to be bridged. Gaps are also present in policy making. While, in theory, efforts are being made to mainstream climate change to development pathway, much remains to be done in linking development and environment policies in practice. The sustainability of CRGE is also questionable, as its implantation depends largely on external funding.[1] For example, a recent ODI study reported that despite the CRGE call for annual spending of USD 7.5 billion to respond to climate change, there appears to be a major financing gap with local and donor funding coming no where closer the amount envisaged (Eshetu *et al.,* 2014). While funding remains important factor, one would surmise that institutional changes are required for greater resilience and increased adaptive capacity of smallholder farmers for adaptation and take advantage of opportunity from to climate change, if any – the subject of the next section.

[1] The exception is GERD being financed largely from domestic sources. The CRGE Facility was set up by the government up to mobilise finance and to disburse climate funds. The aim is to mobilise an estimated USD 200 billion from national and international public and private sources to implement the CRGE over the next 20 years, or until 2030. The strategic directions set by the Environmental Council and the CRGE Ministerial Steering Committee guide the CRGE Facility. MoFED is responsible for the management of the Facility with the EPA (and now MoEF) holding responsibility for technical coordination (Kaur, 2013).

7.5 Opportunities and benefits from climate change

At the micro, household level, most farmers did not see immediate benefits from climate change save its impacts. However, farmers in the highlands appear to benefit from shifting ecozones by growing new crops and plants that had in the past been restricted to the lower altitudes. For example, some areas adjacent to Xexicha started growing and producing coffee, which was not the case in the past, engendering a possibility of increased income earning from coffee. On the other hand, while farming may benefit from the possibilities of increased CO_2 and rainfall that could support crop growth, these advantages would be offset by rising temperature and hence higher evaporation.

Data from the study also suggest that pressure on livelihoods in all AEZs is forcing people to explore innovative approaches to deal with emerging problems. At different levels, the challenges have introduced the need for inventive and innovative thinking in natural resource management such as water resources – river basins and lakes. Other examples include the use of family planning for reduced family size and making concerted effort to educate children. According to FGD and semi-structured interviews, people are already taking measures to limit family size. Views complementing this finding are found in a study carried out in Oromia and the SNNPR regions in Ethiopia (Kidanu *et al*, 2009) where farmers argued for limiting the number of children to help them to cope with the change in climate.

A related benefit with changed times rife with multiple stressors is the need to invest in children's education as a coping mechanism or a means to reduce burden and as insurance toward an uncertain future. The realisation of the benefits depend on whether the children succeed in education and move on to off-farm options – becoming less of a burden on families' land holding and household consumption – or able to support parents at old age. Participants repeatedly mentioned the importance of educating children. The strategy is particularly essential in the context where formal social protection system is undeveloped beyond food for work packages and state employment.

The above are some of the benefits farmers thought to achieve. Apart from these indirect effects and pressures to take positive actions, most farmers did not see positive opportunity in climate change.

On the other hand, at the macro level, participants saw opportunities in climate change. Policy makers seem to hold instrumentalist view of the benefits from climate change. They mentioned funding opportunities in the form of climate finance – namely, the Green Climate Fund (GCF) and the UNDP's Global Environment Facility (GEF). The latter had funded several projects around the study areas, although small in magnitude.[1] Policy makers also pointed to the possibility of planning for climate change in the form of NAPAs and later green growth as concrete proposals that came out from the foresight of climate change. A participant from MoWE expressed optimism in Ethiopia's pursuit of what he referred to 'clean development path,' which is further elaborated below:

> We have wide opportunity. First, we can undertake clean development path. We have opportunities to develop wind energy several projects, geothermal. Solar energy has big potential. You can take Renaissance Dam [GERD], it can sink millions of tons of carbon [CO_2]. We have large hydro dams. The country can benefit and it can contribute to global emissions reduction of CO_2. Afforestation programmes are widely undertaken. (…) We can arrest land degradation associated with climate change. Conservation and mitigation opportunities are also there.

The realisation of the above opportunity in the form of 'green economy' is contingent on funding and technical support from donor countries. A district official expected such support to be extended to a wide array of projects in his district including soil and water conservation to be complemented by 'mass or popular movement' or local community participation. According to the same participant, the midland district undertook 11,291 hectares of basin work involving different terracing during the dry season of 2012 (Participant from midland district). In addition to project level initiatives, participants foresaw strategic and macro level opportunities linked to climate change. A participant from NGO sector made this point abundantly clear when he reported that:

> … Having the CRGE is an opportunity. Having clean development is beneficial. In terms of mitigation, avoiding the dirty development path pursued by others contributes to sustainable development.... In general having green and clean development is an opportunity. (Participant from NGO)

[1] As far as large-scale finance is concerned, policy makers expressed frustration over lengthy processes to acquire funds.

Another macro-level opportunity mentioned by NGO participants related to financial benefits and long-term sustainability. They argue that climate change is forcing natural resource conservation and development as a priority agenda. An NGO participant summed it thus:

> I think it [climate change] has opportunities …[For example] developing countries are earning income from the sale of carbon under REDD and CDMs. There is also knowledge that, by doing so, they can reduce global warming. The role of natural resources in the green economy is great. … What I see as an opportunity is really ecological sustainability even in terms of development thinking. So far, it is known that development meant economic growth. But in the age of environmental movements, there are indications that ecology and economy should be viewed in integrated ways. (Participant from NGO)

The admission of opportunities in finance, green development path and sustainable development are qualified by caution mainly linked to future uncertainty. For example, a participant noted that 'it is difficult to be certain about the future. It is probable for dry areas to become wet. But if the wet areas become dry, then that becomes a threat. If it becomes exceedingly wet, or rains heavily, it could be a disaster' (Participant from FfE, NGO).

Apart from caution, the very identification of opportunities and risks from climate change has sensitised policy makers and farmers to instigate actions to deal with environmental challenges. Sensitising policy makers in itself supports mainstreaming climate change since they are responsible in designing projects and programmes, rules and laws related to development and environment. In other words, informed policy makers are expected to factor climate change adaptation and mitigation into different dimensions of development policy.

Similar experiences from Africa abound. For example, in Uganda, emerging opportunities from the adaptation actions supported attaining resilience and sustainability. The Ugandan Climate Change Adaptation and Development (CC DARE) experiment was carried out on the premise that while it may be hard to 'prevent rain failure and prolonged dry spells taking their toll on the farming communities,' it is possible to help minimize the painful impacts of these natural hazards (Munang and Nkem, 2011). The experiment generated information on seasons to help guide crop substitution and diversification. Then adaptation

technologies such as conservation agriculture and integrated nutrient management in maize production were introduced to farmers benefiting both farmers and district officials. The latter gained knowledge about the impacts of climate change and the available adaptation and mitigation technologies in the region. The experiment exposed Members of Parliament to empirical data on climate change and variability as well as to experiences and strategies of grassroots organizations. The same experiment contributed to good agronomic practices taken up by farmers such as soil and water conservation, use of fertilizers, biological nitrogen fixation by leguminous cover crops and so on. In addition to timely planting at a larger scale improved productivity at field level thus ensuring food availability (Munang and Nkem, 2011, p.1513). While the above views are strategic reflections on development pathways in the age of climate change, policy makers hardly underestimated the preponderance of problems emanating from climate change that far outweigh perceived benefits and opportunities.

7.6 Summary

This chapter presented the results of the research and discussion on adaptation strategies, factors enabling and/or constraining adaptation mainstreaming climate change adaptation, and opportunities envisaged from climate change.

Results from the study show that, faced with the challenges posed by climate change, farmers undertook different measures to cope and adapt. Short-term coping measures include seeking relief or food aid and support through social networks and informal institutions. Besides social capital, resort to spiritual means of coping is also observed. Drawing from earlier work on adaptation to climate change, this study classified adaptation strategies into five risk management categories: diversification, communal pooling, storage, mobility and market exchange. Diversification of livelihoods is reported to be prominent strategy as per the results from survey and qualitative data. Irrigation is the least used adaptation strategy.

Adaptation is enabled by access to extension services, information and training, access to markets, and access to institutions. Barriers to adaptation include lack of

capacity, technological capability, poor potential for irrigation, lack of information about adaptation options, communication gap and incompleteness of knowledge about climate change impacts. The role for public policy and applied research is to help incentivise enabling factors and remove barriers. Mainstreaming adaptation to development policy addresses the critical issue of harmonising policy and institutions, processes and structures to align economic, social and environmental goals to achieve sustainable development. Much remains to be done in the case of Ethiopia in this respect, noting that opportunities exist through climate finance not to mention growing public will and understanding about climate change.

Chapter 8: Conclusions and recommendations

This chapter concludes the study by summarising its findings and recommendations. The contribution of the study and its limitations are also presented along with areas for further research.

8.1 Conclusions

This doctoral study explored perceptions, vulnerability and adaptation to climate change in Ethiopia focused on smallholder farmers. The study was motived by anecdotal evidence, casual observation and conversations with smallholder farmers during my trips to rural areas of Sidama. My training in development economics also lent additional impetus to examine development-environment nexus. In the discussion and presentation of findings of the study, I drew from relevant literature, first-hand field experience and data collected through household survey, focus group discussions and semi-structured interviews.

The study is informed by sustainable livelihood framework as analytical device and supplemented by core issues that focused on four themes representing critical phases in response to climate change. The first theme surveyed, documented and analysed farmers' and policy makers' perception of climate change. The second theme examined impacts and vulnerability to climate change of smallholder farmers who produce enset for subsistence and coffee for global market. The third theme examined the strategies used to cope and adapt to climate change. The fourth theme investigated mainstreaming adaptation in development policy in Ethiopia.

The study commenced with the proposition that a) climate change is the major environmental problem facing the world, and b) the impacts and vulnerability to climate change are felt differently across space and time. Drawing on from broad scientific consensus that pointed to climate change as unequivocal, the study noted that the predictions of the future climate and its impacts on people and their ecosystems are profound. In developing countries, the problem is aggravated for deprived and marginalised people who depend on natural resources. Smallholder farmers in Sidama make stark example of dependence on rain-fed agriculture.

Even among smallholder farmers, the impacts of climate change are differential, localised and context-specific.

Different ecozones face varied impacts of climate change and response measures to reduce vulnerability differ from context to context. Generally, two responses are known to address climate change. One is mitigation and the other is adaptation. In both cases, decision-making is involved requiring in-depth understanding about how the problem is perceived by different stakeholders. Based on smallholder farmers involved in Enset-Coffee livelihoods, the study arrived at a number of conclusions.

Regarding the question of how climate change is perceived in Ethiopia and especially by smallholder farmers of Sidama, results showed that perceptions of climate change – and especially its causes – involve dualistic outcomes at micro and macro levels. At the micro household level, the emerging picture presented mixed results. On the one hand, farmers clearly identified the indicators of climate change. According to the survey results, 76% of the farmers perceived climate change with some areas facing climatic hazards unique to their context. On the other hand, farmers' explanations of the causes and partly their responses to climate change are in marked contrast with perceptions by policy makers as well as with scientific understanding of the problem. Farmers' perceptions are the result of their experience with the local environment and their worldview are largely confined to the local world, often delinked from the global space. For instance, they hardly linked climate change with global warming or green house gas emissions, except stating river pollution caused by local coffee processing plants. Within the locally-bound perception, the most cited attribution of causes of climate change is either human-induced or the work of God.

Some farmers recognised that climate change is caused by land use changes, deforestation and overpopulation. Other reported abandonment of past traditions or practices, declining moral values, the collapse of customs and traditions as causes of climate change. Reference to God is ubiquitous among those who believed climate change has more to do with nature and the supernatural. These findings are in agreement with previous research findings that farmers make sense

of the world around them by drawing from the local beliefs, values and moral responsibilities and cultural interactions with nature (Roncoli *et al.,* 2002; Bulkeley, 2000; Moghariya and Smardon 2012). What is interesting in the context of this study relates to the strength of religious and cultural beliefs in opinion formation. The preponderance of religious rationalization and ever growing faith-based networks can be linked to what one may refer to as *spiritual capital*, which can complement the notion of social capital. Study participants seem to invest in faith and religious beliefs to provide psychological buffer against the impacts of climate change or, according to some, the work of nature. To advance the notion of spiritual capital further, one can explore the links between contemporary religion and development, which is beyond the scope of this study.

At the macro level, policy makers displayed highly advanced perceptions about climate change indicators, causes and impacts and the ways of addressing the problem. They clearly linked climate change to global warming. They seem to be particularly aware that climate change poses a challenge through development-environment nexus. At stake is how to address climate change without compromising development efforts for poverty reduction and economic growth.

In terms of perception of *impacts* of climate change, farmers recognise that their challenge is not only the changed climate but also the unpredictable nature of the changes. Epitomizing the livelihoods of rural societies elsewhere in the world, smallholder farmers in Sidama face multiple stressors, climate change being an important one. They believe that the 'changed times' have impacted their livelihoods, and eventually their wellbeing, crops, livestock and ecosystems. For most of the farmers who depend heavily on rain-fed farming, increasingly unpredictable rain and increased temperature negatively affected their crops and livestock. Both coffee and enset are impacted by climate change. As the predicted $2^{o}C$ average temperature rise would reduce the production of Uganda's Robusta Coffee, limiting it to highlands, similar trajectory is possible for Sidama coffee in the midlands. Yet it remains unknown how future production of coffee from highlands will compensate for the losses from the midlands, both in quality and quantity. It is possible that while consumers of coffee, near and far, may embrace changed quality of coffee, producers in the midlands may loose income.

Apart from change on coffee production, increased heat waves and spread of diseases is also reported to affect human, plant and animal health. These impacts directly translate to food insecurity and sometimes to hunger conditions. These results concur with findings from Africa (Mubaya *et al.,* 2012; Mengistu, 2011) that climate change impacts are pronounced among multiple stressors. However, findings from studies on South America that farmers placed higher significance on volatile market prices over climate variability (Eakin *et al.,* 2005; Bacon, 2005) that are not supported by the results of this study. On the other hand, results from Sidama confirm the finding of studies that perception of climate change is significant among farmers living in the highlands than the lowlands (Deressa *et al.,* 2010). This result appears contrary to conventional wisdom to expect lower sensitivity to climatic hazards among farmers from lower altitudes known for dry conditions.

In the case of the national policy makers, the discourse on impacts of climate change is dominated by sectoral considerations. In their list and priorities of sectoral susceptibility to climate change, they cite agriculture, water resources, biodiversity and human health as the most vulnerable sectors. Apart from sectoral priorities, they seem to place emphasis on mega projects, which resulted in waning focus on smallholder farmers due to diversion of resources. Local government and NGO participants, on the other hand, prioritise the impacts of climate change on the livelihoods and communities.

In terms of vulnerability context, several factors are at play facing smallholder farmers. The study examined climate change related shocks, trends and seasonality such as drought, floods, wind, water scarcity, and diseases. Climate data showed an increase in temperature, high rainfall variability and inter-annual and intra-seasonal variation. These factors are juxtaposed on socio-economic vulnerability of smallholder farmers. The study found that most respondents held less than a hectare of land. Farmers recognise that increasing population size (reported higher family size with an average of 7 people per household), ever shrinking land holding and primeval farming technology did not only contribute to decline in livelihoods, but also risked sustainability. Without important changes,

the continuity of smallholder farming in Sidama as the way of life remains precarious, if not at risk.

The threat to the way of life emanates from the vulnerability context shaped by poverty. The fact that most respondents live in poor conditions indicates the depth of endemic poverty, which compounds vulnerability to climate change. These people derive their income from the sale of crops, coffee and Wesse products, indicating that any climatic hazards directly affect their livelihoods. Their expenditure pattern too is dominated by expenses on basic needs such as clothing, food, debt payment, health and ceremonies. Such a tight budgetary allocation hardly leaves room or flexibility to adopt innovative methods and technologies for sustainable livelihoods. On the other hand, drought and extended dry seasons exacerbate malnutrition and hunger. Vulnerability in the study areas was worsened by lack of development infrastructure such as functioning roads, markets and credit facilities.

In terms of livelihood assets, access to social and human capital is relatively higher than other forms of capital, the least one being financial capital. Membership to social networks contributes to social capital.

In spite of the abovementioned vulnerability context, people reported taking a number of adaptation measures to cope and adapt to climate change. One such measure is diversification of livelihoods such as crop and livestock production and off-farm activities. Examples include farmers engaging in early maturing crop varieties and growing drought tolerant plant varieties such as enset. Combining *Wesse* with maize, coffee and perennial edible trees helped in adapting to climate change. It also resulted in positive livelihood outcomes such as increased income, improved wellbeing and resilience to shocks. The role of agroforestry as a response to climate change is widely noted, yet the drive to secure income from *khat* and eucalyptus trees attracted many farmers to what in the long-term could prove to be mal-adaptation to climate change, given its impact on soil and surrounding ecosystems.

In terms of AEZs, this study established different adaptation strategies in different sites. The midland areas focused on planting edible perennial trees, agroforestry, planting trees, limited irrigation along river basins, growing khat and coffee under trees or enset, and mixed cropping. The highland areas deployed diversification of crops, growing new crop varieties such as apple, growing bamboo for income generation, and planting eucalyptus trees. The lowland areas applied different crop varieties, modified their planting date, used small scale irrigation, planted trees and engaged in off-farm activities.

The study results also found that not all respondents took adaptive action; some have indeed conjured up fatalistic views, withdrawn or looked up to God and Government for assistance to solve problems engendered by 'changed times.' Some reacted by planting hazardous trees, or involved in unsustainable resource use that would result in negative livelihood outcome in the long run.

For policy markers, climate change is a major concern, next to development. Interviews with government officials at different levels provided important insight into national framework of adaptation to climate change in Ethiopia. Efforts at building development infrastructure such as roads and dams seem to absorb resources and attention. So are climate finance negotiations and efforts to coordinate actions of different stakeholders. Other adaptation measures at macro level took the form of improving the forecasting and distribution of weather information to increase public awareness about climate change. Moreover, the government's early warning systems supported coping with disasters in the face of droughts and food insecurity. However, significant barriers exist hampering effective adaptation at local levels. Among them are ineffective institutions and processes, top-down, statist approaches and authoritarian tendencies that curtail free and voluntary local actions.

It is clear that public policy plays a vital role in mainstreaming climate change into development planning. In Ethiopian context, the Climate Resilient Green Economy strategy is exemplary attempt at mainstreaming climate change. At the time of the research, the CRGE was at an early stage of development. Part of it, or the mitigation component, was published but the adaptation component was

incomplete. The real challenge for the CRGE rests not in the design phase but in implementation phase, which challenges the readiness of implementing bodies to convert the plan into reality. The CRGE is informed by GTP, which envisaged boosting agricultural productivity by scaling up technology while replicating good practices of *model farmers* to the rest of country's smallholder farmers. It also hoped to expand commercial agriculture, strengthen the industrial base, and foster export growth. However, the optimistic view about the capacity of smallholder farmers who are still using old-style technology bears the risk of missing the GTP targets.

The CRGE strategy itself assigns a key role of coordination to EPA and MoFED, but the former is new and fledgling agency without offices in some regions, in SNNPR for example. It is also worth noting that most federal agencies including EPA and MoWE focused on large-scale public projects such as hydropower generating dams. The commitment to large-scale projects such as the GERD and associated large-scale investment imposes financing challenge stretching the public budget to its limits. Moreover, financial commitment and sudden change of strategy emanating from top down approach could easily bypass smallholder agriculture and smallholder farmers. By and large, policy makers are now better placed to heed the remarks of Juan Hoffmaister, Co-Chair of the Adaptation Committee of UNFCCC who argued 'climate change can be an opportunity to transform society, an opportunity to learn from the mistakes that we have made and to build a better future.'[1]

8.2 Recommendations

A number of recommendations can be made based on the foregoing analysis. First, in terms of academic research, the use of sustainable livelihoods framework helped explore different aspects of smallholder farmers' livelihoods. Although rarely used in the context of climate change, the framework can be applied in climate change research and practice. In this study, the notions of vulnerability context, livelihood assets and adaptation strategies – notions central to the

[1] United Nations Framework Convention on Climate Change (2014) 'Action to adapt' http://newsroom.unfccc.int/action-to-adapt/new-documentary-raises-awareness-for-adaptation-needs/ There is also a video documentary: https://www.youtube.com/watch?v=REWXV1TlEXo

framework – have proved a useful guide in designing and implementing this research.

Secondly, the study identified gaps that have policy implications. In terms of perceptions of climate change, a need exists to narrow the gap between scientific knowledge on climate change and farmers' understanding of the causes of climate change. Enhancing public awareness about physical causes of climate change goes some way to address the gap. One way of bridging the gap between farmers' perception and scientific method is simplifying technical explanation for example using local materials, better communication and capacity building, through farmers' training centres and better quality extension work. Improved capacity building for extension workers may also trickle down to farmers. This requires the cessation of the practice that once required extension workers to collect debt from farmers and more fundamentally maintaining political neutrality of their work; this avoiding practices that could compromise the position of trust with farmers and negatively impact on agricultural extension service.

Bridging the gap between scientific knowledge and farmers' understanding also means backing up indigenous knowledge for adaptation. On the contrary, ignoring local knowledge contains dangers resulting in policies that constrain rather than enhance the adaptive capacity of communities. Bridging implies aligning local knowledge with scientific understanding, as the latter is steadily improving with better climatological data and modelling. It also calls for agencies to develop deeper understanding of the extent to which smallholder farmers are able to access, trust, and respond to seasonal climate forecasting. The same suggestion applies to narrow the gap between perception of causes of climate change by farmers and by experts or policy makers.

Third, in terms of impact and vulnerability to climate change, no record of comprehensive assessment of vulnerability to climate change in Sidama is available other than rapid rural appraisal on account of disaster, food insecurity, emergency relief work, and early warning mechanisms. A thorough assessment of climate change vulnerability for the whole districts is required to inform policy.

Some groups and areas need urgent adaptation and mitigation intervention. For example, the low-lying areas of Sidama are characterised by severe land degradation, water stress, deforestation and overgrazing, triggering soil erosion and damage to forest regeneration. Without suitable adaptation measures, drier AEZs such as Jara may easily cross biophysical thresholds causing long-term drop in agricultural productivity and threat to livelihood sustainability. Visible exposure of farmers to climatic stress and reliance on climate sensitive activities, as well as low incomes and weak adaptive capacity in this area is a cause for concern. Moreover, the decline of the commons land and forests due to population pressure and the privatisation of commons resulted in loss of livelihoods assets for the communities surveyed. As the consequence, farmers are compelled to reduce the number of livestock they use to get diary products and income generation that would support livelihoods at times of climatic stress. Possible measures to increase adaptive capacity of farmers include improved land use measures, management of water and institutionalisation of the common property resources regimes. For instance, villages surrounding Lake Hawassa may diversify their livelihoods to reduce food insecurity. The current reliance on wild fish catches, unsustainable as it is, may as well be replaced by aquaculture, which needs investment on technology and skills development. Moreover, the total reliance on biomass based fuels which include wood, crop residue or manure is not sustainable and, in the face of growing population, deforestation and soil erosion, rural electrification is needed to reduce existing and future vulnerability of livelihoods.

Fourth, in terms of adaptation, given Ethiopia's low economic development, lack of infrastructure and services, adaptation to climate change is a priority. Such a priority demands exploring ways for further diversification of activities, enhancing provision of water for human consumption and irrigation agriculture, research into affordable inputs (HYVs and fertiliser), the provision of credit and capital for energy efficiency and re-examination of the rights regime including land rights.

In terms of research and innovation, higher education institutions and key research institutions (both agricultural and development) need to 'read' each other to support adaptation policy. Institutes of agricultural research exist at the

national and regional levels with the aim of popularising and supplying improved agricultural technologies as well as coordinating the national agricultural research. They could play an important role in the adaptation process, for example in developing higher yielding, drought-tolerant, shorter duration varieties of crops. They may conduct action research informed by local knowledge and involving farmers. It is also important that their efforts are updated and supported by feedback involving communities. The role of Agricultural Transformation Agency (ATA) in creating greater access to information, knowledge and innovation is vital.

There is also a need for public media to play clear role in awareness raising efforts to increase public awareness about climate change. Similarly, public agencies such as the National Metrological Agency need to establish robust climate information systems with investment in local stations. For informed policy is halfway to solve a challenge.

It is noted that adaptation measures undertaken by farmers are mainly in reaction to climate change. Yet, as Schipper (2007) noted, adaptation to climate change looks forward to the future climate change in an attempt to make anticipatory adjustments. Ad hoc measures in reaction to change as significant as climate change are inadequate without backing by policy, programmes and institutions. A sustainable adaptation process, therefore, requires policy reform as well as institutional and attitudinal changes to create enabling conditions complemented by technological and infrastructural changes.

Sustainability in the context of Ethiopia calls for equitable resource allocation that takes account of regional population size and economic contribution. For this reason, the country's vision of economic transformation to elevated income status (becoming a middle income country by 2025 with zero carbon emission) needs to go beyond underscoring aggregate per capita income to ensure that income is evenly distributed across the regions and populations. On the other hand, sustainability requires local capacity building to contain perpetual dependence on foreign aid. It also calls for local – in place of centralised state – ownership of solutions to problems, be it developmental or environmental. And sustainability of local livelihoods requires environmental and biodiversity protection. Moreover,

attempts to achieve the Millennium Development Goals and the forthcoming Sustainable Development Goals depend on reforms to the governance and the policy framework.

Above all, adaptation to climate change in Ethiopia requires investment in agriculture, and particularly in small-scale agriculture. Elsewhere in East Asia, smallholder-based agricultural development reportedly played an important role in poverty reduction strategies that focussed mainly on technological options for improving input use, output and yields (Ruben and Heras, 2012, p.464). Thus, it is crucial to develop new options and innovations that enhance the resilience of agricultural production and reduce vulnerability to shocks (Cooper *et al.*, 2008). For example, investments to enhance crop tolerance to drought stress, improving water productivity, and integrated management of land and water resources have the potential to reduce vulnerability to climatic shocks whilst improving productivity. There is also a need to invest in research and innovation, especially on enset production and harvesting, as the plant is marked as drought resistant.

Related research and feedback need to involve communities and other stakeholders (research institutions, GOs, NGOs and CBOs, the media and educational institutions). The involvement of research institutions can contribute to the process of adaptation by introducing new and appropriate technologies. Higher education institutions may want to conduct applied research on climate change or mainstreaming environmental studies in their curriculum. In two of the research sites (Xexicha and Jara), farmers have already stated their need for better-researched and tested quality seeds that are suitable for local weather and soil conditions. Farmers in Jara went further in requesting collaborative research with academic or research agencies and NGOs to enable them to grow their own seeds for own and commercial use. The problem in identifying and providing suitable seeds for specific agroecological conditions is widespread and it needs to be resolved. The lack of NGOs and independent Civil Society Organizations (CSOs)[1] in Sidama is linked to ideological drive of developmental state that tends to throttle CSOs. For example, the CSO proclamation imposed restrictions on areas where CSOs can intervene, their funding sources (either local or external),

[1] CSOs in Ethiopia include NGOs, advocacy organisations, professional associations, cooperatives, trade unions, religious organisations and the independent press and self help associations.

expenditure and staffing. This laws and related restrictions on CBOs and NGOs needs to be reviewed in view of addressing dynamic context of vulnerability in Sidama and Ethiopia.

The involvement of stakeholders including agencies that deliver water provision services, agricultural development, human and animal health, natural resources and forestry sectors is vital. At the national and regional levels, EPA and NMA are closely linked to national climate change agenda being responsible for overseeing policy and providing climate related information, respectively. The media continues to play a role in creating awareness and disseminating information related to climate change.

Fifth, in terms of sustainable development and climate change, policies need to anchor on the principles of sustainable livelihoods. This means enhancing livelihood assets that contribute towards improved adaptive capacity. The study noted chronic shortage of some form of assets, for example, financial, physical and natural capital (although natural capital is not comprehensively addresses as it should be). For example, access to banking or credit facilities help those who want to diversify their livelihoods is limited. Apart from finance, one of the key inputs to farmers' adaptation is the availability of knowledge and information about adaptation options. This could take the form of focused extension services, training of farmers about adaptation to climate change, effective delivery of early warning systems, and providing agronomic weather forecasts in accessible formats – including local languages.

Throughout the research sites and beyond, achieving sustainable livelihoods requires what the World Resources Institute (2014) called Great Balancing Act, namely meeting three needs simultaneously: closing the food gap, supporting economic development, and reducing agriculture's environmental impact. The proposed solutions include actions to achieve replacement level fertility on population, boost crop yield, improve land and water management, apply shift agriculture to degraded lands and increase aquaculture's productivity. Others recommended a shift in focus to 'a food system that nourishes the planet without compromising the soils, crop diversity, and fresh water on which we all depend'

(Munang and Nkem, 2011). Besides these suggestions, more research is required on sustainable production of organic coffee in the highlands that would be home to coffee due to future climate change alongside a policy support to midlands to address their loss of earnings and preserve or enhance their livelihoods.

Sixth, in terms of institutions and policy, their place in adaptation to climate change is important. More specifically, institutions providing agricultural inputs, credit supply, market access, information services and strengthening of local knowledge need to become integral part of government policies to assist farmers to adapt to the impacts of climate change (Kassie *et al.*, 2013). From what is observed, coordinated action is needed to help farmers adapt to climate change. The dominant modus operandi of the current sectoral public service design is based on centralised, functional, and silo approach. This means that one only deals with one's piece of the jigsaw. Such an approach cannot address the complex interactions between climatic, economic, political, institutional, social and technological processes. For instance, NMA is a centralised agency with strong access to global institutions, yet it has poor coordination with zonal and research institutions at the regional level, at least as far as the study areas are concerned. Apart from coordination, it also operates with limited resources and weather stations, especially in remote areas with inadequate road and communication networks. At all levels, NMA needs to have improved capacity of climate knowledge management, forecasting and projection, and early warning and disaster management. The Agency may as well collaborate with universities to create and access trained manpower for climate modelling and especially downscaling of climate change scenarios at local level.

Apart from government, farmers need to access support from different sources. Access to NGOs is vital, all the more so when it is combined with government support. Some areas have limited access to NGOs due to restrictive government priorities despite demonstrable needs of the local population. For example, district officials in Sidama Zone felt that registering and licensing NGOs or civil society organisations is the prerogative of the region (SNNPR) to and not of the Zone. For this and perhaps other reasons, there were limited numbers of NGOs operating on climate change platform in the rural areas of Sidama. This study observed not only

lack of NGOs but also lack of grass-root community participation in adaptation planning. This compares less favourably with other areas – for example countries of South Asia especially Bangladesh, India and Nepal – where community based adaptation is advanced by NGOs and research organizations.[1]

Seventh, in terms of mainstreaming climate change, addressing the challenges imposed by environment-development nexus requires developing a policy regime that takes social, economic and environmental sustainability as part and parcel of policy design and implementation. It also requires improving institutional capacity among stakeholders to co-operate and collaborate. It means embracing climate smart policies with tacit recognition that climate change is a crosscutting issue involving integrated approach to food security, environment, human welfare and other development goals. As a strategy, Ethiopia's CRGE goes a long way in this direction although it is yet to be seen how it unfolds in practice. Climate-proofing development implies that the design of development programmes ranging from resettlement, rural development and building mega-hydropower dams such as the Gilgel Gibe and Grand Ethiopian Renaissance Dam (GERD) need in-depth assessment and appraisal given climatic factors such as flooding, drought and winds.

Finally, in both adaptation and mitigation measures, focused attention and integrated approaches are needed, without which some areas such as the lowlands of Sidama, would gradually be converted to semi-desert conditions.

8.3 Contributions of the study

The study makes important contributions to research and policy. At least three main contributions are highlighted here: a) modest effort in studying Sidama context, b) comprehensive account of climate change, and c) the use of sustainable livelihoods framework.

[1] [Online] Available at: http://weadapt.org/initiative/community-based-adaptation
Also http://www.iied.org/community-based-adaptation-climate-change

First, the study documented and analysed climate change in the context of Sidama. Research on Sidama at large and especially in relation to climate change is virtually absent. The study expanded the vista of knowledge about the socio-economic, political and environmental challenges facing smallholder farmers – one of the marginalised and invisible groups of people in the world. In so doing, it deepened evidence base in one of the least studied areas in the country. Both the baseline information and study findings would benefit different stakeholders that include farmers, research communities involved in climate change, governmental and non-governmental institutions, as well as all those engaged in agricultural development, natural resource and health management practices.

Second, it provided comprehensive analysis of climate change by combining the critical phases of perceptions, vulnerability and adaptation to climate change. Hence perception is considered as an entry point since perceiving climate change affects strategies for adaptation to climate change. The adoption of holistic approach, which is in contrast to previous studies that focused on one or two aspects of climate change, enabled deeper understanding of vulnerability of smallholder farmers. Focusing on livelihoods that depend on cash crops and staple plant, the study identified who or what is vulnerable with a view to support national and international efforts in climate change adaptation. Results showed that smallholder farmers producing coffee are vulnerable to both climatic hazards and price related shocks. To encounter the double exposure associated with coffee, growing enset plant (regarded as drought-resistant) is expected to support livelihoods and build resilience. Yet the sustainability of this scenario is questionable in the face of a long-term rise in temperature in all AEZs. For example, while the midland face hostile condition for both coffee and enset, the highlands may expect a window of opportunity to diversify production and plant crops hitherto not accustomed. Yet the risks associated with climate change excel possible opportunities with implications on food security and poverty reduction measures in affected areas.

Third, it deployed sustainable livelihoods framework as analytical tool to study vulnerability and adaptation to climate change. Most previous research used the framework in the context of rural development and poverty studies. The

application of the framework for climate change studies is rare. This study found that not only the framework could be amended and applied on climate change study, but also it provides a useful approach to understand the vulnerability context to climatic hazards, livelihood assets, institutions and adaptation strategies and livelihood outcomes. The examination of institutions linked the micro level processes with macro level policies that determined the state of mainstreaming climate change in Ethiopia's. The same examination highlighted the dominant thread of the country's policy design, which is largely top-down process (e.g. NAPAs and CRGE). Successful application of adaptation measures requires involvement and active participation of vital stakeholders. The study highlighted that smallholder farmers, community based adaptation and other bottom-up approaches did not receive emphasis they deserve.

Fourth, in terms of sharing knowledge, the research project produced subsidiary results in terms of disseminating findings to the research community. So far three works including a conference paper, a book chapter and journal article have been published (Hameso, 2012, 2014a and 2014b). Apart from knowledge sharing, the process of the research made the marginalized and poor smallholder farmers more visible by listening and documenting their narratives and experiences. The timing of the fieldwork was poignant about ever-present risk of climatic hazards in Sidama and in Ethiopia. Fieldwork took place a year after severe drought that occurred in 2011 which affected southern-most parts of Ethiopia and some of the Horn of Africa region and the conflict-ridden Somalia. In the course of the study, I came to believe that we have only one Planet Earth whose behaviour we must observe and adjust so much as we seek to change it.

Finally, although the scope of the study is limited to specific livelihood system, region and response measures, the findings emerging from this research can be used in understanding similar contexts around the world. Moreover, the study created a juncture to explore opportunities and benefits from climate change. While few opportunities exist in the form of climate finance and the pursuit of environment friendly development path, the burden emerging from climate change far outweighs the benefits. This indicated to the need for undertaking adaptation and mitigation measures as a matter of policy imperative. Finally, the

study established information base for policy on improving perception about climate change, reducing vulnerability and enhancing adaptive capacity of smallholder farmers.

8.4 Limitations of the study

The study is not without limitations that include the quality of climate data, the sample size, treatment of some livelihood assets (mainly natural capital) and selective focus on rural areas.

First, regarding weather data, the challenge is one of availability in the areas of interest. Significant uncertainties and data limitation existed on climate information at a detailed local level to link climate data and socio-economic factors. Synoptic stations are not set up in all districts of Sidama, there is only one in Hawassa. Even the lower class, non-synoptic weather stations currently available are not managed well to produce continuous and reliable climate data. It is also vital to have weather data for longer period of time (this research relied on data of 20 years) as climate change takes longer time horizon. The study of this sort can be enriched by modelling how projected climate change scenarios will spatially and temporally impact coffee and enset production.

Secondly, the sample size for survey data is 120 respondents, which may not be representative of the population. The sample size is kept low due to time and other resource limitations. However, the quantitative data is complemented by qualitative data. Some of the federal agencies of relevance such as the Ministry of Health (MoH) could be engaged to document health impacts of climate change and assess its preparedness to deal with health impacts of climate change.

Third, the survey questionnaire limited itself to fewer natural capital items (mainly livestock) and, by so doing, understated the role of other elements such as land, forest, water and other communally held resources. At the design stage of the questions, the fact that land in Ethiopia is under the ownership of state (over which farmers possess limited user rights) was the reason for exclusion from the contents of natural capital. Moreover dwindling common property assets such as forests and pastureland reduced the significance of ownership or access to these

assets by individual households. In the least, however, on-farm tree assets could have been considered as they are as important as livestock. For instance, households in the study sites were observed to maintain existing trees or to plant new ones as part of agroforestry landscape common. On the other hand, it is notable that some forms of natural capital are incorporated in qualitative data and in different parts of the survey without being listed under natural capital; for example, water availability and pasture are analysed in Table 10. Over all, however, future studies can expand on these and other aspects of natural capital.

Finally, adaptation to climate change is not confined to rural areas and smallholder farmers; it also include urban areas and populations, particularly given a rising trend in urbanisation and rural to urban migration. Studies that explored the urban dimension of climate change adaptation in Ethiopia[1] are very few and they are non-existent in Sidama.

8.5 Future studies

Having detailed the findings, contributions and limitations of this work, it is finally time to pinpoint areas of future work. First, this work focused on perceptions, vulnerability and adaptation to climate change. Yet agriculture has also the potential to mitigate climate change. In as far as agriculture and smallholder farming contribute to climate change, they are also responsible to reduce GHGs through sequestration through soil, water, forest and crop management practices. The subject of carbon markets and linked mitigation measures by smallholder farmers in Sidama and Ethiopia, or even Africa, are not well developed and not covered in this study. This is an area for further research.

Secondly, within the context of adaptation, the relationship between environmental stress and human mobility is left without conclusive result. This study could not establish solid link between migration and climate change. Farmers are not seen flocking to towns or other areas due to climate change. Future studies may explore both themes in the context of 'environmental refugees'.

[1]An exception is the study by Cochrane and Costolanski (2013) in the case of Addis Ababa.

Third, the incidence and impacts of drought, heat waves and floods on human nutrition, floods and waterborne disease require further book. So far, the changing patterns of malaria transmission are well studied although studies on the incidence of malaria in the context of climate change in Sidama are seriously lacking. In this book, attempt is made to include the government's health policy guidelines and documents. Visits to Kebele*s* also enabled personal observation of the state of health extension service. What is observed in terms of health service provision showed that a lot remains to be done. Further research could include the Ministry of Health to explore its plans for climate change adaptation.

Finally, challenges as complex as climate change and development require a multi-disciplinary approach in theoretical design and multi-agency co-operation in practical implementation. Further research could benefit by involving all stakeholders thus involving more structures and institutions than included here. For example, the Ministry of Finance and Economic Development (MoFED) plays a key role in formulating macro policies; it also coordinates the country's finances for development and climate change. Moreover, sectoral ministries that formulate policies in their respective areas need to be engaged. The inclusion of stakeholders will enrich research on climate change policy in Ethiopia.

Bibliography

Aadland, Øyvind (2002) 'Sera: traditionalism or living democratic values? A case study of the Sidama in Southern Ethiopia', in Zewde, B. and Pausewang, S. (eds.) *The challenge of democracy from below in Ethiopia.* Uppsala: Nordiska Afrikainstitutet, pp.29-44.

Abebe, T. Z. (2014) 'The potentials of local institutions for sustainable rural livelihoods: the case of farming households in Dawuro Zone, Ethiopia,' *Public Policy and Administration Review* 2(2), pp. 95-129.

Abid, M., Scheffran, J. Schneider, U. A. and Ashfaq, M. (2014) 'Farmers' perceptions of and adaptation strategies to climate change and their determinants; the case of Punjab province, Pakistan', *Earth System Dynamics Discussion* 5, pp.1359–1406.

Adams, A. M. Cekan, J., Sauerborn, R. (1998) 'Towards a conceptual framework of household coping: reflections from rural West Africa', *Africa*, 68(2), pp.263-283.

Adams, W.M. (2006) 'The future of sustainability: re-thinking environment and development in the twenty-first century.' Report of the IUCN Renowned Thinkers Meeting, 29-31 January. [Online] Available at: http://cmsdata. iucn.org/downloads/iucn_future_of_sustanability.pdf (Accessed: 29 July 2014).

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

Adger, W.N., Brooks, N., Bentham, G., Agnew, M., and Eriksen, S. (2004) New indicators of vulnerability and adaptive capacity, Tyndall Centre for Climate Change Research, Technical Report 7.

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), pp.179-195.

Adger, W.N. (2003a) 'Social aspects of adaptive capacity', in Smith, J. B., Klein R. J. T. and Huq, S. (eds.) *Climate change, adaptive capacity and development*. London: Imperial College Press, pp.29-50.

Adger, W.N. (2003b) 'Social capital, collective action, and adaptation to climate change', *Economic Geography*, (79), 4, pp.387-404.

Adger, W.N. and Kelly, P.M. (1999) 'Social vulnerability to climate change and the architecture of entitlements,' *Mitigation and Adaptation Strategies*, 4, pp.253–266.

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

Admassie, A., Adenew, B., and Tadege, A. (2008) 'Perceptions of stakeholders on climate change and adaptation strategies in Ethiopia.' IFPRI and EEA. IFPRI

Research Brief 15-6. [Online]. Available at: http://www.ifpri.org/sites/default/files/publications/rb15_06.pdf (Accessed: 14 February 2014).

Admassie, A. and Adenew, B. (2007) 'Stakeholders' perceptions of climate change and adaptation strategies in Ethiopia.' EEA Research Report, Addis Ababa: Ethiopian Economic Association.

AfDB (2010) 'Coffee production in Africa and the global market situation', *Commodity Market Brief,* 1(2) 12 July.

AfDB (Africa Development Bank) *et al*. (2008) *Poverty and climate change: reducing the vulnerability of the poor through adaptation*. [Online]. Available at: http://www.oecd.org/environment/cc/2502872.pdf (Accessed: 22 February 2014).

AGRA (Alliance for a Green Revolution in Africa) (2014) *Africa agriculture status report (2014) Climate change and smallholder agriculture in sub-Saharan Africa*. Nairobi, Kenya.

Agrawal, A. (2010) 'Local institutions and adaptation to climate change', in Mearns, R., and Norton, A. (eds.) *Social dimensions of climate change equity and vulnerability in a warming world*. Washington DC.: The World Bank, pp.173-198.

Agrawal, A. (2008) 'The role of local institutions in adaptation to climate change.' Paper prepared for the World Bank Social Dimensions of Climate Change Workshop, Washington, DC, March 5–6.

Agrawal, A. and Gupta, K. (2005) 'Decentralization and participation: the governance of common pool resources in Nepal's Terai', *World Development*, 33(7), pp.1101-1114.

Ahmed, I. and Lipton, M. (1999) 'Impact of structural adjustment on sustainable rural livelihoods: A review of the literature', IDS Working Paper 62. Sussex: Institute for Development Studies.

Albrecht, G., Sartore, G.M., Connor. L., Higginbotham, N., Freeman. S., Kelly, B., Stain. H, Tonna, A., Pollard, G. (2007) 'Solastalgia: the distress caused by environmental change', *Australas Psychiatry*, 15 Suppl 1:S95-8.

Altieri, M.A. and Koohafkan, P. (2008) *Enduring farms: climate change, smallholders and traditional farming communities*. Third World Network. Penang. [Online]. Available at: http://www.fao.org/nr/water/docs/ Enduring_Farms.pdf (Accessed: 21 February 2014).

Alwang, J., Siegel, P.B. and Jørgensen, S. L. (2001) 'Vulnerability: a view from different disciplines.' World Bank Social Protection Discussion Paper Series, June.

Assefa, E. and Bork, H. (2014) 'Dynamics and driving forces of agricultural landscapes in Southern Ethiopia – a case study of the Chencha and Arbaminch areas', *Journal of Land Use Science*. doi: 10.1080/1747423X.2014.940613

ATHA (Advanced Training Program on Humanitarian Action) 'Sustainable Livelihoods Framework.' [Online] Available at: http://www.atha.se/content/sustainable-livelihoods-framework (Accessed: 10 September 2014).

Bacon, C. (2005) 'Confronting the coffee crisis: can fair trade, organic, and specialty coffees reduce small-scale farmer vulnerability in Nicaragua?' *World Development,* 33(3), pp.497–511.

Baer, P., Athanasiou, T., Kartha, S. and Kemp- Benedict, E. (2008) *The greenhouse development rights framework: the right to development in a climate- constrained world*, second edition, Berlin: Heinrich Boll Foundation.

Bailey, C. (2007) *A guide to qualitative field research. 2nd edn.* London: Pine Forge Press.

Barbier, E.B., and Lopez, R. (1998) 'Debt, poverty and resource management in a rural smallholder economy.' Paper prepared for the World Congress of Environmental and Resource Economists, Venice, 25- 27 June.

BASIC (2007) 'Handbook of current and next generation vulnerability and adaptation assessment tools, Paper 8.' [Online]. Available at: http://www.basic-project.net (Accessed: 31 August 2011).

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

Beazley, H and Ennew, J. (2006) 'Participatory methods and approaches: tackling the two tyrannies' in Desai, V. and Potter, R. *Doing development research.* London: Sage Publications.

Bebbington, A. (1999) 'Capitals and capabilities: a framework for analysing peasant viability, rural livelihoods and poverty', *World Development,* 27(12), pp.2012-2044.

Bekele, T., Kassa, K. Mengistu, T., Debele, M. and Melka, Y (2013) 'Working with communities to address deforestation in the Wondo Genet Catchment Area, Ethiopia: lessons learnt from a participatory action research', *Research Journal of Agriculture and Environmental Management. 2*(12), pp.448-456.

Belay, K. (2003) Agricultural extension in Ethiopia: the case of participatory demonstration and training extension system, *Journal of Social Development in Africa,* 18 (1), pp.49-83.

Ben, T. (2005) 'A content analysis reports on climate change impacts, vulnerability and adaptation in Uganda.' [Online]. Available at: http://pubs.iied.org/pdfs/10011IIED.pdf (Accessed: 7 September 2011)

Berhanu, K. (2002) 'The role of NGOs in promoting democratic values: the Ethiopian experience', in Zewde, B. and Pausewang, S. (eds.) *The challenge of democracy from below in Ethiopia.* Uppsala: Nordiska Afrikainstitutet, pp.120-129.

Berhanu, K. and Poulton, C. (2014) 'The political economy of agricultural extension policy in Ethiopia: economic growth and political control', *Development Policy Review,* 32(S2), pp.s199-s216.

Berkes, F. and Jolly, D. (2001) 'Adapting to climate change: social-ecological resilience in a Canadian western Arctic community', Co*nservation Ecology,* 5(2), pp.18. [Online]. Available at: http://www.consecol.org/vol5/iss2/art18 (Accessed: 22 August 2011).

Bernier, Q. and Meinzen-Dick, R. (2014) 'Resilience and social capital.' Paper for 2020 Conference: Building resilience for food and nutritional security May. [Online] Available at: http://www.ifpri.org/sites/default/files/publications/2020resilienceconfpaper04.pdf (Accessed: 30 May 2014)

Beyene, A., Kassahun, Y., Addis, T., Assefa, F., Amsalu, A., Legesse, W., Kloos, H., & Triest, L. (2012) 'The impact of traditional coffee processing on river water quality in Ethiopia and the urgency of adopting sound environmental practices', *Environmental Monitoring & Assessment*, 184(11), pp.7053-7063.

Bezabih, M., Holden,S. and Mannberg, A. (2012) 'The role of land certification in reducing gender gaps in productivity in rural Ethiopia', Centre for Land Tenure Studies, Norwegian University of Life Sciences.

Bidwai, P. (2012) 'Climate change, equity and development – India's dilemmas', What Next Volume III: Climate, Development and Equity, Dag Hammarskjold Foundation and the What Next Forum. pp.147-162.

Blaikie, P., Cannon, T., Davis, I., and Wisner, B. (1994) *At risk: natural hazards, people's vulnerability, and disasters.* London: Routledge.

Blokland K. and Gouet C., 2007, 'Peer to peer farmer support for economic development', in Ton G., Bijman J. and Oorthuizen J., eds, *Producer organizations and market chain,* Wageningen: Wageningen Academic Publishers, pp.71–90.

Bock, F. (2014) 'Green gold of Africa – can growing native bamboo in Ethiopia become a commercially viable business?' *The Forestry Chronicle*, 90(5), pp.628-635.

Bourdieu, P. (1986) The forms of capital. Translated by. R. Nice, in Richardson, J. (ed.) *Handbook of theory and social research for the sociology of education.* New York: Greenwood Press, pp.241-258.

Brandt, S.A., Spring, A., Hiebsch, C., McCabe, T., Tabogie, E., Diro, M., Wolde-Michael, G., Yntiso, G., Shigeta, M., and Tesfaye, S. (1997) 'The "tree against hunger": Enset-based agricultural systems in Ethiopia', American Association for the Advancement of Science and others.' [Online]. Available at:

http://www.aaas.org/international/africa/enset/ enset.pdf (Accessed: 8 September 2011).

Brooks, N. (2003) 'Vulnerability, risk and adaptation: a conceptual framework', Tyndall Centre for Climate Change Research Working Paper 38. November.

Bryan, E., Deressa, T. T., Gbetibouo, G. A. and Ringler, C. (2009) 'Adaptation to climate change in Ethiopia and South Africa: options and constraints', *Environmental Science & Policy,* 12, pp.413–426.

Brydon, L. (2006) 'Ethical practices in doing development research', in Desai, V. and Potter, R. *Doing development research.* London: Sage Publications.

Bulkeley, H. (2000) Common knowledge? Public understanding of climate change in Newcastle, Australia. *Public Understanding of Science*, 9, pp.313-333.

Bulmer, M. and Warwick D.P. (eds.) (1993) *Social research in developing countries: surveys and censuses in the Third World.* London: UCL Press.

Burke, M. B., Miguel, E., Satyanath, S., Dykema, J. A., and Lobell, D. B. (2009) 'Warming increases the risk of civil war in Africa', *PNAS*, 106(49), pp.20670–20674.

Burton, I., Soussan, J., and Hammill, A. (2003) Livelihoods and climate change: combining disaster risk reduction, natural resource management and climate change adaptation in a new approach to the reduction of vulnerability and poverty: a conceptual framework. International Institute for Sustainable Development.

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

Byg, A. and Salick, J. (2009) 'Local perspectives on a global phenomenon: climate change in eastern Tibetan villages', *Global Environmental Change* 19(2), pp.156-166.

Campbell, L. and Wiesen, A. (eds) (2009) 'Restorative commons: creating health and well-being through urban landscapes.' General Technical Report NRS-P-39. USDA Forest Service, Northern Research Station.

Carney, D. (1999) 'Approaches to sustainable livelihoods for the rural poor.' ODI Poverty Briefing. Online. Available at: www.odi.org.uk/resources/docs/3093.pdf. (Accessed: 28 January 2014).

Carney, D., Drinkwater. M., Rusinow, T., Neefjes, K., Wanamali, S. and Singh, N. (1999) 'Livelihood approaches compared: a brief comparison of the livelihoods approaches of DFID, CARE, Oxfam, and UNDP.' DFID: London.

Carr, E.R. (2014) 'From description to explanation: using the livelihoods as intimate government (LIG) approach', *Applied Geography,* 52, 110-122

Carson, R. (1962) *Silent spring*. Boston: Houghton Mifflin.

Ceballos, G., Ehrlich, P.R., Barnosky, A.D., García, A., Pringle, R.M., and Palmer, T.M. (2015) 'Accelerated modern human–induced species losses: entering the sixth mass extinction', *Science Advances*. [Online] Available at: http://advances.sciencemag.org/content/advances/1/5/e1400253.full.pdf (Accessed on 22 June 2015).

Chambers, R. (1995) 'Poverty and livelihoods: whose reality counts?' IDS Discussion Paper, No. 241, Brighton: Institute of Development Studies.

Chambers, R. (1983) *Rural development: putting the last first.* Longman, London.

Chambers, R. and Conway, G. (1992) 'Sustainable rural livelihoods: practical concepts for the 21st century', IDS Discussion Paper 296, Brighton: Institute of Development Studies.

Chen, H., Githeko, A.K., Zhou, G., Githure, J.I. & Yan, G. (2006) 'New records of Anopheles arabiensis breeding on the Mount Kenya Highlands indicate indigenous malaria transmission', *Malaria Journal,* 5(17).

Ching, L.L., Edwards, S. and Scialabba, N. (eds.) (2011) *Climate change and food systems resilience in Sub-Saharan Africa*. Rome: Food and Agriculture Organization.

Clements, R., Haggar, J., Quezada, A. and Torres, J. (2011) *Technologies for climate change adaptation – agriculture sector.* Roskilde: UNEP Risø Centre.

Cochrane, L. and Costolanski, P. (2013) 'Climate change vulnerability and adaptability in an urban context: a case study of Addis Ababa, Ethiopia', *International Journal of Sociology and Anthropology*, 5(6), pp.192-204.

Coleman, J. (1988) 'Social capital in the creation of human capital', *The American Journal of Sociology,* 94, pp.S95-S120.

Conway, D., Lisa, E., Schipper, F. (2011) 'Adaptation to climate change in Africa: challenges and opportunities identified from Ethiopia', *Global Environmental Change*, 21(1), pp.227-237.

Conway, D., Schipper, L., Yesuf, M., Kassie, M., Persechino, A., and Kebede, B. (2007) *Reducing vulnerability in Ethiopia: addressing the implications of climate change: integration of results from Phase I.* Norwich: University of East Anglia.

Coppock, D.L. (1994) 'The Borana plateau of southern Ethiopia: synthesis of pastoral research, Development and Change, 1980-91', Systems Study No. 5, International Livestock Centre for Africa, Addis Ababa.

Cooper, P.J.M., Dimes, J., Rao, K.P.C., Shapiro, B., Shiferaw, B., Twomlow. S. (2008) 'Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: an essential first step in adapting to future climate change?' *Agriculture, Ecosystems and Environment*, 126, pp.24–35.

Co-operative and Enterprise Development Directorate (2012) 'A framework for the development of smallholder farmers through cooperative development', Agriculture, Forestry and Fisheries, Republic of South Africa.

Corner, A., Whitmarsh, L., and Xenias, D. (2012) 'Uncertainty, scepticism and attitudes towards climate change: biased assimilation and attitude polarisation', *Climatic Change,* 114(3/4), pp.463-478.

Costantinos, B. T. Mohammed, S. (1999) 'Natural resource competition, conflicts and their managements: case study from Wondo Genet, south-central Ethiopia.' Addis Ababa: Centre for Human Environment and Development.

Crate, S.A., and Nuttall, M. (eds.) (2009) *Anthropology and climate change: from encounters to actions.* Walnut Creek: Left Coast Press.

Crow, G. (1989) 'The use of the concept of "Strategy" in recent sociological literature', *Sociology*, 23(1), pp.1-24.

CSA (2011) Tables: Section-B: Population. [Online]. Available at: http://www.csa.gov.et/index.php?option=com_rubberdoc&view =doc&id=226&format=raw&Itemid=561 (Accessed: 21 Mar 2013

CSA (Central Statistical Authority) (2007) Tables: Southern Peoples, Nations and Nationalities Region. [Online] Available at: http://www.csa.gov.et/ index.php?option=com_rubberdoc&view=doc&id=273&form=ra&Itemid=521 (Accessed: 31 July 2011).

Daddi, J., Gezahegn, T., Wakgari, D., Adugna, W., Daniel, K., Desta, A. (2005). 'Baseline survey for the implementation of insecticide treated mosquito nets in Malaria control in Ethiopia', *Ethiopian Journal of Health Development,* 19(1), pp.16-23.

Davies, S. (1993) 'Are coping strategies a cop-out?' *IDS Bulletin*, 24(4), pp.60.

Davies, M., Guenther, B., Leavy, J., Mitchell, T. and Tanner, T. (2009) 'Climate change adaptation, disaster risk reduction and social protection: complementary roles in agriculture and rural growth?' IDS Working Paper 320.

Davies, M., Guenther, B., Leavy, Mitchell, T.J. and Tanner, T. (2008) '"Adaptive social protection": synergies for poverty reduction', *IDS Bulletin*, 39(4), pp.105-116.

De Angelis, M. (2000) 'Thomas Malthus' theory of population and the working class' Lecture Notes 6. ECO 108 Introduction to Political Economy. [Online] Available: http://homepages.uel.ac.uk/M.DeAngelis/ln6-malthus&wages.pdf (Accessed: 13 October 2014).

Debelo, A.R. (2011) Contested terrains: conflicts between state and local communities over the management and utilization of Nech Sar National Park, Southern Ethiopia', *Journal of Sustainable Development in Africa*, 13(5), pp.49-65). Clarion: Clarion University of Pennsylvania.

Denney, L. and Kassaye, D. (2013) 'Securing communities for development: community policing in Ethiopia's Amhara national regional state', Overseas Development Institute. October. [Online] Available at: http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8656.pdf (Accessed 23 May 2014)

Dercon, S. and Krishnan, P. (1996) 'Income portfolios in rural Ethiopia and Tanzania: choice and constraints,' *Journal of Development Studies*, 32, pp.850-875.

Dercon, S., De Weerdt, J. Bold, T., and Pankhurst, A. (2006) 'Group-based funeral insurance in Ethiopia and Tanzania', *World Development,* 34(4), pp.685-703.

Deressa, T.T., Ringler, C., and Hassan, R.M. (2010) 'Factors affecting the choices of coping strategies for climate extremes: The case of farmers in the Nile Basin of Ethiopia', IFPRI Discussion Paper 01032, November.

Deressa, T., Hassan, R.M., Ringler, C., Alemu, T., and Yesuf, M. (2009) 'Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia', *Global Environmental Change*, 19, pp.248–255.

Deressa, T., Hassan, R.M., and Ringler, C. (2008) 'Measuring Ethiopian farmers' vulnerability to climate change across regional states', IFPRI Discussion Paper 00806, October.

Desai, V. and Potter, R. (2006) *Doing development research.* London: Sage Publications.

Devereux, S. 1992. Household responses to food insecurity in North-eastern Ghana. Unpublished PhD Thesis, University of Oxford.

Devereux, S. and Guenther, B. (2007) *Social protection and agriculture in Ethiopia.* Institute of Development Studies, University of Sussex. 30 November. [Online] http://www.fao.org/fileadmin/templates/tc/spfs/pdf/FAO_2008_-_Social_Protection__Study_Case_Ethiopia.pdf (Accessed: 12 April 2014).

de Waal, A. (1991) *Evil days: thirty years of war and famine in Ethiopia*. New York & London: Human Rights Watch.

DFID (Department for International Development) (1999) *Sustainable livelihoods guidance sheets,* London: DFID.

Diaz, H. and Hurlbert, M. (2014) 'Making science count: climate change and the science/practice interface', in Filho *et al.* (eds), *International perspectives on climate change: Latin America and beyond.* Switzerland: Springer International Publishing, pp.203-215.

Dietz, R. and O'Neill, D. (2013) *Enough is enough: building a sustainable economy in a world of finite resources.* Abingdon: Earthscan.

Di Falco, S., Veronesi, M. and Yesuf, M. (2011) 'Does adaptation to climate change provide food security a micro-perspective from Ethiopia?' *American Journal of Agricultural Economics,* (93) 3, pp.825-842.

Dinar, A., Hassan, R., Mendelsohn, R. and Benhin, J. (eds.) (2008) *Climate change and African agriculture: impact assessment and adaptation strategies*. London: Earthscan.

Dinku, F. (2011) 'Climate risk management and data needs for agriculture in Ethiopia,' Strengthening capacity for climate change adaptation in the Agriculture sector in Ethiopia. Proceedings from National Workshop held in Nazreth, Ethiopia, 5-6 July 2010, FAO.

Doherty, T. J. and Clayton, S. (2011) 'The psychological impacts of global climate change', *American Psychologist,* (66) 4, pp.265-276.

Dorosh, P. and Rashid, S. (eds.) (2012) *Food and agriculture in Ethiopia: progress and policy challenges.* Philadelphia: University of Pennsylvania Press.

Dorward, A. (2009) 'Integrating contested aspirations, processes and policy: development as hanging in, stepping up and stepping out', *Development Policy Review*, 27(2), pp.131-146.

Dorward, A., Anderson, S., Nava, Y., Pattison, J., Paz, R., Rushton, J. and Sanchez-Vera, E. (2005) *A guide to indicators and methods for assessing the contribution of livestock keeping to the livelihoods of the poor.* London: Imperial College.

Dorward, A., Fan, S., Kydd J., Lofgren, H., Morrison J., Poulton, C., Rao, N., Smith, L., Tchale, H., Thorat, S., Urey, I. and Wobst, P. (2004) 'Institutions and economic policies for pro-poor agricultural growth', IFPRI Discussion paper, DSG 15.

Dougherty, M. (2002) 'Gendered scripts and declining soil fertility in Southern Ethiopia', *African Studies Quarterly,* 6(1&2). [Online] Available at: http://asq.africa.ufl.edu/v6/v6i1-2a5.pdf (Accessed: 12 March 2014)

Downing, T.E. and Patwardhan, A. (2003) *Vulnerability assessment for climate adaptation, Adaptation Policy Framework: a guide for policies to facilitate adaptation to climate change*. UNDP.

Drèze, J. and Sen, A.K. (2007) *The political economy of hunger: Volume 1. Entitlement and wellbeing*. Oxford: Clarendon Press.

Drèze. J. and Sen. A.K. (1989) *Hunger and public action. Studies in development economics.* Oxford: Clarendon Press.

Eakin, H. (2012) 'Human vulnerability to global environmental change.' [Online] Available at: http://www.camelclimatechange.org/view/article/153598 (Accessed: 22 July 2014).

Eakin, H. (2008) 'Human vulnerability to global environmental change', in *Encyclopedia of Earth*. Washington, D.C.: Environmental Information Coalition,

National Council for Science and the Environment. [Online]: Available at: http://www.eoearth.org/article/Human_vulnerability_to_global_environmental_change (Accessed: 14 July 2011).

Eakin, H., Tucker, C.M., and Castellanos, E. (2005) 'Market shocks and climate variability: the coffee crisis in Mexico, Guatemala, and Honduras', *Mountain Research and Development*, 25(4), pp.304-309.

Eakin, H. (2003) 'The social vulnerability of irrigated vegetable farming households in central Puebla', *Journal of Environment and Development,* 12, pp.414-429.

Earthwatch Institute (2009) 'Climate change: the social and economic impacts. Earthwatch Educational Resources.' [Online] Available at: www.earthwatch.org (Accessed: 21 August 2013).

Ekstrom, J. A. and Moser, S. C. (2013) 'Institutions as key element to successful adaptation processes: Results from the San Francisco Bay Area', in Moser, S. and Boykoff, M. (2013) *Successful adaptation to climate change: linking science and policy in a rapidly changing world*. Routledge: London, pp.97-113.

ELC (Environmental Literacy Council) (2007) 'Environmental economics. Volume 1: The essentials.' [Online]. Available at: http://enviroliteracy.org/pdf/EnviroEcon-vol1.pdf (Accessed: 13 May 2014).

Ellis, F. (2003) 'A livelihoods approach to migration and poverty reduction', Paper commissioned by DFID, Contract No 03 4890 November.

Ellis, F. (2000a) 'The determinants of rural livelihood diversification in developing countries', *Journal of Agricultural Economics*, 51(2), pp.289-302

Ellis, F. (2000b) *Rural livelihoods and diversity in developing countries.* Oxford University Press.

Ellis, F. (1998) 'Household strategies and rural livelihood diversification,' *The Journal of Development Studies*, 35(1), pp.1-38.

Ellis, F. and Freeman, H.A. (2004) Rural livelihoods and poverty reduction strategies in four African countries. *The Journal of Development Studies*, 40(4), pp.1-30.

Endalamaw, T.B., Lindner, A., and Pretzsch, J. (2013) 'Indicators and determinants of small-scale bamboo commercialization in Ethiopia', *Forests,* 4, pp.710-729.

Eneyew, A. and Bekele, W. (2013) 'Analysis of wealth and livelihood capitals in Southern Ethiopia: a lesson for policy makers', *Current Research Journal of Social Sciences,* 5(1), pp.1-10.

EPA (Ethiopian Environmental Protection Authority) (2012) *National Report of Ethiopia, the United Nations Conference on Sustainable Development (Rio+20).* Federal Democratic Republic of Ethiopia, Addis Ababa.

EPA (2011) 'REDD readiness – Ethiopia', paper presented at Forest Carbon Partnership Facility (FCPF), PC8 meeting, March 24-25.

Eriksen, S., Aldunce, P., Bahinipati, C. S., Martins, R. D., Molefe, J.I., Nhemachena, C., O'brien, K., Olorunfemi, F., Park, J., Sygna, L., and Ulsrud, K. (2011) 'When not every response to climate change is a good one: identifying principles for sustainable adaptation', *Climate and Development,* 3, pp.7-20.

Eriksen, S., Klein, R.J.T., Ulsrud, K., Næss, L.O. and O'Brien, K. (2007) 'Climate change adaptation and poverty reduction: key interactions and critical measures*',* GECHS Report. Oslo: University of Oslo.

Eriksen, S., Brown, K., and Kelly, P.M. (2005) 'The dynamics of vulnerability: locating coping strategies in Kenya and Tanzania', *Geographical Journal*, 171, pp.287-305.

Ermert, V., Fink, A.H., Morse, A.M., and Paeth, H. (2012) 'The impact of regional climate change on malaria risk due to greenhouse forcing and land-use changes in Tropical Africa', *Environmental Health Perspectives*, 120, pp.77–84.

Eshetu, A.A. (2014) 'Microfinance as a pathway out of poverty and viable strategy for livelihood diversification in Ethiopia', *Journal of Business Management and Economics,* 5(6). pp.142-151 September.

Eshetu, Z. Simane, B., Tebeje, G., Negatu, W., Amsalu, A., Berhanu, A., Bird, N., Welham, B., and Trujillo, N.C. (2014) 'Climate finance in Ethiopia', Promoting effective climate finance project report, Overseas Development Institute (ODI).

Fankhauser, S. (2009) *A perspective paper on adaptation as a response to climate change*. Copenhagen Consensus Center, Copenhagen Business School, Denmark.

Fankhauser, S., Smith, J. and Tol, R. (1999) 'Weathering climate change: some simple rules to guide adaptation decisions', *Ecological Economics*, 30(1), pp.67-78.

FAO (Food and Agriculture Organisation) (2011) 'Organic agriculture and climate change mitigation: a report of the round table on organic agriculture and climate change.' Rome: FAO. [Online]. Available at: http://www.fao.org/docrep/ 015/i2537e/i2537e00.pdf (Accessed: 28 February 2014)

FDRE (Federal Democratic Republic of Ethiopia) (2011) crgevision: Ethiopia's vision for a climate resilient green economy, Addis Ababa. Online: http://www.ethioembassy.org.uk/news_archive/crge/Ethiopai's%20Vision%20for%20a%20Climate%20Resilient%20Green%20Economy.pdf (Accessed: 13 January 2014).

Filho, W.L. and Mannke, F. (2014) 'Managing the impacts of climate change in Latin America: the need for technology transfer', in Filho, W.L., Alves, F., Caeiro, S. and Azeiteiro, U.M. (eds.) *International perspectives on climate change: Latin America and beyond.* Switzerland: Springer International Publishing, pp.95-106.

Fleming, A. and Vanclay, F. (2011) 'Farmer responses to climate change and sustainable agriculture', in Lichtfouse, E., Hamelin, M., Navarrete, M. and Debaeke, P. (eds) *Sustainable Agriculture, Volume 2.* Dordrecht: Springer, pp.283-293.

Ford, J. and Smit, B. (2004) 'A framework for assessing the vulnerability of communities in the Canadian Arctic to risks associated with climate change', *Arctic* 57(4), pp.389-400.

Fox, N.J. (2006) 'Postmodern field relations in health research', in Hobbs, D. and Wright, R. (eds.) *The Sage Handbook of Fieldwork*. London: Sage.

Füssel, H. (2007) 'Vulnerability: a generally applicable conceptual framework for climate change research', *Global Environmental Change,* 17(2), pp.155–167.

Füssel, H. and Klein, R.J.T. (2006) Climate change vulnerability assessments: An evolution of conceptual thinking. *Climatic Change.* 75(3), pp.301–329.

Gbetibouo, A.A. and Ringler, C. (2009) 'Mapping South African farming sector vulnerability to climate change and variability: a subnational assessment', IFPRI Discussion Paper 00885. August.

GCEC (Global Commission on the Economy and Climate) (2014) 'Better growth better climate', The New Climate Economy Report: The Synthesis Report. [Online] Available at: http://newclimateeconomy.net

Gebreegziabher, Z., Stage, J. Mekonnen, A. and Alemu, A. (2011) 'Climate change and the Ethiopian economy: a computable general equilibrium analysis', Environment for Development Discussion Paper Series EfD DP 11-09. October.

Gebretsadik, Z.M. (2014) 'Watershed degradation and the growing risk of erosion in Hawassa-Zuria District, Southern Ethiopia'*, Journal of flood risk management,* 7, pp.118–127.

GECE (The Global Commission on the Economy and Climate) (2014) *Better growth better growth, better climate the new climate economy report the synthesis report.* September. Washington, D.C.: New Climate Economy.

Glaser, B.G. and Strauss, A. (1967) *The discovery of grounded theory: strategies for qualitative research.* Chicago: Aldine.

German, L., Mowo, J. and Opondo, C. (2012) 'Integrated natural resource management: from theory to practice.' In German, L., Mowo, J. Amede, T., and Masuki, K. (eds) *Integrated natural resource management in the highlands of Eastern Africa: from concept to practice.* London and New York: Earthscan, pp.1-37.

Gibbs, G. (2002) *Qualitative data analysis: explorations with NVivo.* Buckingham: Open University Press.

Hagos, S., Lunde, T., Mariam, D.H., Woldehanna, T. and Lindtjørn, B. (2014) 'Climate change, crop production and child under nutrition in Ethiopia: a longitudinal panel study', *BMC Public Health.* 14, p.884.

Haile, M. (2005) 'Weather patterns, food security and humanitarian response in sub-Saharan Africa', *Philosophical Transactions of the Royal Society B*, 360, pp.2169-2182.

Halsnæs, K. and Trærup, S. (2009) 'Development and climate change: a mainstreaming approach for assessing economic, social, and environmental impacts of adaptation measures', *Environmental Management,* 43, pp.765–778.

Hamer, J. H. (2009) 'Money, modernization and ambivalence among the Sidama of Northeastern Africa', *History and Anthropology,* 20(1), pp.1-14.

Hamer, J. H (2002) 'The religious conversion process among the Sidāma of North-East Africa', *Africa,* 72 (4), pp.598-627

Hamer, J. (1987) *Humane Development: participation and change among the Sadama of Ethiopia.* Tuscaloosa: The University of Alabama Press.

Hameso, S. (2014a) 'Perceptions about climate change in Sidama, Ethiopia' in Filho, *et al.* (eds.), *International perspectives on climate change: Latin America and beyond*. Switzerland: Springer International Publishing. pp.267-286.

Hameso, S. (2014b) Doing field research on climate change with smallholder farmers in Ethiopia. In *SAGE Research Methods Cases*. London: SAGE Publications. doi: http://dx.doi.org/10.4135/978144627305014533931

Hameso, S. (2013) 'Crops and carbon: Paying farmers to combat climate change', [Book Review] *Economic Analysis and Policy*. (43)1, March: pp.109-111. [Online]. Available at: http://www.eap-journal.com/archive/v43_i1_07-Book_Reveiws.pdf (Accessed: 28 February 2014).

Hameso, S. (2012) 'Development challenges in the age of climate change: the case of Sidama.' Paper presented at the workshop on the economy of Southern Ethiopia, Ethiopian Economics Association. Hawassa. March 1.

Hameso, S. (2006) 'The Sidama nation: an introduction', in Hameso, S. and Hassen, M. (eds.) *Arrested development in Ethiopia: Essays on under-development, democracy and self-determination.* Trenton: Red Sea Press, pp.57-75.

Hardin, G. (1968) 'The tragedy of the commons', S*cience,* 162, pp.1243-1248.

Hartel, C.E. and Pearman, G.I. (2010) 'Understanding and responding to the climate change issue: towards a whole-of-science research agenda', *Journal of Management & Organization,* 16, pp.16-47.

Hassan, R. (2010) 'The double challenge of adapting to climate change while accelerating development in sub-Saharan Africa', *Environment and Development Economics,* 15, pp.661–685.

Hassan, R. & Nhemachena, C. (2008) 'Determinants of climate adaptation strategies of African farmers: multinomial choice analysis.' *African Journal of Agricultural and Resource Economics* 2, pp.83-104.

Heuson, C., Gawel, E. and Lehmann, P. (2014) 'State of the art on the economics of adaptation', in Markandya, A., Galarraga, I. and de Murieta, E.S. (eds.)1 *Routledge handbook of the economics of climate change adaptation.* London: Routledge, pp.27-55.

Hussein, J.W., Beyene, F. and Wentzell, R.J. (2014) 'The political ecology of resource-based inter-ethnic violence: the case of the Jarso and the Girhi in Eastern Ethiopia', *Journal of Asian and African Studies.* doi:10.1177/002190 9614547600

Gage, K. L., Burkot, T. R., Eisen, R. J., Hayes, E. B. (2008) 'Climate and vector borne diseases', *American Journal of Preventive Medicine.* (35)5, pp.436–450.

Ghirotti M. (1998) 'The role of livestock in mitigating land degradation, poverty and child malnutrition in mixed farming systems: the case of coffee-growing midland of Sidama – Ethiopia', in Proceedings of the International Conference on Livestock and the Environment, Wageningen, 16-20 Jun 1997. Nell, A.J. (ed.). World Bank, Washington DC. 129-145. [Online]. Available at: http://www.fao.org/wairdocs/lead/x6130e/X6130E06.htm (Accessed: 12 March 2014).

Giddens, A. (2009) *The politics of climate change.* Malden: Polity.

Glaser, B.G., and Strauss, A. (1967) *The discovery of grounded theory: strategies for qualitative research.* Chicago. IL: Aldine.

Halderman, M. (2004) 'The political economy of pro-poor livestock policy making in Ethiopia', PPLPI Working Paper 19. Pro-Poor Livestock Policy Initiative, Rome: Food and Agriculture Organization.

Hassan, R. (2010) 'The double challenge of adapting to climate change while accelerating development in sub-Saharan Africa', *Environment and Development Economics*, 15, pp.661–685.

Heltberg, R., Siegel, P.B., Jorgensen, S.L. (2009) 'Addressing human vulnerability to climate change: toward a 'No Regrets' approach', *Global Environmental Change*, 19(1), pp.89-99.

Hoben, A. (1995) 'Paradigms and politics: the cultural construction of environmental policy in Ethiopia', *World Development,* 23(6), pp.1007-1021.

Hope, K.R. (2009) 'Climate change and poverty in Africa', *International Journal of Sustainable Development & World Ecology,* 16(6), pp.451-461.

Huq, S. and Reid, H. (2004) 'Mainstreaming adaptation in development', *IDS Bulletin*, 35(3), pp.15-21.

Ibrahim, S. and Tiwari, M. (eds) (2014) *The capability approach: from theory to practice.* Houndmills: Palgrave and Macmillan.

IEA (International Energy Agency) (2011) *Energy Statistics*, www.iea.org/stats/index.asp

IFAD (International Fund for Agricultural Development) (2013) *The adaptation advantage: the economic benefits of preparing small-scale farmers for climate change.* Rome: IFAD. [Online]. Available at: http://www.ifad.org/climate/resources/adaptation_farmers.pdf (Accessed: 26 February 2014).

IFAD & UNEP (2013) *Smallholders, food security, and the environment.* Rome: IFAD and UNEP.

IFPRI (International Food Policy Research Institute) (2006) *Atlas of the Ethiopian rural economy*. Washington, D.C.: IFPRI.

IISD (International Institute for Sustainable Development) (2003) *Livelihoods and climate change: a conceptual framework paper prepared by the task force on climate change, vulnerable communities and adaptation*. Winnipeg: International Institute for Sustainable Development.

Ingelaere, B. (2014) 'What's on a peasant's mind? Experiencing RPF state reach and overreach in post-genocide Rwanda (2000–10)', *Journal of Eastern African Studies*, 8(2), pp.214-230

IPCC (2014) *Climate Change 2014: Impacts, adaptation, and vulnerability*. IPCC Working Group II Contribution to AR5

IPCC (2013) *Climate Change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge and New York: Cambridge University Press.

IPCC (2007a) *Climate Change 2007: The physical science basis, contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge: Cambridge University Press.

IPCC (2007b) *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: Cambridge University Press, pp.273–313.

IPCC (2007c) *Climate Change 2007: Synthesis report*. Cambridge: Cambridge University Press.

IPCC (2001) *Climate Change 2001: Impacts, adaptation and vulnerability, summary for policymakers and technical summary of the Working Group II Report.* Geneva: IPCC.

IPCC (1996) *Climate Change 1995: A report of the Intergovernmental Panel on Climate Change, Second Assessment Report*, Geneva: IPCC.

Jagger, P., Pender, J. (2003) 'The role of trees for sustainable management of less-favored lands: the case of Eucalyptus in Ethiopia', *Forest Policy and Economics*, 5(1), pp.83–95.

Jaja, J. and Dawson, J. (2014) 'What contributes to climate change adaptive capacity? A retrospective case study in a Caribbean Small Island community', in Filho *et al.* (eds.), *International perspectives on climate change: Latin America and beyond*. Switzerland: Springer International Publishing. pp.123-133.

Jessop, R., Diallo, B., Duursma, M., Mallek, A., Harms, J. and van Manen, B. (2012) *Creating access to agricultural finance based on a horizontal study of Cambodia, Mali, Senegal, Tanzania, Thailand and Tunisia.* Paris: Agence Francaise de Developpement.

Jima, D., Tesfaye, G., Deressa, W., Woyessa, A., Kebede, D. and Alamirew, D. (2005) 'Baseline survey for the implementation of insecticide treated mosquito nets in Malaria control in Ethiopia', *Ethiopian Journal of Health Development*. 19, pp.16-24.

Johansen C., Haque M.E., Bell R.W., Thierfelder, C., Esdaile R.J. (2012) Conservation agriculture for small holder rain fed farming: Conservation agriculture for small holder rainfed farming: opportunities and constraints of new mechanized seeding systems.' *Field Crops,'* 132, pp.18-32.

Juana, S. J., Kahaka, Z. and Okurut, F.N. (2013) 'Farmers' perceptions and adaptations to climate change in Sub-Sahara Africa: A synthesis of empirical studies and implications for public policy in African agriculture', *Journal of Agricultural Science*, (5)4; pp.121-135.

Jufare, Ayele Tessema (2008) Livelihood adaptation, risks and vulnerability in rural Wolaita, Ethiopia. Unpublished PhD Thesis. Norwegian University of Life Sciences, UMB.

Kanninen, T. (2013) *Crisis of global sustainability.* Abingdon: Routledge.

Kanshie, T. K. (2002) *Five thousand years of sustainability? A case study on Gedeo land use (Southern Ethiopia).* Heelsum, The Netherlands: Treemail Publishers.

Kassie, B, Hengsdijk, H, Rötter, R, Kahiluoto, H, Asseng, S, & Ittersum, M (2013), 'Adapting to climate variability and change: experiences from cereal-based farming in the Central Rift and Kobo Valleys, Ethiopia', *Environmental Management*, (52) 5, pp.1115-1131.

Kaur, N. (2013) 'Ethiopia: Can it adapt to climate change and build a green economy?' IIED. Available. [Online]. Available at: http://www.iied.org/ethiopia-can-it-adapt-climate-change-build-green-economy 25 March. (Accessed: 23 February 2014).

Kebede, D. and Adane, H. (2011) 'Climate change adaptations and induced farming livelihoods', DCG Report No. 64 October.

Keller, E. (1992) 'Drought, war, and the politics of famine in Ethiopia and Eritrea', *The Journal of Modern African Studies* 40(4), pp.609-624.

Kelly, P.M. and Adger, W. N. (2000) 'Theory and practice in assessing vulnerability to climate change and facilitating adaptation', *Climatic Change,* 47, pp.321-352.

Kent, R. and Dorward, A. (2015) 'Livelihood responses to *Lantana camara* invasion and biodiversity change in southern India: application of an asset function framework', *Regional Environmental Change* 15, pp.353-364.

Kent, R. and MacRae, M. (2010) 'Agricultural livelihoods and nutrition – exploring the links with women in Zambia', *Gender & Development,* 18(3), pp.387-409.

Kewessa, G., Abebe, T. and Demissie, A. (2015) 'Indigenous knowledge on the use and management of medicinal trees and shrubs in Dale District, Sidama Zone, Southern Ethiopia', *Ethnobotany Research & Applications* 14, pp.171-182.

Kia, K. (2014) *Ethiopia's ethnic federalism and the right to self-determination: the experience of Sidama people.* Saarbrucken: Lap Lambert Academic Publishing

Kidanu, A, Rovin, K., and Hardee, K. (2009) *Linking population, fertility and family planning with adaptation to climate change: views from Ethiopia.* Addis Ababa: Miz-Hasab Research Center, Population Action International, Washington DC.

Kindra, J. (2014) 'Building food security in Ethiopia', *IRIN* [Online] Available at: http://www.irinnews.org/printreport.aspx?reportid=100367 (Accessed: 18 July 2014)

Kirby, P. (2006) *Vulnerability and violence: the impact of globalisation*. London: Pluto Press.

Knutsson, P. (2006) 'The sustainable livelihoods approach: a framework for knowledge integration assessment', *Human Ecology Review,* 13(1), pp.90-99.

Kollmair, M. and Gamper, St. 'The sustainable livelihoods approach.' Development Study Group, University of Zurich. [Online] Available at: (http://www.nccr-pakistan.org/publications_pdf/General/SLA_Gamper_ Kollmair.pdf) (Accessed: 15 May 2014).

Krishnana, P. and Patnamb, M. (2012) 'Neighbours and extension agents in Ethiopia: Who matters more for technology diffusion?' International Growth Centre. Working Paper 12/0159. March.

Krysanova, V., Dickens, C., Timmerman, J. *et al.* (2010) 'Cross-comparison of climate Change adaptation strategies across large river basins in Europe, Africa and Asia', *Water Resource Management,* 24, pp.4121-4160.

Laderach P, Jarvis A, Ramirez J (2008) 'The impact of climate change in coffee-growing regions', in Taller de Adaptacion al Cambio Climatico en las Comunidades Cafetaleras de la Sierra Madre de Chiapas, Tuxtla Gutierrez, Chiapas, 17–18 November.

Lautze, S. Aklilu, Y., Raven-Roberts, A., Young, H., Kebede, G., Leaning, J. (2003) *Risk and vulnerability in Ethiopia: learning from the past, responding to the present, preparing for the future.* Boston: Feinstein International Famine Centre.

Leach, M., Bloom, G., Ely, A., Nightingale, P., Scoones, I., Shah, E. and Smith, A. (2007) 'Understanding governance: pathways to sustainability', STEPS Working Paper 2, STEPS Centre. Brighton: Institute of Development Studies.

Leach, M., Mearns, R. and Scoones, I. (1999) 'Environmental entitlements: dynamics and institutions in community-based natural resource management', *World Development,* 27(2), pp.225-47.

Laestadius, L.I., Neff, R.A., Barry, C.L. and Frattaroli, S. (2014) '"We don't tell people what to do'': an examination of the factors influencing NGO decisions to campaign for reduced meat consumption in light of climate change', *Global Environmental Change,* 29, pp.32-40.

Legesse, B. (2006) 'Risk perceptions, risk minimizing and coping strategies of smallholder farmers in the Eastern Highlands of Ethiopia', in Havinevik, K., Negash, T., and Beyene, A. (eds.) *Of global concern: rural livelihood dynamics and natural resource governance*. Sida Studies No. 16.

Leichenko, R., O'Brien, K. (2008) Environmental change and globalization: double exposures. Oxford: Oxford University Press.

Lempert, R.J., Schlesinger, M.E., Bankes, S.C. and Andronova, N.G. (2000) 'The impacts of climate variability on near-term policy choices and the value of information', *Climatic Change* 45, 129-161.

Leonard, S., Parsons, M. Olawsky, K. and Kofod, F. (2013) 'The role of culture and traditional knowledge in climate change adaptation: Insights from East Kimberley, Australia', *Global Environmental Change,* 23(3), pp.623-632

Lin, B., B. (2007) 'Agroforestry management as adaptive strategy against potential microclimate extremes in coffee agriculture', *Agricultural and Forest Meteorology* 144, pp.85-94.

Lipton, M. (2005) 'The family farm in a globalizing world: the role of crop science in alleviating poverty', IFPRI, 2020 Discussion Paper 40. [Online]. Available at: http://www.ifpri.org/sites/default/files/publications/vp40.pdf (Accessed: 27 February 2014).

Litre, G., Nasuti, S., Garcez, C.A.G., and Others (2014) 'From rainforests to drylands: comparing family farmers' perceptions of climate change in three Brazilian Biomes', in Filho *et al.* (eds.), *International perspectives on climate change: Latin America and beyond.* Switzerland: Springer International Publishing. pp.165-185.

Lundahl, M. and Ndulu, B.J. (eds.) (1996) *New directions in development economics: growth, environmental concerns and government in the 1990s*. Routledge: London.

Mack, N., Woodsong, C., MacQueen, K.M, Guest, G. and Namey, E. (2005) *Qualitative methods: a data collector's field guide.* North Carolina: Family Health International.

Maddison, D. (2007) 'The perception of an adaptation to climate change in Africa', Policy Research Working Paper, The World Bank, Development Research Group, Sustainable Rural and Urban Development Team, Pretoria, South Africa.

Mangham-Jefferies, L., Mathewos, B., Russell, J., and Bekele, A. (2014) 'How do health extension workers in Ethiopia allocate their time?' *Human Resources for Health,* pp.12(61).

Maslin, M. (2014) 'How does the IPCC know climate change is happening?' The Conversation. [Online] Available at: https://theconversation.com/how-does-the-ipcc-know-climate-change-is-happening-33704 (Accessed: 3 November 2014).

Mavunganidze, Z., Madakadze, I.C., Munyaradzi Junior Mutenje, M.J., and Nyamangara, J. (2013) 'Factors affecting the choice of conservation agriculture practices adopted by smallholder cotton farmers in Zimbabwe', *African Journal of Agricultural Research*, 8(17), pp.1641-1649.

McCaffrey, M. (2012) *Climate literacy handbook.* [Online] Available at: http://www.eoearth.org/view/article/151183 (Accessed: 15 November 2014).

McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. and White, K.S. (eds.) (2001) *Climate change 2001: Impacts, adaptation and vulnerability.* Cambridge, UK: Cambridge University Press.

McCarthy, S. (2007) 'Linking smallholder producer groups to higher value markets 'Ethiopia's coffee cooperatives: a case study', Presentation to The World Bank Workshop on Rural Institutions. February 12.

Mckee, J. (2007) 'Ethiopia country environmental profile,' EC Delegation, Addis Ababa. [Online]. http://ec.europa.eu/development/icenter/repository/Ethiopia-ENVIRONMENTAL-PROFILE-08-2007_en.pdf (Accessed: 13 March 2014).

McSweeney, C., New, M., and Lizcano, G. (2010) *UNDP climate change country profiles, Ethiopia.* UNDP, School of Geography and Environment, University of Oxford and Tyndall Centre for Climate Change Research. [Online] Available at: http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/UNDP_reports/Ethiopia/Ethiopia.lowres.report.pdf (Accessed: 13 January 2014).

Meadows, D.H., Meadows, D.L., Randers, J. and Behrens, W.W. (1972) *The limits to growth*, First edn. New York: Universe Books.

Mekonnen, A., Abebe Damte, A. and Bekele, R. D. (2015) 'The impact of natural resource scarcity on agriculture in Ethiopia', Environment for Development Discussion Paper Series, June. EfD DP 15-13.
Melaku, E., Ewnetu, Z. Teketay, D. (2014) 'Non-timber forest products and household incomes in Bonga forest area, southwestern Ethiopia', *Journal of Forestry Research,* 25(1), pp.215–223.

Mengistu, D. K. (2011) 'Farmers' perception and knowledge of climate change and their coping strategies to the related hazards: case study from Adiha, central Tigray, *Ethiopia Agricultural Sciences,* (2)2, pp.138-145.

Mimura, N. (2010) 'Scope and roles of adaptation to climate change', in Sumi, A., Fukushi, K. and Hiramatsu, A. (eds.) *Adaptation and mitigation strategies for climate change.* Tokyo: Springer.

Mitchell, J.F.B., Lowe, J., Wood, R.W. and Vellinga, M. (2006) 'Extreme events due to human-induced climate change', *Philosophical Transactions Royal Society A,* 364, pp.2117-2133.

Mitchell, T. D. and Hulme, M. (1999) 'Predicting regional climate change: living with uncertainty', *Progress in Physical Geography* 23, pp.57-78.

MoARD (2006) *Productive safety net programme: programme implementation manual,* Revised. Addis Ababa: Ministry of Agriculture and Rural Development.

Moghariya, D., and Smardon, R. (2012) 'Rural perspectives of climate change: a study from Saurastra and Kutch of Western India', *Public Understanding of Science* doi:10.1177/0963662512465698

MoH (Ministry of Health) (2010) National strategic plan for malaria prevention control and elimination in Ethiopia 2011-2015. Addis Ababa: Ministry of Health.

Morrissey, J. (2011) Mobility in context: exploring the impact of environmental stress on mobility decisions in Northern Ethiopia. Unpublished PhD Thesis. Oxford University.

Morton, J. (2007) 'The impact of climate change on smallholder and subsistence agriculture', *PNAS*, 104(50), pp.19680-19685. [Online]. Available at: http://www.pnas.org/content/104/50/19680.full.pdf (Accessed: 23 May 2011).

Mortreux, C. and Barnett, J. (2009) 'Climate change, migration and adaptation in Funafuti, Tuvalu', *Global Environmental Change,* 19, pp.105-112

Moser, S. and Boykoff, M. (2013) 'Climate change and adaptation success: the scope of the challenge' in Moser, S. and Boykoff, M. (2013) *Successful adaptation to climate change: linking science and policy in a rapidly changing world*. London: Routledge.

Moser, S.C. and Ekstrom, J. A. (2010) 'A framework to diagnose barriers to climate change adaptation', *PNAS*, 107(51), pp.22026-22031

MoFED (Ministry of Finance and Economic Development) (2012) *Ethiopia's progress towards eradicating poverty: an interim report on poverty analysis study.* Addis Ababa: MoFED.

MoFED (2006) Ethiopia: building on progress - a plan for accelerated and sustained development to end poverty (PASDEP) (2005/06-2009/10). Addis Ababa.

Mubaya, C. P. (2010) Farmer strategies towards climate variability and change in Zimbabwe and Zambia. Unpublished PhD Thesis. University of the Free State, Bloemfontein.

Mubaya, C., Njuki, J., Mutsvangwa, E., Mugabe, F. and 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, pp.9-17.

Munang, R. and Nkem, J. N. (2011) 'Using small-scale adaptation actions to address the food crisis in the Horn of Africa: Going beyond food aid and cash transfers', *Sustainability*, 3, pp.1510-1516.

Munga, S., Minakawa, N., Zhou, G., Mushinzimana, E., Barrack, O.O.J., Githeko, A.K. and Yan, G. (2006) 'Association between land cover and habitat productivity of malaria vectors in western Kenyan highlands', *American Journal of Tropical Medicine and Hygiene*, 74, pp.69-75.

Negash, A. and Niehof, A. (2004) 'The significance of enset culture and biodiversity for rural household food and livelihood security in southwestern Ethiopia', *Agriculture and Human Values,* 21(1), pp.61-71

Nelson, D. R., Adger, W. N. and Brown, K. (2007) 'Adaptation to environmental change: contributions of a resilience framework', *The Annual Review of Environment and Resources*, 32, pp.395-419.

Niehof, A. (2004) 'The significance of diversification for rural livelihood systems', *Food Policy,* 29, pp.321-338.

Nielsen. J. Ø. and D'haen, S.A.L. (2014) 'Asking about climate change: reflections on methodology in qualitative climate change research published in Global Environmental Change since 2000', *Global Environmental Change,* 24, pp.402-409.

NMA (National Metrological Agency) (2007) *Climate change national adaptation programme of action (NAPA) of Ethiopia*. Ministry of Water Resources and National Meteorological Agency. Addis Ababa: Federal Democratic Republic of Ethiopia.

Nordhaus, W. (2007) 'The challenge of global warming: economic models and environmental policy', New Haven. [Online]. Available at: http://nordhaus.econ. yale.edu/dice_mss_072407_all.pdf (Accessed: 30 August 2011).

North, D. (1990) *Institutions, institutional change and economic performance*. Cambridge: Cambridge University Press.

NREPA (Natural Resources and Environmental Protection Agency) (2012) SNNPR's climate change adaptation plan – Draft Document [Amharic] Hawassa: SNNPR, NREPA.

Nussbaum, M. (2011) *Creating capabilities: the human development approach*. Cambridge: Harvard University Press.

Nyong, A. (2009) 'Climate change impacts in the developing world: implications for sustainable development', in Brainard, L., Jones A, Purvis, N. (eds.) *Climate change and global poverty: a billion lives in the balance?* Washington, D.C.: Brookings Institution Press, p.43-64.

Nyong, A. and Niang-Diop, I. (2006) 'Impacts of climate change in the Tropics: the African Experience', in Schellnhuber, H.J., Cramer, W., Nakicenovic, N., Wigley, T., Yohe, G. (2006) *Avoiding dangerous climate change*. Cambridge: Cambridege University Press.

O'Brien, K. Eriksen, S., Schjolden, A. and Nygaard, L. (2004a) 'What's in a word? Conflicting interpretations of vulnerability in climate change research', Center for International Climate and Environmental Research Working Paper. Oslo.

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H. (2004b) 'Mapping vulnerability to multiple stressors: climate change and globalization in India', *Global Environmental Change,* 14(4), pp.303-313.

OECD (Organisation for Economic Co-operation and Development) (2006) 'Putting climate change adaptation in the development mainstream', *Policy Brief,* March.

OECD (2003) *Poverty and climate change: reducing the vulnerability of the poor through adaptation.* [Online] Available at: http://www.oecd.org/environment/cc/developmentandclimatechange.htm (Accessed: 1 September 2014).

OECD (2001) *Adoption of technologies for sustainable farming systems,* Wageningen workshop proceedings. Paris: OECD

OPHI (Oxford Poverty and Human Development Initiative), (2014) OPHI Country Briefing 2014: Ethiopia. [Online] Available at: http://www.ophi.org.uk/multidimensional-poverty-index/mpi-2014/mpi-country-briefings/ (Accessed: 29 July 2014).

O'Neill, M. (2013) The NVivo toolkit: how to apply NVivo in your PhD for research and publishing success.[Online] Available at: http://blog.qsrinternational.com/how-a-phd-student-developed-her-own-nvivo-toolkit/

Osore, A. and Moges, A. (2014) 'Extent of gully erosion and farmer's perception of soil erosion in Alalicha watershed, Southern Ethiopia', *Journal of Environment and Earth Science,* 4(15), pp.74-81. [Online] Available at: http://www.iiste.org/Journals/index.php/JEES/index (Accessed: 7 September 2014).

Ostrom, E., Burger, J., Field, C. B., Norgaard, R. B., & Policansky, D. (1999) 'Revisiting the commons: local lessons, global challenges,' *Science,* 284(5412), 278-282.

Ostrom, E. (1990) *Governing the commons: the evolution of institutions for collective action.* Cambridge: Cambridge University Press.

Pelling, M. (2011) *Adaptation to climate change: from resilience to transformation*. London: Routledge.

Petheram, L., Campbell, B.M., High, C. and Stacey, N. (2010) ' "Strange changes": indigenous perspectives of climate change and adaptation in NE Arnhem Land (Australia)', *Global Environmental Change, 20,* pp.681-692.

Pettit, J. (2004) 'Climate Justice: a new social movement for atmospheric rights', *IDS Bulletin,* (35) 3, pp.102-106.

Pielke, R., Prins, G., Rayner, S., Sarewitz, D. (2007) 'Climate change 2007: lifting the taboo on adaptation', *Nature*, 445, pp.597-598.

Pouliotte, J., Smit. B. and Westerhoff, L. (2009) 'Adaptation and development: livelihoods and climate change in Subarnabad, Bangladesh', *Climate and Development,* 1, pp.31-46.

Pound, B. and Jonfa, E. (2005) 'Soil fertility practices in Wolaita Zone, southern Ethiopia: learning from farmers', *Policy and Research Series 2*, FARM Africa.

Quinn, C. H., Ziervogel, G., Taylor, A., Takama, T. and Thomalla, F. (2011) 'Coping with multiple stresses in rural South Africa', *Ecology and Society,* 16(3): 2. http://dx.doi.org/10.5751/ES-04216-160302

Rahmato, D. (1988) 'Peasant survival strategies', *Disasters*, 12(4), pp.326-44.

Rahmato, D. (1987) Famine and survival strategies: a case study from northeast Ethiopia, Food and Famine Monographs No. 1, Addis Ababa: Institute of Development Research.

Regassa, N and Stoecker, B. (2011) 'Household food insecurity and hunger among households in Sidama district, southern Ethiopia', *Public Health Nutrition,* 15(7), pp.1276-83.

Reid, P., and Vogel, C. (2006) 'Living and responding to multiple stressors in South Africa: glimpses from KwaZulu-Natal', *Global Environmental Change*, *16,* pp.195-206.

Robbins, M. (2011) *Crops and carbon: paying farmers to combat climate change*. London: Earthscan.

Roncoli, C., Ingram, K., and Kirshen, P. (2002) 'Reading the rains: local knowledge and rainfall forecasting among farmers of Burkina Faso', *Society and Natural Resources*, 15, pp.411-430.

Rosegrant, M. W., Ewing, M., Yohe, G., Burton, I., Huq, S. and Valmonte-Santos, R. (2008) 'Climate change and agriculture: threats and opportunities', GTZ. [Online]

Available at: http://ccsl.iccip.net/gtz_climatechange-agriculture.pdf (Accessed: 7 June 2014).

Rosenzweig, C., Hillel, D. (1995) 'Potential impacts of climate change on agriculture and world food supply', *Consequences,* 1(2), pp.23-32.

Ruben, R. and Heras, J. (2012) 'Social capital, governance and performance of Ethiopian coffee cooperatives', *Annals of Public and Cooperative Economics* 83(4), pp.463-484.

Rudiak-Gould, P. (2012) 'Promiscuous corroboration and climate change translation: a case Study from the Marshall Islands. *Global Environmental Change*, 22(1), pp.46-54.

Sachs, W. (2007) 'Global challenges: climate chaos and the future of development', *IDS Bulletin,* 38(2), pp.36-39.

Salami, A., Kamara A. B. and Brixiova, Z. (2010) 'Smallholder agriculture in East Africa: trends, constraints and opportunities.' African Development Bank. Working Paper No. 105

Sanga, G. J., Moshi, A. B. and Hella, J. P. (2013) 'Small scale farmers' adaptation to climate change effects in Pangani River Basin and Pemba: challenges and opportunities,' *International Journal of Modern Social Sciences, 2*(3), pp.169-194.

Scalet, S. and Schmidtz, D. (2009) 'Famine, poverty, and property rights,' in Morris, C.W. (ed.) *Amartya Sen*. Cambridge: Cambridge University Press, pp.170-190.

Scheffran, J. and Battaglini, A. (2010) 'Climate and conflicts: the security risks of global warming', *Regional Environmental Change*, 1, pp.13-13.

Scheyvens, R. and Storey, D. (2003) 'Introduction', in Scheyvens, R. and Storey, D. (eds), *Development fieldwork: a practical guide.* London: Sage Publications, pp.1-14.

Schindler, K. (2009) 'Credit for what? Informal credit as a coping strategy of market women in northern Ghana. Revised Version', German Institute for Economic Research, Discussion paper, 715.

Schipper, E.L.F. (2007) 'Climate change adaptation and development: exploring the linkages', Tyndall Centre Working Paper No. 107, July.

Schipper, E.L.F. (2004) Exploring adaptation to climate change: a development perspective*.* Unpublished PhD Thesis. University of East Anglia.

Scoones, I. (2009) 'Livelihoods perspectives and rural development', *Journal of Peasant Studies,* 36(1), pp.71-196.

Scoones, I. (1998) 'Sustainable rural livelihoods: a framework for analysis', IDS Working Paper, 72, Brighton: Institute of Development Studies.

Seers, D. (1969) 'The meaning of development', *International Development Review,* 11, pp.2-6.

Seers, D. (1972) 'What are we trying to measure?' *Journal of Development Studies*, 8 (3), pp.21-36.

Seers, D. (1979) 'The meaning of development, with a postscript', in Seers, D. Nafziger, E.W., O'Brien, D.C. and Bernstein, H. (eds.) *Development theory: four critical studies.* London: Frank Cass.

Sen, A. (1999) *Development as freedom.* Oxford: Oxford University Press.

Sen, A. (1989) 'Development as capability expansion' *Journal of Development Planning*, 19, pp.41-58.

Sen, A. (1981) *Poverty and famines: an essay on entitlement and deprivation*. Oxford: Oxford University Press.

Sena, S.D., Deressa, W.A. and Ali, A.A. (2013) 'Predictors of long-lasting insecticide treated bed net ownership and utilization: evidence from community based cross-sectional comparative study, Southwest Ethiopia', *Malaria Journal,* 12(406), pp.1-9.

Senbeta, A. F. (2009) *Climate change impact on livelihood, vulnerability and coping mechanisms: a case study of West-Arsi zone, Ethiopia.* Unpublished MSc Dissertation, Lund University.

Shalizi, Z. and Lecocq, F. (2009) 'To mitigate or to adapt: Is that the question? Observations on an appropriate response to the climate change challenge to development strategies', *The World Bank Research Observer.* Oxford: Oxford University Press.

Shiferaw, B. A., Okello, J. and Reddy, R. V. (2009) 'Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices', *Environment, Development and Sustainability*, (11)3, pp.601-619.

Siegel, P. and Alwang, J. (1999) 'An asset-based approach to social risk management: a conceptual framework, social protection', Discussion Papers 21324. Washington, D.C.: The World Bank.

Seleshi, Y. and Zanke, U. (2004) 'Recent changes in rainfall and rainy days in Ethiopia' *International Journal of Climatology*, 24, pp. 973–983.

Siraj, A. S., Santos-Vega, M., Bouma, M. J., Yadeta, D., Ruiz Carrascal, D. and Pascual. M. (2014) 'Altitudinal changes in malaria incidence in highlands of Ethiopia and Colombia', *Science,* 343(6175), pp.1154-1158.

Smit, B. and Wandel, J. (2006) 'Adaptation, adaptive capacity and vulnerability', *Global Environmental Change* 16, pp.282-292

Smit, B. and Pilifosova, O. (2001) Adaptation to climate change in the context of sustainable development and equity, In McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. and White, K.S. (eds.) *Climate change 2001: impacts, adaptation, and vulnerability, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge University Press, Cambridge.

Smit, B., Burton, B., Klein, R.J.T. and Wandel, J. (2000) 'An anatomy of adaptation to climate change and variability', *Climatic Change,* 45, pp.223-251.

Smit, B., Burton, I., Klein, R.J.T. and Street, R. (1999) 'The science of adaptation: a framework for assessment', *Mitigation and Adaptation Strategies for Global Change* 4, pp: 199-213.

Smit, B., McNabb, D. and Smithers, J. (1996) 'Agricultural adaptation to climatic variation', *Climatic Change,* 33, pp.7-29.

Solesbury, W. (2003) 'Sustainable livelihoods: a case study of the evolution of DFID policy', Working Paper 217. Overseas Development Institute, June.

Stone, D. (2014) 'Fungus, climate change threatening big Part of global coffee supply' *National Geographic.* MAY 31. [Online] Available at: http://news.nationalgeographic.com/news/2014/05/140531-coffee-rust-columbia-brazil-cost-problems/ (Accessed: 17 July 2014).

Streeten, P. (1984) 'Basic needs: some unsettled questions', *World Development,* (12)9, pp.973-980.

Steinbruner, J. D., Stern, P.C. and Husbands, J.L. (eds.) (2013) *Climate and social stress: implications for security analysis.* Washington, DC: National Academy of Sciences.

Stern, N. (2009) *The global deal: climate change and the creation of a new era of progress and prosperity.* Now York: Public Affairs.

Stern, N. (2007) *The economics of climate change: the Stern review*. Cambridge: Cambridge University Press.

Stewart, D.W., Shamdasani, P.N. and Rook, D.W. (2006) *Focus groups: theory and practice,* 2nd edn. Newbury Park, CA: Sage

Stiglitz, J.E., 1991, 'The invisible hand and modern Welfare Economics', Working Paper No. 3641 Cambridge, MA: National Bureau of Economic Research.

Strauss, A. and Corbin, J. (1990) *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage.

Strauss, A. and Corbin, J. (1994) 'Grounded theory methodology', in Denzin, N.K. and Lincoln, Y.S. (eds.) *Handbook of qualitative research*. Thousand Oaks, CA: Sage, pp.273-285.

Streck, C. and Terhalle, M. (2013) 'The changing geopolitics of climate change', *Climate Policy*, (13)5, pp.533-537.

Sultana, F. (2007) 'Reflexivity, positionality and participatory ethics: negotiating fieldwork dilemmas in international research', *ACME: An International E-Journal for Critical Geographies*, 6 (3), pp.374-385.

Sumi, A., Fukushi, K. and Hiramatsu, A. (eds.) (2010) *Adaptation and mitigation strategies for climate change.* Tokyo: Springer.

Sumner, A. and Tiwari, M. (2009) *After 2015: international development policy at a crossroads*. London: Palgrave, Macmillan.

Tadele, D. Teketay, D. (2014) 'Growth and yield of two grain crops on sites former covered with eucalypt plantations in Koga Watershed, northwestern Ethiopia', *Journal of Forestry Research,* 25(4) pp.935–940.

Tanner, T. and Mitchell, T. (2008) 'Entrenchment or enhancement: could climate change adaptation help to reduce chronic poverty?' *IDS Bulletin*, 39(4) September.

Tanner, T. and Horn-Phathanothai, L. (2014) *Climate change and development.* Abingdon: Routledge.

Tanner, T., Lockwood, M. and Seballos, F. (2012) *Learning to tackle climate change*. The Learning Hub, Brighton: Institute of Development Studies.

Tanzler, D., Mohns, T. and Ziegenhagen, K. (2013) *Adaptation to climate change for peace and stability.* Berlin: German Federal Environment Agency.

Tauli-Corpuz, V., de Chavez, R., Eleonor Baldo-Soriano, E. Helen Magata, H., CGolocan, C., Bugtong, M.V., Enkiwe-Abayao, L. and Cariño, J. (2009) *Guide on Climate Change & Indigenous Peoples. Second Edition*. Baguio City: Tebtebba Foundation.

Taylor, A.L., Dessai, S., de Bruin, W.B. (2014) 'Public perception of climate risk and adaptation in the UK: a review of the literature', *Climate Risk Management*, 4(5), pp.1-16.

Teshome, A. (2006) 'Agriculture, growth and poverty reduction in Ethiopia: policy processes around the new PRSP (PASDEP)', www.future-agricultures.org

Teshome B.W. and Záhořík, J. (2008) 'Federalism in Africa: the case of ethnic-based federalism in Ethiopia', *International Journal of Human Sciences*, 5(2). [Online]. Available at: http://www.j-humansciences.com/ojs/index.php/IJHS/article/view/506

Tiwari, M. (2013) 'What works on the ground to end poverty?' in OECD, *Development co-operation report 2013: ending poverty,* OECD Publishing. pp.95-102.

Todaro, M. P., Smith, S.C. (2006) *Economic development.* (9th edn.) Harow: Pearson, Addison Wesley.

Toman, M. A. (ed.) (2001) *Climate change economics and policy: an RFF anthology.* Washington, D.C.: Resources for the Future.

Tsegaye, A. (2007) 'Effects of repetitive transplanting and leaf pruning on growth and dry matter partitioning of Enset (Ensete ventricosum (Welw.) Cheesman', *Journal of Agronomy*, 6, pp.45-52.

Turner II, B.L., Kasperson, R.E., Matson, P.A., *et al. (*2003) A framework for vulnerability analysis in sustainability science. Proceedings of the National Academy of Sciences of the United States of America 100, pp.8074-8079.

Turton, D. (2006) 'Introduction', in Turton, D. (ed.) *Ethnic federalism: the Ethiopian experience in comparative perspective.* Addis Ababa: Addis Ababa University Press, pp.1-31.

UN (United Nations) (2013) *Statistics and indicators for the post-2015 development agenda.* New York: UN System Task Team on the Post- 2015 Development Agenda.

UNDP (2014) *Human development report 2014: sustaining human progress: reducing vulnerabilities and building resilience.* New York: UNDP.

UNDP (2012) *One Planet to share: sustaining human progress in a changing climate*. New Delhi: UNDP Asia-Pacific Regional Centre/ Routledge.

UNDP (2010) *Human development report 2010: The real wealth of nations: pathways to human development.* 20th Anniversary Edition. New York: Palgrave Macmillan.

UNDP (2007) *Human development report 2007/08. Fighting climate change: solidarity in a divided world.* Cambridge: United Nations Development Programme.

UNDP (2004) *Adaptation policy frameworks for climate change: developing strategies, policies and measures.* New York: Cambridge University Press.

UNFCCC (1992) *The United Nations framework convention on climate change*, A/AC.237/18, 9 May.

UNFCCC (2011) Decision 1/CP.16 The Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention, FCCC/CP/2010/7/Add.1, March. [Online] Available at: http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf#page=2

UNISDR (United Nations International Strategy for Disaster Reduction) (2009) UNISDR terminology on disaster risk reduction. Online: http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf (Accessed: 26 April 2014).

UNISDR (2005) Hyogo Framework for Action 2005-2015: Building the resilience of nations and communities to disasters, A/CONF. 206/6, World Conference on

Disasters Reduction, 18-20 January, Kobe, Hyogo, Japan. Online: http://www.unisdr.org/2005/wcdr/intergover/official-doc/L-docs/Hyogo-framework-for-action-english.pdf (Accessed: 12 May 2014).

USAID (2005) Sidama maize belt livelihood Zone (SMB), SNNPR, Ethiopia. SNNPR livelihood zone reports. [Online] Available at: http://pdf.usaid.gov/ pdf_docs/Pnadj866.pdf (Accessed: 29 April 2014).

van Vuuren, D. P., Isaac, M., Kundzewicz, Z. W., Arnell, N., Barker, T. Criqui, P., Berkhout, F., Hilderink, H., Hinkel, J., Hof, A., Kitous, A., Kram, T., Reinhard Mechler, R., Scrieciu, S. (2011) 'The use of scenarios as the basis for combined assessment of climate change mitigation and adaptation', *Global Environmental Change*, 21(2), pp.575-591.

Verhoeven, H. (2011) 'Climate change, conflict and development in Sudan: global Neo-Malthusian narratives and local power struggles', *Development and Change, 42*(3), pp.679-707.

Viste, E., Korecha, D., Sorteberg, A. (2013) 'Recent drought and precipitation tendencies in Ethiopia', *Theoretical and Applied Climatology*, (112)3-4, pp 535-551.

Wang-Helmreich, H., Sterk, W., Wehnert, T. and Arens, C. (2011) Current developments in pilot Nationally Appropriate Mitigation Actions of developing countries (NAMAs), Wuppertal Institute, August. [Online] Available at: http://www.jiko- bmu.de/files/basisinformationen/application/pdf/pp_namas_ wuppertal_institute.pdf

WCED (World Commission on Environment and Development) (1987) *Our common future.* Oxford: Oxford University Press.

Westhoek, H., Lesschen, J.P., Rood, T., Wagner, S., Marco, A.D., Murphy-Bokern, D., Leip, A., van Grinsven, H., Sutton, M., Oenema, O. (2014) 'Food choices, health and environment: effects of cutting Europe's meat and dairy intake', *Global Environmental Change*, 26, pp.196-205.

Wheeler, D. (2011) 'Quantifying vulnerability to climate change: implications for adaptation assistance', CGD Working Paper 240. Washington, D.C.: Centre for Global Development. Available at: http://www.cgdev.org/content/ publications/ detail/1424759 (Accessed: 18 August 2011).

WHO (World Health Organisation) (2013) 'Climate change and health', Fact sheet N°266. November. [Online] Available at: http://www.who.int/mediacentre/ factsheets/fs266/en/ (Accessed: 23 February 2014).

Wielgosz, B., Kato, E. and Ringler, C. (2014) 'Agroecology, household economics and malaria in Uganda: empirical correlations between agricultural and health outcomes', *Malaria Journal*, 13(251) [Online] Available at: http://www.malariajournal.com/content/13/1/251 (Accessed: 19 July 2014)

Wisner, B., Blaikie, P., Cannon, T. and Davis, I. (2004) *At risk: natural hazards, people's vulnerability and disasters* (2nd edn). New York: Routledge.

Woldemariam, M. (1984) *Rural vulnerability to famine in Ethiopia, 1958-1977*. New Dehli: Vikas Publication.

WMO (World Meteorological Organization) (2007) *The role of climatological normals in a changing climate.* Geneva: World Meteorological Organization.

Wood, S.A., Jina, S., Jain, M., Kristjanson, P., Ruth, S. and DeFries, R.S. (2014) 'Smallholder farmer cropping decisions related to climate variability across multiple regions', *Global Environmental Change*, 25, pp. 163-172.

Woolcock, M. and Narayan, D. (2000) 'Social capital: implications for development theory, research, and policy', *World Bank Research Observer,* 15(2), pp.225-249.

World Bank (2010a) *Natural hazards, UnNatural disasters: the economics of effective prevention.* Washington D.C.: The World Bank.

World Bank (2010b) *World development report 2010: development and climate change.* Washington, DC.: The World Bank.

World Bank (2009) 'Making development climate-resilient: a World Bank strategy for sub-Saharan Africa', Report No. 46947-AFR. Washington DC.: The World Bank.

World Bank (2006) *Managing water resources to maximise sustainable growth: a country water resources assistance strategy for Ethiopia.* World Bank, Washington, DC.

WFP (World Food Programme) (2013) 'Ethiopia: food security outlook update', Available online: http://reliefweb.int/sites/reliefweb.int/files/resources/Ethiopia%20Food%20Security%20Outlook%20Update%20May%202013.pdf (Accessed: 10 May 2014)

Whitmarsh, L. (2011) 'Scepticism and uncertainty about climate change: dimensions, determinants and change over time', *Global Environmental Change*, 21, pp.690-700.

WRI (2013) (World Resources Institute) 'The global food challenge explained in 18 graphics'. blog by Janet Ranganathan. December 03. http://www.wri.org/blog/global-food-challenge-explained-18-graphics [Online] (Accessed: 7 March 2014).

Wynne, B. (2010) 'Strange weather, again: climate science as political art', *Theory, Culture & Society* 27, 289-305.

Yamin, F., Rahman, A. and Huq, S. (2005) 'Vulnerability, adaptation and climate disasters: a conceptual overview', *IDS Bulletin*, 36(4), pp.1-14.

Yaro, J. A. (2002) 'The poor peasant: one label, different lives: the dynamics of rural livelihood strategies in the Gia-Kajelo community, Northern Ghana', *Norwegian Journal of Geography,* 56, pp.10-20.

Yin, R. (2003) *Case study research: design and methods.* London: Sage Publications

Yohe, G. and Tol, R.S.J. (2002) 'Indicators for social and economic coping capacity: moving toward a working definition of adaptive capacity,' *Global Environmental Change*, 12, pp.25-40.

Zaman, Tahir (2012) The noble sanctuary: interpreting Islamic traditions of asylum in the contemporary world. Unpublished PhD Thesis, University of East London.

Zenebe, G., Jesper S., Alemu, M. and Atlaw, A. (2011) 'Climate change and the Ethiopian economy. A Computable General Equilibrium Analysis', Environment for Development, Discussion Paper Series. Ethiopia.

Ziervogel, G. and Cartwright, A. (2010) 'The use of climate science in agricultural adaptation in Africa', in Fujikura, R. and Kawanishi, M. (eds.) *Climate change adaptation and international development: making development cooperation more effective.* London: Earthscan.

Seyoum Yunkura Hameso (PhD)

Assistant Professor, Department of Economics, College of Business and Economics, Hawassa University, P. O. Box: 05, Hawassa, Ethiopia
Email: hameso@gmail.com

Dr. Seyoum Yunkura Hameso is Assistant Professor of Economics, at the Department of Economics, College of Social Sciences, Hawassa University, Ethiopia. Formerly, he taught at the University of East London and University of West London, UK.
Highly skilled professional with many years of experience in research, teaching, publishing,planning, project management, and fund raising. Well versed in ICT applications for teaching and research with proven knowledge and skills of data gathering and critical analysis, problem solving, project management and networking.

RESEARCH INTEREST
Economic development, Climate change, Adaptation, Resilience, mitigation, sustainable development, smallholder farmers

Liberty Academic Books

ISBN 978-195509402-3

New York, US- 2021